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Sustainable Education and Sustainability in Education

Policy and Implementation Direction
in the Era of SDGs

Edited by
Gazi Mahabubul Alam

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Sustainable Education and Sustainability in Education: Policy and Implementation Direction in the Era of SDGs

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Guest Editor

Gazi Mahabubul Alam



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About the Editor

Gazi Mahabubul Alam

Professor Gazi Mahabubul Alam, PhD, FRSA, is an internationally renowned public policy analyst who specializes in higher education and skill development. He has worked in Malaysia, Bangladesh, the UK, Canada, China, and the USA, among other countries. He works for both the Institute of Higher Education and Partner for Development.

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His studies have been published in several journals and have garnered a significant number of citations.

Preface

While sustainability in education aims to provide a healthier nature and environment, sustainable education is thought to be the key to building a sustainable society. Conversely, education for sustainable development serves as a leading force in implementing the United Nations' (UN) Sustainable Development Goals (SDGs) agenda. In the guise of modernity, humanization, and technological advancement, the UN is perceived as the driving force behind Western interest.

The commodification era, which is based on capitalism and portrays a modern, technologically sophisticated society, may simply be a hypocrisy to forward the humanization objective. Aside from supporting SDGs, holistic studies that address sustainability in education and sustainable education have little to offer in this climate. Although this collection may in some ways advance the SDGs, it has also critically assessed and, to some extent, challenged the SDG agenda.

For the progression of theme, both qualitative and quantitative research are equally significant. Logics are the foundation of qualitative research, and their ultimate objective is to create mathematical science, which quantitative research would then use. Unfortunately, many researchers were obliged to do qualitative investigations due to their arithmetic phobia, which is weakening the fundamental logical underpinning of research. Despite their eventual failure to overcome this obstacle, quantitative studies are nevertheless being used in this situation, which is regrettable in a time when research is being commercialized and commodified.

This collection made an effort to publish both qualitative and quantitative studies in recognition of these inescapable and inevitable flaws explained earlier. The requirement for university ranking, which is also a byproduct of commodification, has put academics under a lot of strain these days due to "publishing disease". I therefore accept responsibility for any unanticipated flaws in this collection in my capacity as editor, but I would like to express my gratitude to the authors, reviewers and the editorial support team of *Sustainability* for their invaluable assistance along the way. Of particular note is Mr. Wohler Huang, assistant editor.

Gazi Mahabubul Alam

Guest Editor

Editorial

Sustainable Education, Sustainability in Education and Education for Sustainable Development: The Reconciliation of Variables and the Path of Education Research in an Era of Technologization

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1. Introduction

The editorial is part of a collection titled “Sustainable Education and Sustainability in Education: Policy and Implementation Direction in the Era of SDGs”. While the theme of this collection appears to be wide rather than very specific, it fundamentally focuses on the concept of “sustainable education”. The three concepts presented in this collection, namely “sustainable education”, “sustainability in education”, and “education for sustainable development” (ESD), might appear to be the same on the surface [1], but this assumption would be a misconception, in addition to being misleading [1]. Although they might have been grouped in the same zone in a contemporary context, they are distinct and specialized in nature and function [1].

To illustrate their distinctiveness, sustainable education refers to actions and functions that are associated with the development of an education system, institute, and educational content, enabling us to develop an advanced and humane society [1,2]. Sustainability in education refers to actions within the education system and the programs offered that support the development of a sustainable environment and atmosphere (nature)-friendly geography both within the campus and beyond [1,3,4]. Lastly, education for sustainable development refers to the undertakings planned and enacted by the education sector to ensure the execution of the sustainable development goals (SDGs), which are part of an arbitrational agenda and obligations set forth by the United Nations (UN), either for common global interests or the vested interests of the West—an unsettled debate [1,4,5].

With a 35% acceptance rate (65% rejection rate) for submissions, this collection comprises sixteen published papers, two of which are literature reviews and fourteen of which are papers produced through empirical studies conducted in different parts of the globe, covering several continents—although studies from Asia dominate. Of these publications, 31% investigated how sustainable and substantial societies can be formed with the use of education. Of these, some studies also argue that education in the modern day does not necessarily shape society but that it is rather social elitisms, social constellations of power and politics, and globalization that rule education. Such education formation is what accords certain people the privilege of benefitting from education without minimizing the social gaps that exist in many emerging economies.

While a very small percentage of studies investigated the role of education in national and global development, 55% investigated how different kinds of tools, technologies, techniques, innovations, and mental and psychological interventions can support educational outcomes. Most of these studies established a positive correlation between these factors



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(tools, technology, techniques, innovations, and mental and psychological interventions) and educational outcomes.

On the surface, these studies' findings may appear satisfactory; however, upon deeper consideration, concern arises because these tools, technologies, techniques, innovations, and mental and psychological interventions are the products of developed nations, whereas emerging economies' educational systems are the customers of said nations. Therefore, education in emerging economies becomes dependent on that of their developed counterparts.

In this climate, education in emerging economies does not reform the societies of these economies but results in them following a theory known as "dependency theory" [5]. Although the small number of studies that investigated the role of education on national and global development discovered a positive correlation, to our surprise none of the submissions investigated the competitive advantages gained by both developed and developing nations from education in the era of globalization, digitalization, and artificial intelligence.

In this regard, some studies [2,4,5] might be able to clarify some of the following basic research queries: Does education in the era of globalization, digitalization, and artificial intelligence promote "dependency theory", forcing emerging nations to place more reliance on their developed counterparts? Does education as a Western commodity to the East narrow the social gaps of emerging nations or expand them? Does education in emerging nations serve to construct their societies, or do the social constellations of power and privilege only help elites benefit from education? Further robust studies in this area would be able to provide answers to these questions and might be able to produce empirical results. However, said studies should ideally re-examine or take a new look at the variables and research paths present in order to establish the association among these. This is the fundamental aim of this editorial.

2. Knowledge, Innovation and Skills in Education: Variables and Paths

The concepts of knowledge, innovation, and skills lack clear definitions and distinct characteristics. In the absence of such definitions and characteristics, they are often treated as the same concepts [2,5]. Although they hold a reciprocally symbiotic relationship and are interdependent on each other, they are distinct from one another [2,5]. While knowledge explores discourse to develop a society, an innovation constitutes either a tangible or intangible product/concept presented in order to progress a society, and skills ensure proper usage of an innovation for social mobilization.

It is therefore knowledge that is the root of education, and it serves as an independent variable in the development of an association among these three concepts (knowledge, innovation, and skills—the fundamental composition of modern education), thereby creating interdependency (Figure 1). An independent society must have balanced development in these three domains to properly embody the concept of "multi-tasking". Having said this, a lack of development, particularly in the domain of knowledge, would inevitably force a society to follow "dependency theory", even if said society may have high levels of development in the domains of innovation and/or skills [2,5]. Initially, knowledge was the only domain considered to be an element of education; however, all three domains are now considered a part of modern education.

The history of education has not been firmly able to assert the genesis/root of education [5]. However, a system called "guru-shishya" (which might have linguistic differences in different regions) is deemed the root of education in many societies [2]. In this process, a sage or an innovative or a skilled individual known as a guru (Ustaz) was the source of education, who then disseminated it to his/her shishyas (disciples) with the aim of constructing a decent and "civilized" society [2].

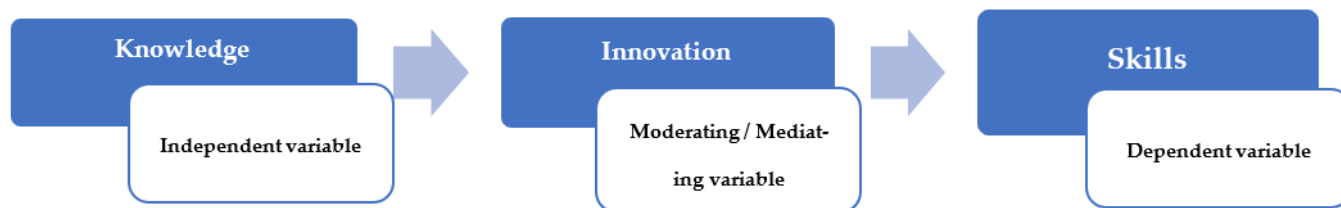


Figure 1. The association among knowledge, innovation, and skills (the composition of modern education). Source: own creation.

The success and popularity of such traditions in constructing societies resulted in formal and systematic education [2]. During this era, education was considered an independent variable, regulating the concepts known as knowledge/innovation/skills (the outcome of education), and such knowledge/innovation/skills was then treated as an either mediating or moderating variable for social construction [2,5]. Hence, social construction was treated as a dependent variable—a traditional and orthodox research path in education (Figure 2). This situation encouraged the framing of education as a public good [2,5,6].

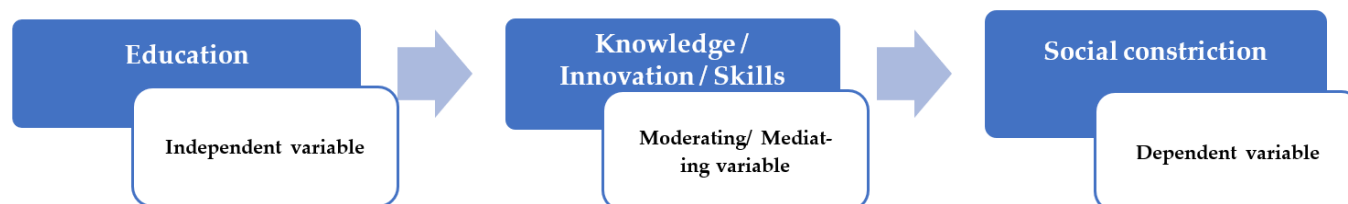


Figure 2. The association among education, knowledge/innovation/skills, and social construction. Source: own creation.

After the adoption of the formal education system on a massive scale, the benefits of education largely translated into private benefits [6]. The private benefits of education have maintained their privileged status by disproportionally limiting the public benefits of education [5,6]. This has disbalanced the relationship among education, knowledge, and society [4,5]. Under these circumstances, it is the societal position of an individual that determines his/her access to and performance in education in many societies, thereby primarily determining their knowledge [2,5].

Education in this contemporary globalized world cannot be viewed as a social good nor can it be viewed as a public or private good [7]. It has rather become an international “commodity” that channels global businesses supporting the views of “dependency theory” [2,5]. Under such conditions, education does not act as the “backbone” of national development for many societies but performs as a “cane” that promotes international development, thereby promoting social reform that follows an international agenda [5,8]. This has enabled the social constellation of power to control education and knowledge on a monumental scale [5,7,8]. Therefore, education does not shape knowledge in the present day, especially in emerging societies; rather, social and global constellations of power shape knowledge. As a result, the educational system often eagerly waits to test and validate such knowledge [5]; these have become the new norms in education.

Under this new paradigm, the variables and research paths in education—especially for an emerging society as a customer of education following “dependency theory”—should be re-examined in order to evaluate the associations present among society, knowledge, and education [2,5]. In this new research route, global and social constellations of power may be situated as the independent variables, whereas knowledge/innovation may act as either the moderating or mediating variable, and education could serve as the dependent

variable. This could constitute a paradigm transformation for research paths in education, especially for emerging nations (Figure 3).

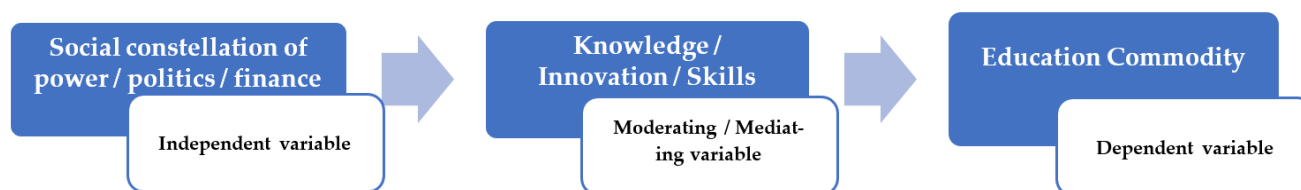


Figure 3. The association among social constellations, knowledge/innovation/skills, and education. Source: own creation.

A common saying is to marketize—education reforms and shapes a society through the knowledge, innovation, and skills’ revolution, and it then presents a balanced society [9]. Afterwards, said balanced society equally contributes to the generation of more knowledge, innovation, and skills, thereby developing a substantial education system [8]. By maintaining this cycle of coexistence, education, knowledge/innovation/skills, and society bear a reciprocally symbiotic relationship where interdependence can prevail [8,9]. This is true of a society that is the producer of globalized education, but the scenario of a society that consumes globalized education is different. Hence, the new research path shown in Figure 3 might be able to reveal a new means of settling the debate on the relationship between education and society in emerging nations.

Education: Educational Support—“Dependency Theory” and “Commodification”

Within an educational system, the educational content also referred to as the curriculum is treated as the heart, while others, such as pedagogical science (student-centric learning, objective-based learning—OBE), teaching, classroom management, and learning aids (i.e., computers, online platforms, digitalization, and many macro and micro elements) are labeled educational support tools [8]. It is imperative to understand whether a decent system of education is the key to innovation, which enables the development of educational support, or whether educational support should be the key to a good educational system [6–9].

Given that the above-mentioned issue remains unsettled, we must ask the following question: should nature/the universe serve as the mother (root/foundation) of knowledge, while human intellect acts as the father of knowledge? (This tenet may vary depending on the nature of the program referenced—for instance, from applied sciences to the arts.) This approach to education content development was followed during its establishment [8] but is now completely ignored in many emerging societies [5].

Without devoting much attention to these basic and underpinning philosophies of education, many emerging societies import their educational content from their developed counterparts, in addition to educational support tools [6]. In this climate, the existence of a local educational institute does not play a significantly distinct role in removing the effect of “dependency theory” from an emerging nation, especially in comparison to the role Western or international institutes are allowed to play [5,8]. Thus, educational content in many emerging societies does not mitigate the adverse effect of “dependency theory” but rather amplifies it.

In the absence of their own educational content, many emerging societies fail to have their own innovative educational support tools, such as pedagogical science, teaching aids, classrooms, and learning aids (i.e., computers, online platforms, digitalization, and many more macro- and micro-elements). This forces many emerging societies to heavily rely on their developed counterparts [5,6,8]. Therefore, educational content and its supporting

elements have become very important global business commodities, of which developed countries have become exporters while emerging nations have become importers [8]. This is also known as “commodification in education” in the era of globalization [5].

This scenario has diverted the variables and research paths in educational settings, especially in emerging nations. In an ideal atmosphere (possibly the West), where education contributes to the development of its own content and support elements, education may act as an independent variable, while educational content and support elements may either be the moderating or mediating variables (Figure 4) used to construct a balanced society. However, this may not be the case for an emerging society as the customer of educational content and educational support tools.

The privileged individual of an emerging society continually has access to the latest imported items. Once educational content and educational support elements become commodities—particularly imported items in emerging countries—the local elite gain unrestricted and unequal access to them. In this climate, education content and educational support elements in an emerging society do not serve to narrow the social gap and construct society. Rather, they aggravate and contribute to social deconstruction, thus causing a new tenet to be produced.

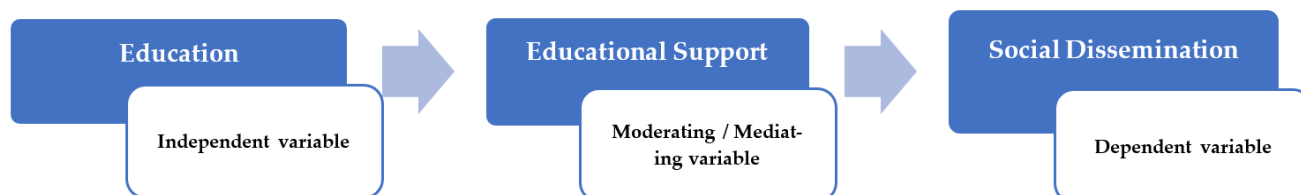


Figure 4. The association among education, educational support, and social dissemination. Source: own creation.

In studies that develop this new tenet, the social gap (social constellation) acts as an independent variable that navigates an individual’s access to educational content and support elements. Hence, access to educational content and elements serves as a moderating/mediating variable for an individual’s success (Figure 5). This research direction should ideally explore the relationship among social constellations, access to educational content and support elements, and individual gain—a new horizon known as “commodification in education” in the era of “capitalism”.

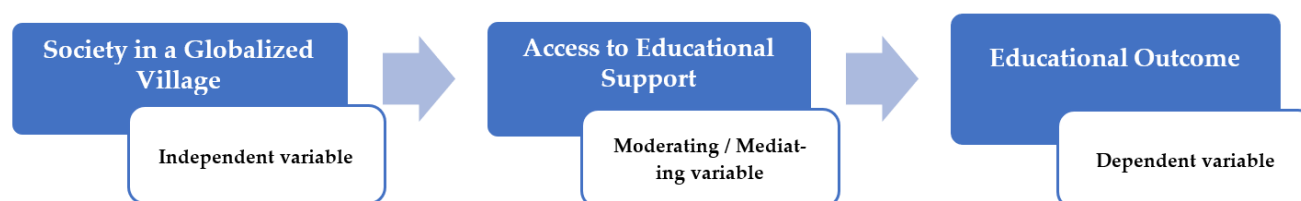


Figure 5. The association among globalization, educational support, and educational outcome. Source: own creation.

3. Sustainable Education: The Contribution of This SI and Beyond

Whether concerning ratification (GATS, COP28) or accession (MDGs, SDGs)—any form of global policy document presented by the United Nations has never been above criticism [2,9]. The UN is an organization that is fundamental in spreading the business of its principal sponsors (the West) by using ratification and accession as soft tools [8]. The UN has never made significant efforts to be free from this criticism. Keeping this view in mind, critics have argued that the SDGs are the latest sophisticated weapons of the UN to expand the new business of its sponsors via innovation, technology, and skills [5,6,8,9].

The term “sustainability” has become a popular buzz word after the introduction of the SDGs, and its focus in education has led to the utilization of at least three concepts, namely, sustainable education, education for sustainable development (ESD), and sustainability in education [6]. Adherence to any component of these concepts would inevitably bestow the adverse effect of “dependency theory” on emerging nations, but they do not have an alternative to consider [5–8].

Of the sixteen publications in this SI, ten contributions (Contributions 1–10) mainly covered the issue of sustainable education, while perspectives on ESD (Contributions 11–14) and sustainability in education (Contributions 15, 16) are covered by four and two different publications, respectively. Of ten publications that covered the sustainable education perspective, five papers have advocated using the latest teaching and learning aid kits to ensure sustainable education (Contributions 2–6).

An overarching investigation suggests that most emerging nations must rely on the innovation of their developed counterparts in order to acquire the latest teaching and learning aid kits. Four publications suggested that content reform is the key to enabling sustainable education. They, however, surprisingly suggested that content reform should be undertaken by considering what developed nations have done so far. These actions would act as a promoter of “dependency theory”, as argued in one of these contributions (Contribution 1). While sustainable education contributes to the development of “dependency theory”, ESD and sustainability in education act as principal agents of this [2,5].

Alam [2,5] argued that upon dismantling the originality and foundation of sustainability, sustainable development, hence referred to as sustainable education, could be a popular source of dialogue but would indeed remain far from reality in the era of “commodification” and “capitalism”. For example, privileged children who had benefitted from kindergarten, nursery care, or Montessori school held advantages with regard to their readiness for primary school, which created a gap among different clusters of children within the society studied. To remove said gap, underprivileged students were brought into the system (kindergarten, nursery, or Montessori school). This undoubtably did not narrow the gap between the different clusters of children due to the existence of different types and natures of educational entities and their facilities. However, it could be argued that this removed the sanctity of childhood—a key aspect of sustainable child development that is impossible to recover in the era of “capitalism” or through the “double-income” policy and workaholism—forcing us to consider an alternative path based on new norms and reality in order to innovate in the era of sustainable development.

Learned Lessons to Ensure Sustainable Education

There may be a reciprocal symbiotic relationship between sustainable education and a sustainable society. However, heavy reliance on “dependency theory” neither supports the creation of a sustainable society nor offers a sustainable education system. Numerous studies have been carried out to ensure the creation of a sustainable education system and, consequently, a sustainable society; nevertheless, these have instead contributed to the adverse effects of “dependency theory”. The philosophies and policies behind the educational systems of emerging nations are seen as the main determinants of developing dependency according to “dependency theory”, which then leads to many consequences that exacerbate various adverse effects.

These days, the priority of primary and junior secondary education is to allocate more focus to the supply of graduates for higher education without preparing students for participation in a decent civic society by ensuring their fair treatment as members of the nation’s school-age population. Moreover, the core business of senior secondary education is to ensure that an adequate amount of hard and semi-hard skills (focusing on the trade

and sector specializations of the nation) is provided to graduates (after reaching labor market age) so that they can be productive.

Unfortunately, senior secondary education is providing Western-driven science education to privileged children in order to create a more beneficial road to higher education for them, while underprivileged children are provided with access to the arts and social science programs that are internationally non-competitive. These underprivileged secondary graduates from the arts and social sciences programs drop out from the system without achieving much in terms of labor market gains. This situation, however, allows privileged graduates of the sciences to pursue their higher education in the arts and social sciences.

The expansion of higher education in many emerging nations does not follow a model that is proportionate for their economies as those that are designed for highly skilled, innovative, and intellectual jobs. Hence, the oversupply of graduates and a mismatch between higher education and the needs of the labor market have resulted in a situation whereby graduates remain unemployed. To resolve this crisis, a model applicable to the needs of the emerging nation must be introduced, and students must be provided with a variety of options in secondary education (in the sciences, arts, and social sciences). It is also important to ensure that the able students are also brought into arts and social science programs in higher education, not just the leftovers from science, to ensure that decent intellectuals are produced. Intellectuals are the source of knowledge that navigates innovation and skills.

4. Concluding Remarks

Education should guide society and individuals to succeed by following the right path. However, the success of individuals and society is dictating the education these days. Under this circumstance, a derailed “TickTocker” would not be guided by the education to construct the society, but the success of “TickTocker” would oblige the university to offer courses in “TickTocking”. Whatever the success is or whatever way the success comes should not be education; education should rather make a path, so the success should be a product of the right path to construct nature and society—an underpinning either for sustainable education or for ESD or for sustainability in education.

Now is the time for new studies that consider the reconciliation of variables and paths, as outlined in this editorial. Studies should be conducted to tackle the forthcoming challenges of emerging nations in the era of capitalism, digitalization, and artificial intelligence. In order to face these challenges, publication should not be undertaken with a statistical aim or in order to meet KPIs. This editorial suggests that these are not the remedy.

Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions:

1. Alam, G.M. Has Secondary Science Education Become an Elite Product in Emerging Nations?—A Perspective of Sustainable Education in the Era of MDGs and SDGs. *Sustainability* **2023**, *15*, 1596. <https://doi.org/10.3390/su15021596>.
2. Wen, Y.; Chen, H.; Wei, X.; Li, K.; Liu, F.; Liu, X. Examining Predictors and Outcomes of Decent Work among Chinese Female Pre-Service Primary School Teachers. *Sustainability* **2023**, *15*, 730. <https://doi.org/10.3390/su15010730>.
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Article

Has Secondary Science Education Become an Elite Product in Emerging Nations?—A Perspective of Sustainable Education in the Era of MDGs and SDGs

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Abstract: Education is considered the single most important tool that supports the achievement of a nation's sustainable development. However, if a particular education program itself deprives students with a lower socioeconomic status (SES) to access it and subsequently restricts them from achieving a better performance, should such an education program be labelled as sustainable education, supporting the achievement of the SDGs (Sustainable Development Goals)? This question remains to be answered. Science education, which is also treated as an “international product”, is the most essential component in education required to ensure sustainable national development. Consequently, science education should be a “right-based education program” that every “capable student”, regardless of his/her SES, is able to obtain. This motive should ideally ensure the best practice mode of sustainable development in education. Keeping this view in mind, this research was conducted in an emerging nation, namely Bangladesh, to examine whether secondary science education has become an elite product and its consequential effect on sustainable education. A qualitative research method that adopts a descriptive analysis of secondary data was primarily used. The secondary data were collected from the public archive(s). Findings suggest that, mostly, students with a privileged SES can access science education programs. Moreover, these students perform well in major public examination(s). Primary data further collected by Focus Group Discussions (FGDs) summarise that science education is an international product. The following artificial perception has thus developed. To participate in such a program, a significant informal budget from parents' pockets is required in order to perform well. This is an obvious conflict with the spirit of sustainable education and SDGs. Hence, policy reform guidelines for decent practice are provided to resolve this misleading perception.

Keywords: sustainable education; SDGs; education and development; elitist view in education; socioeconomic status and education



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1. Introduction

One of the central agendas of the sustainable development of education suggests that education quality should be unified [1]. Ideally, the same quality education should be provided to all children regardless of their SES, race, gender, and religious faith [2]. The agenda further recommends that the availability of subjects and programs should ideally be controlled according to the needs of the country, where students' abilities, merits, competencies, and interests would serve as the basis for allocating subjects and programs to be studied [3]. Providing prejudice based on SES, race, and other factors in order to study a favourable subject or a program is not just labelled as a form of discrimination and disparity, but it is considered a graver threat to sustainable development in education [4]. Although the effect of several issues (such as private schools, private tuition, parental interventions, and favourable policies) on the substantiable development of education deserves research attention, the impact of elitism in science education is an intense issue [5].

The writing that follows explains why this issue should be a substantial research problem that is to be studied more.

Education is generally viewed as the most powerful weapon for national development, as argued by Alam et al. [6]. Following their arguments, education is often considered a public good. However, debates are ongoing regarding whether all forms of education should be a part of public goods [7]. An enormous consensus suggests that primary and secondary education provisions should be maintained as public goods, and the debate for tertiary education is generating heat [6,7]. Despite a consensus being made in favour of primary and secondary provisions to be public goods, many traditions, practices, and policies have prevailed, suggesting that the public good concept in education, both for primary and secondary provisions, is merely a theory that remains isolated from practice [8].

Primary education, known as universal education, covers some common subjects that all students should learn [7]. Streaming systems have also been identified as clustering education, an affair that often commences in the secondary provision [8]. Many countries follow a rigid clustering system including science, business, and the arts [8]. Students studying in the clustering system in many developing countries must consider one of the clusters from the three [8,9]. Science is considered a favourable cluster because students from the science cluster can always move to other clusters (for instance, to business or the arts) in order to pursue further studies [8,9]. Moreover, graduates from the science cluster can be employed for any job regardless of area of expertise [8,9].

On the other hand, students from the business and arts clusters should only be able to pursue further studies in their own cluster, and subsequently, they can only be employed in one specific area [8,9]. Therefore, secondary science education in many developing countries is a “hot-cake” compared to its business and arts counterparts that may bring fortune because, as a doctor, scientist, or engineer, an individual can also occupy the highest position of public administration that serves the interest of public policy or philosophy [8,9]. Studies have been conducted and have found that this unsustainable and unsubstantial development of education has created a greater level of both vertical and horizontal mismatch, forcing wide misuse of public funds [8–10]. However, no significant steps have been taken to resolve this issue, especially in developing nations. Hence, one largely accepted proposition may suggest that, because elites are mainly studying science programs in emerging nations, this hinders the sustainable development of education, especially science education in the secondary provision [11]. This uneven development does not support all students equally regardless of their SES [12,13].

Science education requires a higher budget compared to its business and arts counterparts [11]. Therefore, misuse and mismanagement in science education are more endangering compared to its other counterparts, though no misuse and mismanagement in education should be tolerated by any means [11,12]. Within all types of education, science education is considered the most powerful tool for sustainable development, as it accelerates both the national economy and individuals’ prosperity [11]. Hence, if students with privileged SESs are able to succeed by studying science, and if students with lower SESs are deprived in the name of tradition, practice, or policy, this hampers the sustainable development of education in the era of SDGs, which is the core problem of this study [11–13]. After identifying the research problem, the existing gap in the literature is mapped so that the scope of this paper can be explored before determining the research objective and questions.

Research Gap and Scope: Objective and Questions

STEM (science, technology, engineering, and mathematics) is an important field and has been widely studied in the last three decades [14], and it is a broader term used to group several disciplines. Hence, the term is more applicable to tertiary education [14]. The science cluster of the secondary provision in many countries also represents STEM [14]. Thus, the term secondary science education is used in this paper. Studies in connection to STEM were initiated in the mid-1900s [14]. Since then, several movements have been made to transform attention and focus [14].

Most studies conducted since the mid-1900s to early 2000s in STEM for the secondary provision were devoted to discovering substantial courses and curricula so that competent graduates are produced who are able to undertake the challenges involved in higher education [14,15]. The pedagogical affairs and instructional technology of STEM received much attention starting in the early 2000s. Soon, the STEM community also realised that a significant portion of students had dropped from the STEM provision [16]. Thus, some studies have recently focused on how to handle this drop-out issue [16]. According to [14–16], a few studies have also focused on discovering a mechanism of how to make these drop-out students ready for the work of world (especially semi-skilled provision). Lately, gender perspectives and geographical distributions have been considered within STEM studies [16]. However, studies should also be conducted to examine the SES of students studying the science cluster [14–16]; this comparative study is the first attempt to fill this gap, especially in developing countries of southern Asia, such as Bangladesh.

Having identified the research gap and scope, the aim, objectives, and research questions are outlined here. This research aims to discover the SES of the students who are studying secondary science education by comparing three groups, namely science, business, and the arts. Three objectives are presented to achieve the aim, as follows: to explore the SES statuses of students studying in the secondary provision to determine the statuses of students in the science cluster; to analyse the academic performance of students studying in the secondary provision in order to identify the performance of science cluster students; and to establish evidence for whether SES background influences access to and performance in secondary science education programs. By accomplishing these objectives, the following research questions can be answered with regard to the secondary provision:

- RQ 1. Does SES matter regarding access to science education?
- RQ 2. Does SES impact performance in science education?
- RQ 3. What is the impact of SES on science education?
- RQ 4. How can sustainable education be developed in the era of SDGs?

After the introductory section, a literature review is presented before the accuracy of the adopted research design is justified. As the paper progresses further, findings and discussions are reported before implication and concluding remarks of this study are noted.

2. Literature Review

This section firstly critically explains the concept of development before the relationship between development and education is identified. The literature review concludes by discussing the effect of developmental goals in education, especially from the perspectives of the MDGs (Millennium Development Goals) and SDGs.

2.1. Economic and Social Development—Human Needs Perspectives: Capitalist vs. Socialist

Discussion on national development commenced in the early 1950s. Since then, three schools of thoughts have been established, namely economic development, social development, and human needs perspectives [6,7]. Economic development refers to the income capacity of a particular country, which is measured by a number of indicators, such as GDP, GNP, and GNI [6,7]. Economists have heavily emphasised economic development in ensuring national prosperity [16–19]. Owing respect towards the growing popularity of this idea, most countries around the globe have started jumping into global economic competition since the late 1960s to achieve the targeted numbers for economic indicators in their respective policy documents [20].

To achieve the set targets/goals for economic development, some countries have heavily relied on innovation, technology, and capital-intensive goods [6]. Other countries have depended on the export of natural resources (to the countries mentioned prior), and others have had no choice but to rely on the export of labour-intensive goods or “body drain” to the above-mentioned countries [6,20]. The race of economic indicators might have provided both modernisation and commodification by producing a number game for developmental discourse, thereby developing a capitalist ideology [6]; however, it

has certainly failed to reduce the economic disparity amongst different nations, instead substantially widening the gap [6,19].

Ideally, such a global economic race should be considered global politics, exploiting natural and human resources in the interest of leading nations that are technologically and innovatively advanced, as argued by [6,19,20]. On the other hand, this race might have helped a small number of people from the other two country groups to be extra-ordinarily affluent overnight, which subsequently has also supported the growth of their national economic indicators at the cost of huge internal economic disparity within their countries [6]. Refs. [6,19] further argued that social development is an important prerequisite for economic development to be sustainably functional. Moreover, [21,22] noted that, without ensuring social development, the benefit of economic development is no longer effective.

Since the early 1980s, scholars have started heavily arguing in favour of social development [22–24]. A well-known academic, Mahabub Ul Haq, developed a mechanism known as the HDI (human development index) under the supervision of the United Nation to measure national development [6,23]. The HDI includes a number of indicators in addition to economic indicator(s) [6,23]. As claimed by [6,23,24], these additional indicators (such as health, political transparency, education, freedom of speech, etc.) represent the social development status of a particular country.

The measurement of national development via the HDI started receiving popularity in the 1990s, as it was highly advocated by the United Nation [6]. Since then, most countries have transformed their development plans and strategies in order to respond the achievement of the HDI [6]. The robust response towards the HDI made by UN signatories helped them to achieve their desired targets via a “number game” [6,18,23]. However, whether such achievement of targets via the “number game” ensures human needs perspectives is an unsettled debate [25]. Hence, human needs perspectives began as a new item in the concept of national development in the mid-1990s [26].

The concept of national development, its criteria, and its schemata was designed in the West [6,26]. International developmental thoughts developed in the West are implemented in Western countries by their respective governments [6]. The government of a Western country might choose one path/approach, namely the “capitalist” approach, the “socialist” approach, or a blend of the two, in order to respond to national development strategies [27,28]. However, regardless of which approach is considered in a Western country, human needs perspectives remain a central focus [28]. Therefore, the development strategy of a Western country might follow the “capitalist” path for an international audience, and a local audience may benefit from some policies that support “socialist” views [28,29].

Although the developmental strategies of Western countries are executed by their governments, countries in the East depend on the supervisory role played by development partners, especially the United Nations [30]. Hence, countries in the East lack the required competency and voice to explore a substantial development strategy and approach, forcing them to be reliant on the UN and developmental partners (World Bank, ADP, USAID, etc.). The UN and development partners are the “foot soldiers” of the West [31], precisely for sponsoring countries. Consequently, the developmental strategies and approaches that are considered in an Eastern country under the supervision of the UN are not distinct in nature for pursuing the substantial development of a particular country/region [32,33].

The UN often offers a “common prescription” for its signatories’ developmental strategies and approaches (labelled as developing/emerging) [33]. Currently, the UN’s prescription has moved from the MDGs to the SDGs [32,33]. Whether a common UN prescription helps signatories (labelled as developing/emerging) to achieve sustainable development is hard to determine [31–33]. Indeed, the conjoint development agenda of the UN has forced its signatories, known as developing countries (followers), to follow the dependency theory [28,34]. Here, to conclude the literature review, the impact of the MDGs and SDGs on the development of UN signatories is explored with a particular focus on education. The following examines the relationship between development and education.

2.2. Relationship between Development and Education

Studies conducted in the area of development and education primarily investigate the role of education on development [6]. Although almost all evidence supports that education greatly supports national development, very few studies [6,28,35] have claimed that education aggravates the adverse effect of the dependency theory in the name of enhancing national development. However, education is considered the most powerful tool for national development [6,35]. Is education itself an item for development agenda, or is it a tool for development? This is a discourse that has never been brought to light [6,35].

The previous discussion (Section 2.1) illuminates that development is an idealist concept [28,29]. This idealist concept has become an intangible good, which has also become an export item [32] that is diplomatically freighted to countries that are labelled as followers [32,33]. Under such a climate, it is important to study the relationship between development and education. However, this topic lacks attention because the role of education on national development experiences dominating focus [6,28]. The following does not communicate evidence from field research; rather, it is a critical discussion using the literature to logically map the relationship between development and education.

Without generating further debate, it is humbly acknowledged that education always supports both economic and social development, as well as human needs perspectives. Either a comparison between educated and non-educated counterparts or an evaluation of the conditions of pre- and post-education eras would surely assert that education supports the development of national and individual levels under any circumstance [6,28]. However, research covering investigations of the competitive advantages received from education by leading nations (developed country) and following nations (developing country) is yet to be popularised [6,28]. It is thus likely an important time to conduct such research, an appeal that is spotlighted by the following discussion.

Firstly, education, especially the tertiary and secondary provisions, often help learners accrue necessary skills and competencies that are needed for the work of world, as argued by [36,37], but this is, in fact, not factual for every situation [6]. However, even if the claim made by Bogviz et al. 2020 [36] and Buchanan et al. 2015 [37] is 100% factual, the skills and competencies delivered by Eastern institutes are borrowed from their Western counterparts, aggravating the adverse effect of the dependency theory [6,28]. Education in Eastern countries serves as an agent, not as an innovator or manufacturer [6,28]. Regarding education that is not capable of producing leaders and innovators but that may develop agents, would such a particular education be able to offset the adverse effect of the dependency theory? This is a question that is yet to be answered [6,28,32].

Secondly, education, in particular referencing the primary and secondary provisions, provides necessary attributes, skills, and competencies to pupils in order to boost social development [6]. Are these attributes, skills, and competencies related to social development the fundamental parts of theoretical learning? Or is this a practice that is driven by society and context? This issue often generates heated discourse [6,28]. Adopting attributes related to productive cultures, decent traditions, equality, equity, inequality, social justice, good governance, and political ideology cannot be injected using only a borrowed theory from the West [38]. Hence, education remains within the agenda of social development, where society and context need to shape education for self-motivated demands, not only using education to obtain degrees for personal gain [5]. Theory-driven learning on social development, which is isolated from contextual social norms and practices, may produce a small elite society without making many contributions to influence positive change in social development [23].

Finally, both public and private education consume formal and informal budgets [39]. Investment in education is large for a country, and it is often found that investment in education is significantly worthwhile [38]. Although it is urged that more investment in education is badly needed, it is further argued that the finance of imported education that develops dependency is utterly a bad investment [32,33]. Hence, it is also suggested that contextual innovation is important for the development of education in order to mitigate

the specific problem that a country faces without being heavily reliant on a common prescription made by the UN [6,40]. One prescription may help leader countries to export international development as an intangible product, where the education of emerging nations can be an agent without being an innovator or manufacturer [6]. The following explores the effect of international developmental goals (especially MDGs and SDGs) on the education systems of developing countries.

2.3. Developmental Goals: MDGs to SDGs—Science Education and Elitism in Education

Before introducing the MDGs in 2000 and SDGs in 2015, ratifications and agreements (such as EFA, GATS, UNFCC, etc.) were the prime tools used by the UN to monitor and supervise its signatories [30,31]. After establishing the MDGs and SDGs, both the terms and references set for developmental goals and existing ratifications, as well as agreements, were used to supervise UN signatories (30, 31). Moreover, new ratifications and agreements are produced from time to time in order to ensure the achievement of developmental goals [40]. The following does not necessarily explain the entire phenomena of the developmental goals of the UN; rather, it exclusively focuses on education.

Considering education as a public good, a public exchequer can be used to cover it in order to avoid commercialisation and commodification in education [6]. Following the GATS' agreement prescribed by the WTO, many developing nations introduced a private education sector in the early 1990s. According to the GATS verdict, the signatories should remove the trade barrier from their education systems, allowing commercialisation [33,34]. When the MDGs commenced in 2000, EFA (education for all) was a UN fundamental mandate for education [6]. According to this mandate, all signatories must provide universal education to every child regardless of their SES, race, ethnicity, and gender [4–6]. To achieve this target, signatories are advocated to expand their education sectors dramatically via NGOs and private provisions [5,6].

This approach was upheld by arguing that this would subside the burden placed upon governments [6]. Although students from privileged SESs would obviously go to the private sector, poor pupils could receive education both from NGOs and their public counterparts [41]. This strategy was further prescribed, suggesting that public anarchy in education must be driven out [6,7]. With the support of this approach, multiple providers were welcomed to compete, and education became a “commercial commodity” [41]. The concept of “unified education” for national interest was challenged in many ways [41,42]. The strategy was at least largely successful in allowing access to universal education for everyone. However, this strategy was also silently ensuring freedom of choice in education for elites only via a response to the capitalist view [42].

Enrolment in education was dramatically increased because of a collective force working to ensure EFA [41,42]. This sudden increased enrolment also created enormous pressure for secondary and tertiary provisions (6, 7). The secondary provision, especially higher secondary and tertiary education counterparts, were overwhelmed [12,13]. To resolve this crisis, the governments of UN signatories were advocated to expand their private education sectors drastically, especially for the tertiary and secondary provisions [15]. Moreover, informal investment (such as private tutors, support from private coaching centres, and additional support from teachers in exchange for private funds) was encouraged particularly to learn science education because, being an international product, science education is more expansive compared to its arts and business counterparts [14].

Financially solvent parents were happy with this approach, making science education a luxury product that only they could buy to ensure a better future for their children [16]. Poor children had no choice but to be reliant on public funds, which might be insufficient for any form of education, let alone science education [6]. Ref. [16] further noted that, as a consequential effect of the MDGs (especially EFA), a commercially viable private higher education (HE) sector was established that also follows a rigid capitalist view to ensure education for the elite [12]. Elitism in education is not a recent phenomenon [1]; however,

the above discussion suggests that the MDGs era has brought a new horizon for the concept of elitism in education.

As claimed by the EFA monitoring team, the MDGs era was largely successful in meeting the EFA targets [1]. The team has, however, realised that the drastic and rapid expansion in education as a result of MDG policies has primarily ensured quantitative success [1]. Therefore, the team has advocated in favour of quality education as part of the strategy outlined in the SDGs [6]. To ensure quality education, a number of agendas (such as objective-based learning, OBE for HE, TVET education for the poor, technology-based learning and assessment, blended learning, and sustainability technology in education) have been outlined [6,16].

Whether the education agenda of the SDGs really improves education quality or promotes a capitalist view in emerging countries' education is a matter that deserves more research attention in the era of the SDGs [6,28]. For instance, the purpose of HE is to produce leaders, innovators, and critical thinkers [12]. Would massive and monopolistic adoption of OBE meet the authentic purpose of higher education, or would it further aggravate the adverse effect of the dependency theory in education? An answer to this question is badly needed before responding to the SDGs. HE and research not only shape the entire education system of a country but also help it progress further [6]. Adaptation to the dependency theory in education must welcome more adverse challenges, which would certainly hinder sustainable development in education [28].

2.4. Convention against Discrimination in Education 1960 and Interventions: Flashback

In an era of the ongoing popularisation of education, scholars have asserted that education not only supports national development and public welfare but also ensures private benefit [6]. Thus, discrimination in education in order to obtain private gains has become a more serious concern since the early 1940s [11,12], which was the main enemy for the substantial function of education. To address this crisis, UNESCO imposed a ratification labelled the Convention against Discrimination in Education 1960 for its signatories. According to this convention, any form of discrimination in education cannot be tolerated under any circumstance. Such a convention obviously helped various minority and vulnerable groups access education (based on race, ethnicity, gender, and physical and mental condition), which has created and extended the market of education [1].

Additionally, a number of global interventions, such as EFA, the MDGs, and the SDGs, have also helped to extend the market of education [1,3,6]. Using the scope of such an extended market, a market-drive theory has been slowly built by replacing philosophical thoughts in education [5,6]. Hence, education has become a commercial product/commodity instead of a program that is operated based on philosophy and principle. Today, the market determines every phenomenon in education [7,8]. This attitude has not only developed various types and patterns of education but has also created education with a different quality and purpose [3,4].

Several international interventions in education (such as EFA, the SDGs, and the MDGs) needed to be customised for contextual fitting. Hence, non-customised interventions have made education in some emerging nation a "class-based" program instead of a right-based agenda in which the capacity and interests of students are not the prime parameters, rather regulating student choices in education according to SES [7,8]. This has silently developed an anarchy in education which reminds us to remember the UNESCO Convention against Discrimination in Education 1960.

3. Research Context

The following explains some relevant information on the research context, namely Bangladesh. Firstly, the secondary education system, which helps to justify the research focus, is described. Secondly, the effect of the MDGs on the school system in Bangladesh is noted. This information also supports the justification of the accuracy of the adopted research design, as explained in the next section.

3.1. Secondary Education

Four types of providers deliver secondary education in Bangladesh, of which one is known as the general secondary provision, which covers almost 81% of students [8–10]. Another provision known as madrasa education is the second largest counterpart, which covers almost 12% [10]. The remaining two types of education, namely vocational education and international education, cover 5% and 2%, respectively [42]. These two providers are completely isolated from the general system [43]. Only the super elite group, which is very small in number, pursues international education, such as American and British models of schools operated in Bangladesh. The extremely poor group either goes to the madrasa or vocational provisions [42]. Hence, general secondary education is a major part of the country's secondary education, which is the subject of this study, as explained below.

General secondary education, which is divided into three steps, is a seven-year program that starts in grade six and ends at grade twelve. Grades six to eight are labelled as the junior secondary provision, whereas grades nine to ten and eleven to twelve are labelled as the secondary and higher secondary provisions, respectively [44,45]. Universal education, also known as compulsory education, has recently extended to grade eight from grade five [42]. Vocational education starts in grade nine. After completing grade eight, students may shift to the vocational path if they do not want to continue with general secondary education [46].

Students who move to the vocational system are not allowed to re-move to the general system. However, students in the general system who study science programs are allowed to move to the vocational path or any desired path at any point in their education career [46]. Students need to attend a public examination known as the secondary school certificate (SSC) at the end of grade ten [8]. Students who successfully complete this examination achieve the status of an SSC (general) graduate. Successful students from the vocational path achieve the status of an SSC (VOC) graduate who can only pursue the polytechnic provision to continue further studies [46].

SSC (general) graduates from the science path either go to the higher secondary provision or the polytechnic provision to pursue further education [45]. Furthermore, SSC (general) graduates from the science path can study science, business, or the arts in the higher secondary provision, and their counterparts, i.e., students from the arts and business paths, must remain on the same path if they continue to study higher secondary education [8]. Selecting a cluster or path starts in year nine in Bangladesh [8–10]. Students studying a particular cluster must study the subjects that are determined for his/her chosen cluster [8–10]. The system is not liberal enough to allow studying various subjects covering multiple areas, such as science, business, and the arts [8].

Although students in the secondary provision in many developed countries enjoy the liberty of choosing their desired subjects from different areas (i.e., science, business, and the arts), students in some developing countries, including Bangladesh, are restricted to consider one cluster [8–10]. With policy support, students in the science cluster can pursue higher education (HE) in any area, whereas students from other clusters are restricted to study higher education in their respective area only. The scope of HE and the job market in developing countries is very narrow [9]. The limited scope of HE and jobs in the area of business and the arts is occupied by science graduates as a result of one-way traffic that favours the science cluster [10]. This has made the science path a “hot-cake” in the secondary provision, and students from higher SESs study science to achieve the SSC at any cost to deprive others, which is the subject of this study [8,10].

3.2. The Effect of MDGs and SDGs on Secondary School

Before the introduction of the MDGs, particularly the EFA agenda, both public and semi-public schools delivered secondary education [42,43]. The government exchequer provided 100% and almost 90% of the budget of public and semi-public schools, respectively [12]. After the introduction of the MDGs, both NGO and private school provisions were added as providers of secondary education [42]. Private schools, which are funded

by the students' parents, are in the elite/affluent areas of an urban geography [42]. NGO schools funded by development partners are in poor areas of both urban and rural geographies [41,42]. This approach was considered to ensure extensive coverage so that students from all economic backgrounds can be covered [42]. Although NGO schools cover students from lower SESs, their private counterparts provide access to students with higher SESs [42,43].

Ideally, public and semi-public schools would provide access to students regardless of their SES. Before the MDGs, the expansion of public and semi-public schools was based on political interference only [43]. Activities related to the MDGs have managed to minimise political interference for the establishment and development of schools [41]. The MDG team working both in the UN and in the Bangladesh government system managed to develop some models for the establishment/development of schools and their funding mechanisms [43].

These models concentrated on regional and demographic affairs from various angles to establish new schools and to develop older schools so that both high-income and middle-income groups, as well as low-income groups, can access education in a particular public or semi-public school [45]. One of the main setbacks of these models is that a public/semi-public school is no longer a common place for students from all kinds of economic backgrounds; rather, a particular school is dedicated to a specific group of people [46]. On the other hand, one of the outstanding advantages is that these models offer help to determine whether students from lower SESs are attending schools, and based on the information gathered, subsequent follow-up actions can be taken to ensure access for students from lower SESs [12,46].

The MDG team further developed a few models for data collection and analysis so that the real situation of access to education and performance in education made by different groups (such as those depending on economic factors, gender, and location) of students can be traced easily [8,41]. The data management system in education, especially for primary and secondary provisions, was substantially improved by the MDGs [47,48]. Having said that, the MDGs should not be blamed for the silent development of the elitism of science education in Bangladesh, as it was not within the purview of the MDGs. The policymakers of the country should have taken measures to address specific problems that Bangladesh faces, which is a statement given by a member of the MDG team [47].

The effect of the SGDs is yet to be explored because the groundwork of the SGDs only started in late 2016. Soon after their commencement, COVID-19 affected the education system in 2020 and continues to do so. However, most elite schools started adopting technology-based learning and assessment, blended learning, and sustainability technology in education following a dependency model [28,36,37]. The University Grants Commission (UGC) of Bangladesh issued a verdict, in which all universities must follow OBE without paying due attention to the effect of OBE on higher education [12].

4. Research Design

Firstly, the reason for adopting a qualitative method is justified before the involved data collection process is explained. Prior to explaining the primary data in the final two sub-sections, the development of the used domain and data analysis for secondary sources is described.

4.1. Methodological Approach: Justification for a Qualitative Method

Given the nature of the outlined research questions, a qualitative method is used, adopting data collected from both secondary and primary sources. Before explaining the data, the reason for using a qualitative method is first justified.

Of the four research questions outlined in the introduction, none are able to be used to develop a hypothesis that can be considered either null or alternative. Hypotheses are often tested to understand the norms of relationships that may be either positive, negative, or casual [49]. To test these relationships, different quantitative techniques are

often used [50]. Thus, a quantitative method cannot be adopted [51,52]. For instance, if this study considered a hypothesis regarding whether the rich are only studying science, a quantitative technique would be able to establish a relationship.

Instead of testing such a hypothesis, this study aims to discover insight into what kind of SES background that students have who are studying different clusters (such as science, business, and the arts) in the secondary provision. The aim of this comparative discourse (comparison made among three clusters) is to generate possible directions that future studies can use to develop hypotheses—a core purpose of a qualitative study [53]. Hence, this qualitative study adopts a descriptive analysis of data collected from both secondary and primary sources. Why and how the descriptive analysis was made are explained later.

4.2. Area and School Selection for Secondary Data

Currently, Bangladesh has eight divisional cities, namely Barisal, Chittagong, Dhaka, Khulna, Mymensingh, Rajshahi, Sylhet, and Rangpur. Bangladesh commenced its journey just after gaining independence in 1971 with four divisional cities, namely Chittagong, Dhaka, Khulna, and Rajshahi, whereas the others were the largest municipalities except Mymensingh. These largest municipalities were gradually added as divisional cities. Mymensingh was the latest city added as a division in 2015. Because the impact of the MGDs and SGDs is still being witnessed, Mymensingh is not included in the sample area. All divisional cities are considered because other cities within a division ideally follow its divisional counterpart in the trend of development.

All divisional cities have urban, semi-urban, and rural areas [42]. Following suggestions from the MDG agenda, schools are classified as upper class, middle class, and lower class, located across the country. For example, all kinds of school are situated in the urban, semi-urban, and rural areas [41,42]. However, urban areas should ideally have more upper-class schools compared to their rural counterpart, and a significant number of lower-class schools should also be situated in urban areas [42]. For example, Dhaka is the capital city, and it is also known as the most urbanised city in Bangladesh, as it is dominated by lower-class schools and many poor people in urban slums, settlements, and tin sheds [42]. Hence, all schools that were established by 2010 in these divisional cities are considered.

The data on the appearance and performance on the SSC are the key subject of this research. Students who were admitted to grade nine in 2010 should have taken the SSC examination in 2012. Hence, the SSC data of all schools located within the seven divisional cities since 2012 were used. Data from every four years was used, i.e., data from 2012, 2016, and 2020. It was hard to collect data from every year and input them into a computer, which is why data from every four years were used.

A total of 3315 schools are involved in the seven divisional cities, of which 887 schools are in urban areas, and the others (2438) are located in rural areas (Figure 1). Of 3315 schools, the number of upper, middle, and lower-class schools are 138, 833, and 2344, respectively (Figure 1). A total of 925,717 students participated in the SSC from 3315 schools (Figure 1), of which upper, middle, and lower-class schools had 120,577, 389,254, and 415,786 students, respectively (Table 1). Of 925,717 students, years 2012, 2016, and 2020 had 252,295, 303,340, and 369,982 students, respectively (Table 1). More information on the sharing of schools and students by the seven divisional cities can be found in Figure 1.



Figure 1. Number of schools by location and their status. Black-coloured fonts represent location and status-wise numbers of schools in different districts.

Table 1. Number of students by year and economic class.

Year	SES	Total Appear	Total Pass	Business		Arts		Science		GPA 5		
				Appear	Pass	Appear	Pass	Appear	Pass	Business	Arts	Science
2020	Upper class	48,378	45,816	11,968	11,014	5543	4398	30,867	30,404	674	141	17,645
	Middle class	167,746	144,872	56,003	49,057	61,730	47,909	50,013	47,906	757	248	13,984
	Lower class	153,858	130,506	42,464	36,986	73,430	58,150	37,964	35,370	390	281	5697
2016	Upper class	39,711	38,451	11,679	11,000	3045	2651	24,987	24,800	908	77	16,087
	Middle class	124,322	112,871	52,183	47,643	34,477	28,872	37,662	36,356	1064	94	10,721
	Lower class	139,407	123,978	49,507	44,740	56,354	47,458	33,446	31,780	611	95	5114
2012	Upper class	32,488	31,203	12,039	11,336	3,112	2748	17,337	17,119	2122	140	11,468
	Middle class	97,186	86,237	45,205	39,842	27,875	23,521	24,106	22,874	2179	235	7085
	Lower class	122,621	105,090	48,562	42,004	51,051	41,806	23,008	21,280	1024	204	2821

Table 1. Cont.

Year	SES	Total Appear	Total Pass	Business		Arts		Science		GPA 5		
				Appear	Pass	Appear	Pass	Appear	Pass	Business	Arts	Science
Overall	Upper class	120,577	115,470	35,686	33,350	11,700	9797	73,191	72,323	3704	358	45,200
	Middle class	389,254	343,980	153,391	136,542	124,082	100,302	111,781	107,136	4000	577	31,790
	Lower class	415,886	359,574	140,533	123,730	180,835	147,414	94,418	88,430	2025	580	13,632
	Total	925,717	819,024	329,610	293,622	316,617	257,513	279,390	267,88	9729	1515	90,622

Given the individualistic nature of the research question, multiple types of data with different natures and differentiated tools and analyses were used to respond to the need of each research question (Table 2). Hence, RQ1 and RQ2 are answered via secondary data, whereas RQ3 and RQ4 are answered via further discussion of RQ1 and RQ2 and via primary data (Table 2). The following discussions note the development of domains for secondary data, their sequential collection process, and data analysis.

Table 2. Data collection tools for individual RQ.

RQ	Primary Tool(s)	Auxiliary Tool(s)	Method
Does SES matter regarding access to science education?	Domain and tool development; data collected from BANBEIS and WBRSEB archive based on the developed domains	Percentage analysis according to different domains	Qualitative (Descriptive analysis of secondary data)
Does SES impact performance in science education?	Domain and tool development; data collected from BANBEIS and WBRSEB archive based on the developed domains	Percentage analysis according to different domains	Qualitative (Descriptive analysis of secondary data)
What is the impact of SES on science education?	FGDs with different stakeholders who are the subjects of the domain	Literature review, interpretation of the findings, and discussion of earlier research questions	Qualitative (Discourse and narrative analysis)
How can sustainable education be developed in the era of SDGs?	FGDs with different stakeholders who are the subjects of the domain	Literature review, interpretation of the findings, and discussion of earlier research questions	Qualitative (Discourse and narrative analysis)

4.3. Domain (Instrument) Development: Secondary Data Collection, Analysis, and Reliability

A pre-determined domain, known as school classification (upper, middle, and lower), used for monitoring the agendas of the MDGs and SDGs, is the key subject and fixed domain of this research. The second domain, known as clustering (science, business, and the arts), is used to understand the distribution of the students within the different categories of the first domain. This can help to understand whether a particular class of students (upper, middle, and lower) dominates within the second domain, known as clustering (science, business, and the arts). This helps to understand the influence of SES on education choice, a prime inquiry (RQ1).

The third and final domain is the academic result. The academic performance domain, which is divided into three categories, namely fail, pass, and grade point average (GPA) (GPA 5 is considered the best performance), is checked against the other two domains,

namely school classification (upper, middle, and lower) and clustering (science, business, and the arts) in order to understand whether academic performance is controlled by the other two domains. This would certainly provide information that can be used to examine the role of SESs on program choice and the subsequent effect on academic performance, an inquiry made in RQ2 (Table 2). Now, the processes involved in collecting the data are presented.

BANBEIS (Bangladesh Bureau of Educational Information and Statistics) is a UNESCO patronised public institute and is responsible for the management of data related to educational policy and planning. Fundamental information on Bangladesh education is accessible via the BANBEIS website. In-depth data related to a particular study can be collected via contacting the library wing of BANBEIS. A classified list of schools (upper, middle, and lower-class schools) located in the seven divisional districts was collected from the library wing.

A public archive named Web-based Results Publication System for Examination Boards (WBRSEB) preserves the information regarding the SSC and HSC examinations of students from each school in Bangladesh. Firstly, a list of students and their SSC registration numbers (SSC ID No.) was collected for each school for a total of 3315 samples (covering upper, middle, and lower classes) via the website for the years of 2012, 2016, and 2020. This provided us the data of students studying in different types of schools (upper, middle, and lower classes) with their geographical locations (such as urban and rural).

Using the SSC ID, each student's chosen cluster (science, business, and the arts) and their achieved academic performance were traced. This is how information was obtained on the chosen clusters (science, business, and the arts) and academic performance of each student from every school. Subsequently, information of all schools regardless of their status (upper, middle, and lower classes) was obtained. This information can be further segregated (divisional diversity, economic diversity, and location—urban and rural) in different ways as required for data analysis. However, school classification (upper, middle, and lower classes) remained as the focus of data analysis.

This research neither tested null and alternative hypotheses nor developed a causal relationship between different variables, as presenting mathematical or statistical models (such regression or SEM—Structural Equation Model) is not important [51–54]. Moreover, selective samples were not used, nor were the mean, median, and average values obtained for every group. Rather, information was collected from each student from all available students in a particular year. Moreover, no testing and comparisons were made among different years either to develop a causal relation or to assess a hypothesis. However, no intended comparison was made to test a particular issue (such as equity, inequality, and diversity amid different demography) among the seven divisions. Hence, as argued by [55–57], under such a climate, various statistical tests (such as the “*t*-test”, “*z*-test”, “chi-squared test”, “ANOVA test”, “binomial test”, “one sample median test”, etc.) were no longer relevant.

Information from each respondent was firstly deposited independently, which then led to a total value. This independent information was not based on a perception, but rather on a fact that resulted in a number. The numbers were generated based on real fact that finally contributed to a total. Subsequently, the totals were distributed to the domains according to a percentage of the total. Under such circumstances, as argued by Bolster [56], no “significance test” that is used as a statistical parameter is required. An analysis via presenting a percentage is one of the most acceptable ways for this kind of analysis, as argued by [56,57]. This approach should be labelled as “descriptive analysis”—an important tool to develop further hypothesis for future research [56,57].

4.4. Sampling and Triangulation for FGD: Primary Data

Primary data were collected via focused group discussions (FGDs) in the second phase. The first phase collected the secondary data and analysed them before the second phase started, which is considered an appropriate approach, as argued by [51,52]. The

purpose of these primary data was not to quantify any perspective or perception [51,52]. RQ3 and RQ4 concentrate on having some deeper understanding of the affairs exposed by RQ1 and RQ2. Hence, any form of quantification is not a focus; rather, “fact finding” for deeper understanding was the main objective [53,55]. Consequently, FGDs were considered to provide in-depth information [54,55]. Because quantification was not a concern, the number was not a prime pre-condition for sampling [55]; rather, “triangulation” through representative samples was the matter of emphasis [54].

A total of 27 FGDs were conducted with three groups (students, parents, and teachers) involved in three clusters (such as science, business, and the arts) of three types of schools (upper, middle, and lower classes). A separate FGD was conducted for each cluster of students (i.e., science, business, and the arts) from three types of schools (i.e., upper, middle, and lower classes), resulting in 9 FGDs with students. The same was conducted with parents and teachers, as a result of which 27 FGDs (Table 3) occurred to value the concept of triangulation [51,52,54].

Table 3. Sample and sampling.

Type of Economic Class	Type of Cluster	Type of Stakeholders for FGD			Total FGDs
		Teacher	Parents	Student	
Upper class	Business	1	1	1	3
	Arts	1	1	1	3
	Science	1	1	1	3
Middle class	Business	1	1	1	3
	Arts	1	1	1	3
	Science	1	1	1	3
Lower class	Business	1	1	1	3
	Arts	1	1	1	3
	Science	1	1	1	3
Total		9	9	9	27

4.5. Primary Data Collection, Analysis: Confidentiality, Coding and Limitations

FGDs were conducted in the respective schools using the common room, which is often used for the purpose of cocurricular activities. The first round of FGDs was conducted with the students, whereas the second and final rounds were conducted with the parents and teachers, respectively. This sequence was made with the idea that some important facts might arise from the first round that could be clarified with the parents. The final round was conducted with teachers, as they might have been in a better position to illuminate the points that were generated from the first and second rounds.

Before starting the FGDs, the research purpose and focus were explained. The findings of the secondary data were presented in the FGDs so that the respondents could provide us with clarification of the facts from their own experiences and circumstances. A set of semi-structured questionnaires was prepared for each group. However, leading questions were often made to clarify many evolving issues raised within the discussions. The development of a rapport was attempted by providing attention to their responses with eye contact and a positive vibe. However, caution was given in order to not make them feel biased or make them biased. All the FGDs ended with positive conclusions. Before ending, the respondents were asked if anyone wanted to share something that was not discussed but that might be relevant. After this statement, several useful comments were given.

Permission to record the FGDs was sought, and all participants agreed, allowing us to record, transcribe, and listen to the consenting participants’ discussions for our analysis. The respondents were assured that the confidentiality of the discussions would be maintained. In the interest of respondent anonymity, codes were assigned for each FGD. Hence, S, P, and T codes were assigned to represent students, parents, and teachers, respectively. SC, BU, and AT codes were assigned to represent the clusters of science, business, and the arts, respectively. U, M, and L codes were assigned to represent schools

from upper, middle, and lower classes, respectively. Hence, for example, an FGD with students from the science cluster from an upper-class school was assigned a full code of SSCU, and the full code for the FGDs with students from middle and lower-class schools was SSCM and SSCL, respectively.

This study also experienced some challenges that are common issues in other FGDs. Some of the respondents who wanted to dominate the conversation were more vocal. This sometimes derailed the conversation and demotivated some introverted respondents to express their viewpoints. To resolve this situation, passion, silence, and close listening were employed. The scheduled time was extended in case anyone wanted talk even after the FGD officially ended. Constraints were faced from time to time under different circumstances, so past experience (three decades in education management) was utilized to the greatest effect possible. Despite all these efforts, some limitations were unavoidable, but they did not greatly impact the novelty of this study. Hence, this study may be a milestone supporting the development of hypotheses for future studies.

5. Findings and Discussions

Given the nature of qualitative inquiry, the findings and their discussions are made in parallel before noting the research implications and conclusions in the final section. The first two sub-sections that follow attempts to report on the first two research questions via secondary data, prior to reporting the last two RQs via primary data.

5.1. Mapping of Access: Impact of SES on the Choice of Cluster—An Elitist View

Amongst the three clusters (science, business, and the arts), science was the smallest group in 2012, which was 25.5% (Figure 2). Gradually, the share of science increased, as it was 32.1% in 2020 (Figure 2). Although the share of the arts group was quite unstable, the share of the business counterpart constantly declined (Figure 2). According to Figure 2, the share of the business cluster was 41.9% in 2012, which decreased to 29.8% by 2020 (Figure 2). One of the possible reasons for this decrease could be that students wanted to keep both avenues (science and business clusters) open in the HSC provision because only SSC graduates from the science cluster were offered this advantage [8–10]. Ref. [8] found that the share of the business cluster in HSC is the largest, and SSC science graduates shifting to business have contributed to this largest share.

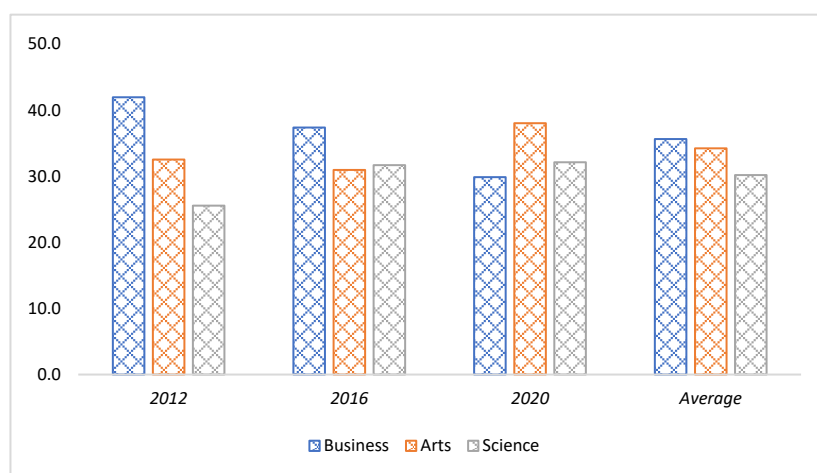


Figure 2. Cluster-wise student sharing in different years. Horizontal axis represents clusters and years, and vertical axis represents percentage share of students.

However, although science is not the largest group, it has been increasing over time; thus, it is important to understand whether students with any specialised background related to SES contributed to the growth. Before, this issue is discussed further, it should be noted that the number of upper-class schools was lower compared to the lower and

middle-class counterparts. Subsequently, upper-class schools shared a small percentage of student within the total student population (Figure 3). For instance, 12.9% of students were involved in upper-class schools in 2012, which slightly increased to 13.1% by 2020 (Figure 3). A major portion of students studied both at middle and lower-class schools (Figure 3). Both middle- and lower-class schools competed with each other regarding having the highest share of students (Figure 3).

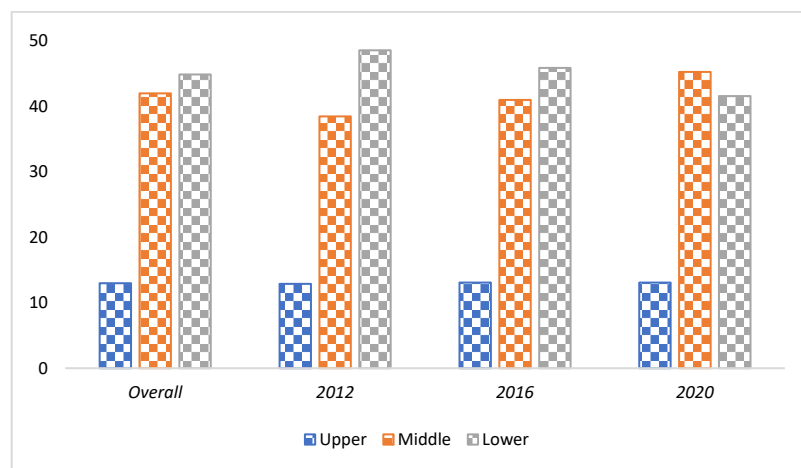


Figure 3. Overall percentage share of students based on different economic classes. Horizontal axis represents economic status, and vertical axis represents economic class-wise percentage share of students.

Although upper-class schools had a lower percentage of students within the total share, the science cluster was the largest group in this provision. The share of the science cluster has also continuously improved (Figure 4). According to Figure 4, the science cluster of upper-class schools shared 53.4% of students in 2012, which increased to 63.8% by 2020. On the other hand, lower-class schools were mainly dominated by students from the arts cluster, followed by the business counterpart (Figure 4). Middle-class schools were dominated by students from the business cluster, followed by the arts counterpart.

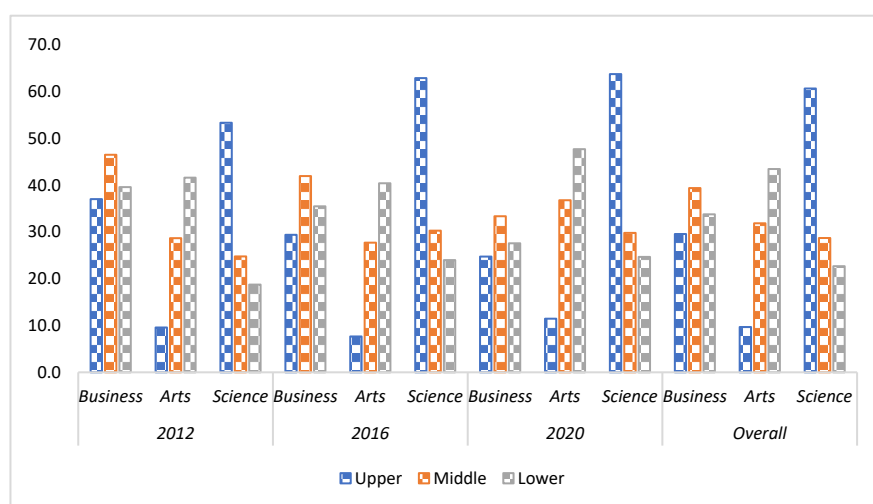


Figure 4. Share of students with different economic backgrounds in three clusters. Horizontal axis represents cluster and economic background, and vertical axis represents cluster-wise percentage share of students.

Science education not only provides a promising future but also offers multiple avenues for furthering the education and job market, as argued by [8–10]. Therefore, science

education has gained high demand [8–12]. Hence, a shortage of supply to meet the demand made science education as an “elite product” [12,15,16]—a view that is further supported by this study. Should science education be an elite program that follows the economic principle of luxury products? This question deserves greater attention in this era, referring to “rightism in education” or “commodification in education” [1,6,8–10,28]. The above discussion highlights how science education has become an elite product in the era of MDGs and SDGs. The following section examines whether an “elitist view in education” is only limited to access or if it has spread with performance.

5.2. SES and Education Performance: An Elitist Perspective

Both pass rate and GPA 5 holders are comparatively very high for upper-class schools. According to Figures 5 and 6, the average pass rate for all years (2012, 2016, and 2020) involved by combining every cluster (science, business, and the arts) is higher for upper-class schools, which is 95.76% (Figures 5 and 6), whereas the combined average is 88.47% (Figure 5). The pass rates for upper-class schools in the years of 2012, 2016, and 2020 are 96.04%, 96.86%, and 94.70%, respectively (Figure 6), whereas the pass rates of its middle-class counterpart are 88.73%, 90.79%, and 86.36%, respectively (Figure 6). The pass rates for lower-class schools in the same years are 85.70%, 88.93%, and 84.82%, respectively (Figure 6).

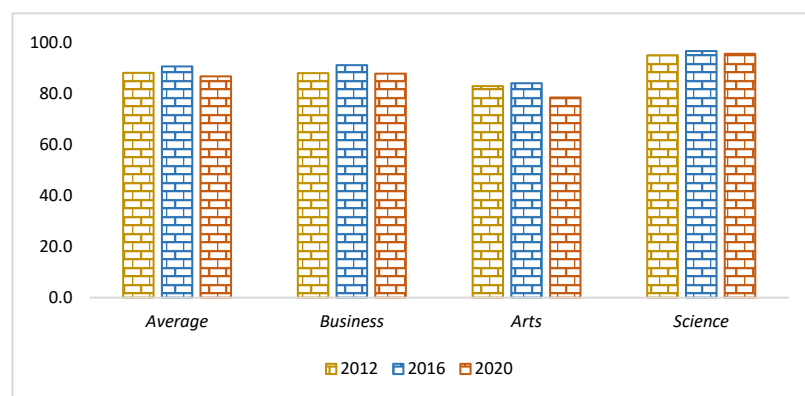


Figure 5. Cluster wise overall pass rate in different years. Horizontal axis represents clusters, and vertical axis represents cluster-wise percentage share of performance of students.

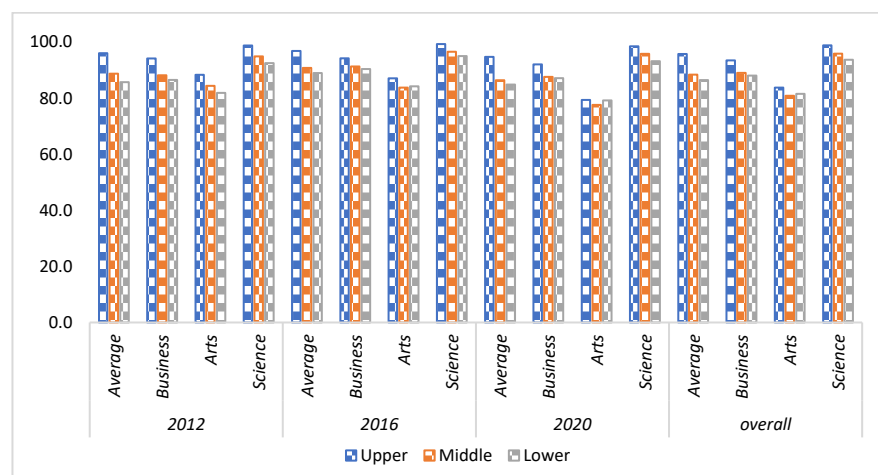


Figure 6. Pass rate of students with different economic classes and different clusters. Horizontal axis represents cluster and economic status, and vertical axis represents percentage share of performance of students of three economic classes and clusters.

The pass rate in upper-class schools is exceptionally better, and the percentage of GPA 5 holders in the upper class is extremely high. For instance, the percentage of GPA 5 holders for upper-class schools in the years of 2012, 2016, and 2020 were 44%, 44.40% and 40.29%, respectively (Figure 7), whereas GPA 5 holders for their middle-class counterparts belonged to 11.01%, 10.52%, and 10.35% of students, respectively (Figure 7). The GPA 5 holders for lower-class schools in the same years were 3.85%, 4.69%, and 4.88%, respectively (Figure 7). In the competition of academic success, neither middle nor lower-class schools could compare with their upper-class counterparts, which, in education, are home to elites. Now, the performance of the three clusters, namely science, business, and the arts, is compared.

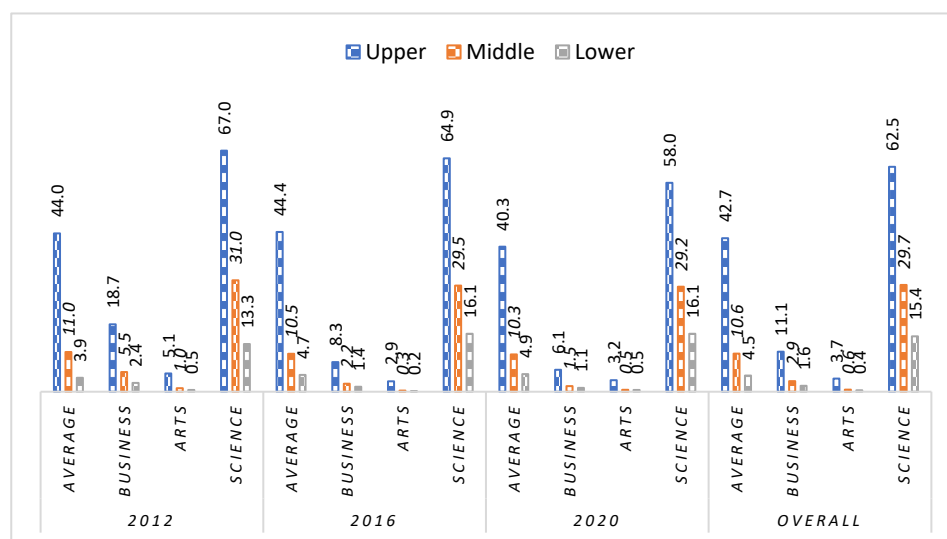


Figure 7. Cluster-wise students with GPA 5 from different economic classes. Horizontal axis represents cluster, and vertical axis represents percentage share of three clusters.

The pass rates for science in the years of 2012, 2016, and 2020, regardless of school status (upper, middle and lower class) were 95.07%, 96.71%, and 95.65%, respectively (Figure 8), whereas those of business were 88.07%, 91.19%, and 87.89%, respectively (Figure 8). The pass rate for the arts in the same years were 82.98%, 84.13%, and 78.50%, respectively (Figure 8). Although the pass rate for the science cluster was exceptionally higher, the percentage of GPA 5 holders in the science cluster was substantially divergent. For instance, the GPA 5 holders for science in the years of 2012, 2016, and 2020 were 34.88%, 52.10%, and 32.83%, respectively (Figure 8), whereas the GPA 5 holders of the business counterpart were 5.71%, 2.50%, and 1.88% (Figure 8). The GPA 5 holders for the arts in the same years were 0.85%, 0.34%, and 0.61%, respectively (Figure 8).

This simply suggests that both the business and arts clusters were unable to compete with the science counterpart in academic competition. Hence, SES has greatly influenced academic performance, in which elites succeed the most. Science education and having a better performance within this cluster have become an exclusive phenomenon for elites. The following sub-section explains the impact of elitism on science education.

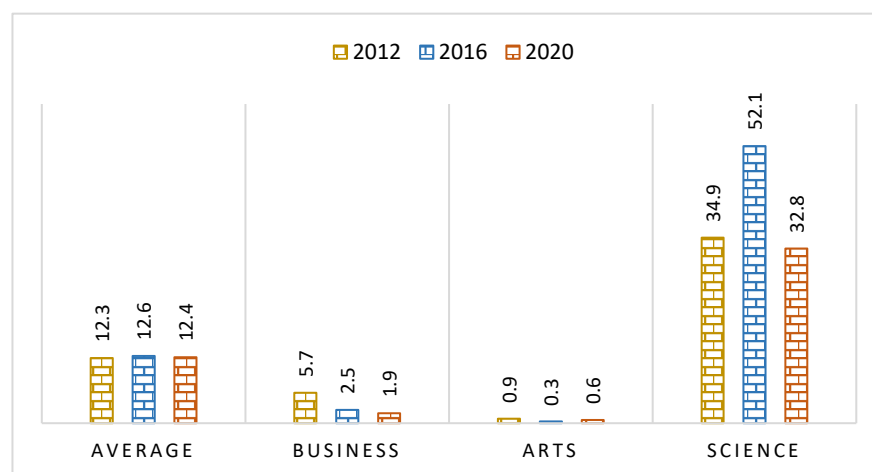


Figure 8. Distribution of GPA 5 holders amongst three clusters in respective three years. Horizontal axis represents clusters, and vertical axis represents percentage share of GPA 5 holders.

5.3. Reason for Elitism in Science Education and its Impact

Two root causes have been found that make science education an elite product, and the other reasons are branches. The following discussion highlights the identified two root causes. Firstly, education is no longer an agent of change making in the 21st century, as confirmed by all teachers, parents, and students involved in the FGDs. According to TSCU, TSCM, TSCL, TBUSU, and TBUM, education has rather become an agent that helps us to adopt changes that have already taken place internationally, especially in the West. Thus, injecting the capacities and skills required for change making is not a prime concern for education (PSCU, PSCM, TSCU, TSCM, and TSCL). Hence, education should rather inject the skills and capacities that help students to adopt changes that have already taken place (TSCU, TSCM, and TSCL).

Science education is the only program that is able to inject such skills needed to adopt the changes that have already taken place, especially in the West (TSCU, TSCM, and TSCL). Hence, science has become an international education program. The development of course curricula, instructional technology, quality assurance, and assessments of science education are developed internationally, especially in the West, which is then subsequently exported to its eastern counterpart (PSCM, PSCU, TSCU, TSCM, and TSCL). As an international product, the learning objectives and outcomes of science education are very compact, as suggested by the international theory. Hence, students need to learn theoretical concepts of science rigorously without much adherence towards practical experiments required for a different context.

Under the mentioned circumstance, indicating a theoretical answer accurately without checking contextual fitting would ideally ensure a full score in the assessment of science education. On the other hand, a minor mistake would not impact the score. Hence, the theory of science needs to be captured carefully. In doing so, support from schools is neither conducive nor exclusive, as suggested by all teachers, parents, and students. Students are required to take additional support via private coaching, as noted by all students, parents, and teachers. Teachers are allowed to offer private coaching, which consumes extra funds from students and parents. It was found that all teachers teaching science programs offered private coaching. A teacher commented the following:

"I am proud to be a science teacher as learning and teaching science are highly prestigious in our society. On the other hand, although teacher teaching subjects related to science programs is not offered a different salary package in the school compared to a teacher teaching subjects related to business and arts programs; by offering private coaching, we can earn at least 10 times more compared to the colleagues who are teaching subjects related to arts and business programs. Science is the only hope and only promise that we need to adapt to cope in the 21st century".

Although these comments sound promising from an individual perspective, they indicate a great concern. Hence, students from privileged SESs can use such a scope to learn science. On the other hand, although business is a semi-international product, the arts is a local product, as said by all teachers. Although it is not possible to achieve a full score in these areas, attempts by individual students may help to obtain scores to pass the programs, as expressed by the SATU, SATM, SATL, SBUM, and SBUL. With this hope, many students with lower SESs study the arts and business programs at least to have some form of qualification before they depart from the education system.

Secondly, the policy perspective has also made science education an elitist product. According to the policy, students from science can pursue further education in any area, such as science, business, social science, and the arts, whereas their counterparts from business and the arts must follow the same path for higher education, continuing to study what they have studied in the secondary provision. Score achieved in the SSC is an important prerequisite to continue with further education.

A greater score achieved in the science program always accelerates the chances for science students to continue with further education in one of the possible clusters, namely science, business, and the arts. Thus, many students from the arts and business clusters leave the education system without pursuing further education. Hence, many secondary science graduates continue with further education in business, the arts, and social sciences. Can patronising only elites in education be a goal for sustainable development? This is a wake-up call for international education and development research. The following writing reports the impact of elitism in science education.

In addition to several causal effects, two central adverse impacts that have developed as a result of elitism in science education are the subjects of the following. Firstly, the misuse of public funds in the name of education is a serious concern. Most students, especially those who study business and arts programs, discontinue education after the secondary provision and subsequently join the labour force (SBUL, SBUU, PBUM, PBUL, SATU, SATM, SATL, TBUM, TATM, and TATL). It was further reported that these students drop from the education system without accruing any form of low or semi-skills needed for their employment.

From conversations with students, parents, and teachers, it is understood that, after leaving the education system, the assignments that adolescents from the business and arts clusters undertake to survive require a substantial amount of knowledge in applied science. Unfortunately, the education system does not inject such knowledge. Hence, public funds and the time spent educating in business and the arts may significantly be misused.

On the other hand, the continuity of further education in business, the arts, and social science by secondary science graduates is a complete misuse of both financial and logistic resources. Moreover, the occupancy of employment in the area of social science, business, and the arts by a science graduate develops both horizontal and vertical mismatch [58–60]. This is what is called either a waste of resources and time or corruption via policy. Should the emotions and time of youths who are from lower SESs be played with in the name of elitist views in education? This is an emerging perspective on account of corruption and crime via legitimate policies, as argued by [1,6].

Secondly, the elitism view in education has challenged the philosophy of education contributed by Aristotle, Plato, Socrates, and Ibn Sina. The fundamental philosophy of primary education is to inject citizenship skills and values, whereas secondary school should add to the skills and competencies needed to undertake low and semi-skilled jobs [6]. In doing so, both the primary and secondary provisions are cautioned to inject skills and values needed to continue higher education for a very selective portion of students who are extraordinarily capable, both in theory and practice.

The purpose of the education system is not to develop a specific group as an extraordinarily capable counterpart. The system should rather support the natural extraordinarily capable group regardless of SES. This is an idealist view that the current society hopes to achieve one day in the education system but that, unfortunately, it has yet to have.

Time is needed for transformation towards an idealistic view in education that is needed for sustainable development. However, it is not acceptable to welcome purposeful discrimination or discrimination developed diplomatically in the era of MDGs and SDGs. The following discussions suggests how to develop a mechanism that may support the substantial development of education.

5.4. Elitism in Education—A Mechanism for Sustainable Education

Elitism in education limits the sustainable development of education not only by bringing disparity but also by dismantling both the philosophy of education and the reciprocal relationship that has prevailed amongst different provisions of education (such as primary, secondary, and tertiary education). The following proposed mechanism for the sustainable development of education is not a new phenomenon; it is, rather, a re-stated fact that emerging nations, including Bangladesh, need to pay serious attention to.

Firstly, the purpose of education and the role of the specific provision of education (such as universal, secondary, higher secondary, and higher education) need to be redefined by following the philosophy of education without allowing the market to rule. In the process of redefining the purpose of education and the role of a specific provision, a country should not simply follow international trends, but it should discover a way that it can compete in the global race of education [6,28,34,35].

Secondly, a country should ensure unified universal education for all school-aged children [41–43]. Universal education, in particular primary education, should not simply be a supplier of graduates for its secondary counterpart. The success of primary education should not be measured on the basis of its capacity to produce competent graduates to study secondary education [41–43]. The success of the primary provision should be judged based on its competency to provide citizenship skills to all its graduates regardless of SES. Hence, stakeholders and society should be the main assessors of primary graduates, not just the teachers who are teaching them [5,7,47,48].

Based on academic ability and interest, a selective portion of universal graduates, regardless of SES, should travel for further education. Secondary education should offer an open choice of subjects for all its students. Students should be able to consider several subjects from different clusters that they have interest and competence in. Higher education must be based on academic ability, competency, and interest without giving any form of prejudice to SES. In the event of furthering education, students need to study prerequisite subjects in the same area in earlier provisions.

If anyone wishes to study a particular subject in higher education that he/she did not learn in earlier provision(s), he/she should re-take the relevant subject(s) from the secondary provision before being admitted to higher education. Students who wish to discontinue education after secondary education need to have some form of education and training by covering either trade, another sector, or both before leaving the education system, which might be helpful for one's potential career path in the future. Hence, information management on demography, sector of employment, and their required skills (such as type of skills and level of skills) are important.

Planning in higher education must avoid elitist views. It also needs to avoid a tendency to be a free market for all secondary graduates. A selective portion of capable secondary graduates, regardless of their SES, should study higher education. Higher education should not meet the demand of “diploma disease”. Enrolment in higher education and its expansion should not be based on the supply of secondary graduates; rather, it needs to focus on the needs of the employment market. The qualification levels and their diversifications are controlled by the needs of labour market and its skill requirements, not just by the demands created as a result of graduates produced in earlier provisions (such as secondary, higher secondary, and bachelor programs).

6. Implications, Further Research, and Limitations

The following includes two major theoretical and practical implications before outlining topics for further research and acknowledging limitations.

6.1. Theoretical Implications and Practice

The disparity and dependency theories and their impact on educational development are often used in conceptual connotations [1,2,6,28]. Although the first theory refers to a scenario of discrimination experienced onshore [6], the latter is used to explain an offshore scenario [6,28]. Hence, this is the first piece of research that explores the connection between the disparity and dependency theories. The findings and discussions suggest that both theories can supplement and complement each other and can also further aggravate the situation. Hence, the dependency theory, referred to in this paper as the internationalisation of science education, is supporting the development of the disparity theory, referred to as elitism in education. This is a new theoretical phenomenon established in this study that adds value to both the disparity and dependency theories.

The philosophy of education identified in earlier centuries has been the key to making education a product of ideologist and novelist views [7,15,26], which have subsequently helped education become popular and acceptable within society [6,15]. Hence, education has become a social product, and everyone within society contributes to and fosters its development [6,28,29]. Taking advantage of the popularity of socialist views in education, a capitalist view is silently practiced [6,28,29]. The silent practice of capitalist views is slowly corrupting the philosophy of education [34,39]. Hence, further revised practice guidelines are provided to confront the challenges involved in the education of the 21st century, in which the original philosophy of education is retained—a major practical contribution of this research. Before using the suggested guidelines, more scenarios in this field should be explored by conducting further studies, as suggested below.

6.2. Further Research and Limitations

The findings and discussions suggest that private investment in education (such as private coaching and tuition, private and elite schools, and many forms of informal funds) is developing a capitalist view in science education, which subsequently supports science education as an elitist product. Funds have always been an important issue, especially for emerging nations. Hence, neglecting private investment may add further problems. Therefore, new research focused on discovering a better model using private investment without waiving the philosophy of education is would be beneficial.

The findings and discussions suggest that a significant portion of students leave the education system after the secondary provision. Injecting employable semi-skills before their departure is important. It is thus important to map the employment sectors that students engage with after departing secondary education and their skill dynamics. This can help reshape secondary education for school leavers, following the philosophy of education. Hence, topics that cover mapping skill requirements for secondary school leavers would be good topics to explore in future research.

Gender perspectives, which are significant for STEM studies, were not considered in this study because an exclusive study on gender in STEM would provide more insight instead of making a sweeping argument; a number of studies have already covered gender issues in STEM; and finally, information/data were collected based on students' SSC IDs numbers from public archive(s), which did not allow tracing student genders, thus preventing the gender issue from being explored.

This is a small-scale research work that does not allow for comparison with many nations. Henceforth, more protracted longitudinal research backed up by the sponsorship of governments and development partners on these issues and other issues suggested for further research would be helpful. Extensive research should yield important insight not discovered here. Such insight would benefit the education system in the eastern part of the globe.

7. Conclusions

The role of science education on development in the era of SDGs and post MDGs is more than inexorable. However, elitism in science education has developed a disparate atmosphere within the education system in the name of internalisation. This situation has further created hindrances for sustainable development in education—a prerequisite for national development in the era of SDGs. Education that lives in isolation from its philosophy and purpose may provide temporary assistance towards national development, either by following capitalist views or by developing a purposeful role. This is a short-sighted view in educational development and may be a problem that hinders the sustainable development of education. Urgent revision of the purposes and roles of national education and their decent implementation are badly needed in light of the philosophy of education—an appeal made in this study.

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Article

Teachers' Resilience Scale for Sustainability Enabled by ICT/Metaverse Learning Technologies: Factorial Structure, Reliability, and Validation

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Abstract: A significant trend in education is the increasing recognition of the need to shift from transmissive teaching to incorporating reflexive practices associated with real-life issues in learning, curriculum, and teaching. Merging Information and Communication Technologies (ICTs) and Metaverse learning technologies in Education for Sustainability (ICT/MeEfS) is critical in responding to current sustainability crises such as climate change. This research article focuses on the factorial structure, reliability, and validity of a teachers' ICT/MeEfS resilience scale. It examines the predictive value of teacher self-efficacy and transformative teaching beliefs in merging ICTs and education for sustainability. The respondents were 1815 in-service teachers in Indonesia, Malaysia, and Vietnam. The principal component analysis showed a two-factor model (factor 1: "personal ICT/MeEfS resilience" and factor 2: "reflexive practice"), with a significant amount of extracted variance (68.26%). The overall Cronbach's alpha reliability analysis of the teachers' resilience scale enabled by ICT/MeEfS was 0.90, indicating a high score and excellent internal consistency. Similarly, the stepwise multiple regression analysis revealed that the two hypothesized predictors, teacher self-efficacy and transformative teaching beliefs, significantly contributed to teachers' ICT/MeEfS resilience, explaining 73% of its variability. The implications of the research results are discussed in terms of research and in developing the capacity of teachers to embed sustainability issues and SDGs in teaching practices, learning environments, and course curricula enabled by ICTs and Metaverse learning technologies.

Keywords: ICTs; Metaverse learning technologies; education for sustainability; teachers' resilience; self-efficacy; transformative teaching; factor analysis



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1. Introduction

The globalization of the UN 2030 Agenda for SDGs has created a comprehensive global dialogue that questions the unsustainable economic growth paradigm that prevailed in the 20th century. Research shows that the effects of environmental problems, such as global warming, air and water pollution, deforestation, ecological destruction, and loss of biological diversity, are all seen as part of climate change, which is threatening the sustainability of the planet [1–3], positioning climate change as the most significant environmental challenge currently facing humanity [4–6]. Recent studies demonstrate the harmful effects of climate change across all natural and social systems [7–9], which makes resilience a critical factor to address in tackling the climate crisis.

Previous research shows that one aspect of resilience that is now gaining increased attention is the capacity of education systems to transform from a stage of passivity driven by a transmissive teaching methodology to a transactive method that could pave the way toward a transformative pedagogy [10–12]. However, today, 20th-century education is part of the driving forces that have led the world to the current climate crisis and injustices regarding sustainability [13,14]. This turns teacher education for sustainability resilience into

a critical factor in restoring the role of education as an agent of change [15–17]. Resilience thinking toward sustainability provides a basis for understanding the global sustainability injustices and shifting from the 20th-century unsustainable socio-economic growth paradigm to building a more sustainable and just society. Sustainability-oriented resilience can be thus defined as the capacity to deal with sustainability issues and, more notably, the climate crisis and unlock opportunities for transformative change at the personal and societal levels. It is worth pointing out that the problem is not just the climate crisis per se but the whole spectrum of global sustainability changes needed to sustain human eudemonia and turn education into a transformative changemaker.

Thus, the concept of resilience has become increasingly popular in the current sustainability discourse, research, and practice, connected to theories of change and driven by three key principles: (a) persistence, (b) adaptability, and (c) transformability [18–20]. These three principles connected to education for sustainability (EfS) enabled by ICTs and Metaverse learning technologies could refer to: (1) learning to maintain function and structure (persistence); (2) learning to exist (adaptability); and (3) learning to transform oneself and society (transformability). In particular, developing transformative teachers' resilience is critical for building a sustainable society. Such a kind of concept gives meaning to the capacity of teachers to reflect on “who they are and why”, “what they want to become”, and “where they want to go”. Knowing oneself, learning to become, and envisioning a sustainable and just world are key competencies neglected in 20th-century education. Turning teachers as transmitters of knowledge into transformative intellectuals, coined by Henry Giroux [21], is essential to making the pedagogical more political and the political more pedagogical. For teachers, the political perspective of education refers to their agency to transform current practices to enhance education for sustainability; in other words, turning both teachers and learners into changemakers. This line of thinking gives teachers the theoretical basis to rethink and restructure their teaching, learning, and curriculum to address sustainability challenges. In this context, ICTs and especially Metaverse (merging the “meta” and “universe”) technologies, including VR (Virtual Reality), AI (Artificial Intelligence), and AR (Augmented Reality), can make a difference. The “meta” concept originated in ancient Greek philosophy and means “with”, “after”, or “going beyond”, while “universe” captures “the whole world”. These innovations are underpinned by a holistic and transformative perspective poised to stir up conventional teaching and learning practices [22–24]. Compared to traditional teaching and learning methods, the Metaverse thinking and associated technologies could enable a personalized, immersive, and experiential learning environment [25,26], making learning more meaningful [27]. Thus, developing a construct referring to the teacher's ICT/Metaverse-enabled Education for Sustainability (ICT/MeEfS) resilience demands teachers to be self-confident in dealing with sustainability issues that could, for example, refer to environmental racism, sexism, unfair wages, poverty, and other violations of human rights: unequal distribution of income and opportunities between different groups in society and the lack of respect and recognition of certain people and groups in society. Such issues seem to reflect the four dimensions or constituencies of the newly developed concept of sustainability justice that unifies environmental justice, social justice, economic justice, and cultural justice into a coherent construct entitled sustainability justice by Makrakis [28,29], associated with the fourth bottom pillars of environment, society, economy, and culture.

Based on previous research, resilient teachers, besides being more positive toward their work, experience less stress [30], and express positive attitudes to job satisfaction contrasted with less resilient teachers [31]. They also tend to value active learning processes, learner-centered pedagogies, and interactive learning experiences that demand problem-posing [32,33], collective responsibility [34], critical reflectivity, and discourse [35]. Problem-posing is a teaching methodology driven by active and transformative learning, knowledge construction, and civic engagement by examining solutions to real-life issues that can be elicited mainly through the 17 SDGs. Thus, attempting to construct and validate a new concept addressing teachers' ICT/MeEfS resilience would significantly contribute

to shifting from a transmissive to a constructivist and transformative pedagogy. This transition is essential in positioning education as an agent of change. While international research has revealed some personal factors and resources that are important for developing and sustaining teachers' resilience [36,37], there is a lack of research focusing on teachers' transformative and reflective perspectives of resilience in education for sustainability enabled by ICTs/Metaverse technologies. The concept of transformative teaching was first discussed by Slavich [38–40] to promote meaningful learning and students' lives. This was further elaborated by Mezirow's notion of perspective transformation driven by critical reflection, action, and change [41–43]. Thus, teachers' resilience in connection to Education for Sustainability and SDGs enabled by ICT/Metaverse learning technologies not only turns out to be an essential research area but also necessitates the inclusion of factors with which it could interact, such as self-efficacy in dealing with sustainability issues and transformative teaching beliefs [44]. Previous research also shows the positive relationship between self-efficacy and transformative teaching perceptions of resilience, and two scales were developed and validated [29,45]. The ICT/MeEfS self-efficacy refers to teachers' capacity to use interactive teaching and learning methods to address sustainability and use learners' personal life experiences to deal with sustainability issues. In contrast, transformative learning beliefs refer to independent, autonomous, and meaningful learning, fighting sustainability injustices at any cost, view the curriculum as a living content (process or praxis) and not as a fixed and prescribed package of knowledge to be transmitted.

As ICTs and Metaverse technologies are, along with climate change challenges, increasingly integrated across all societal domains, they generate higher expectations in education in general and education for sustainability in particular. In this study, the contextualization of ICTs with education for sustainability (EfS) is conceived as an innovation that promotes sustainability consciousness and action. Moreover, previous studies show that ICTs help learners make informed and conscious decisions for responsible behavior toward the integrity of the four pillars of sustainability justice [46,47]. The quest for new and innovative educational approaches that can promote transformative teaching and reorientate educational curricula to embed SDGs has been highly acknowledged in recent years [48–51]. Through the literature review, resilience, in general, has been defined variously in different social contexts and academic disciplines. In our case, it refers to strategies, processes, and abilities to successfully embed SDGs in educational processes and practice enabled by ICTs and Metaverse learning technologies. Developing teachers' resilience in merging ICTs and Metaverse learning technologies with Education for Sustainability (EfS) is critical. Thus, this study's primary objective is to develop and validate a newly constructed scale measuring teacher ICT/Metaverse resilience to embed sustainability and SDGs in learning, course curricula, and teaching practices. It also purports to test the predictive value of two independent factors, namely self-efficacy and transformative teaching beliefs, on teachers' resilience enabled by ICT/Metaverse learning technologies.

In line with these objectives and previous research, it is hypothesized that self-efficacy in ICT/MeEfS (H1) and transformative teaching beliefs (H2) could be significant predictors of the newly constructed and validated concept of ICT/MeEfS teachers' resilience.

2. Methodology

2.1. Background of Subjects and Procedure

As pointed out, this study was designed for and carried out in the context of the ICT/MeEfS project funded by the European Commission, focusing on seven higher education institutions in Indonesia, Malaysia, and Vietnam, which were affiliated with local primary and secondary schools. The participants were selected based on a convenient sample of 1815 in-service teachers working either as ICT coordinators and/or knowledgeable in ICTs. In terms of working place, the majority were working in urban schools (43%), followed by semi-urban schools (27%), and finally, rural schools (30%) in Indonesia (N = 360), Malaysia (N = 1253), and Vietnam (N = 202). There were 726 male teachers (40%) and 1089 female teachers (60%) representing multiple teaching subjects. Of the teachers partici-

pating in the survey, 51% declared they had experience using ICTs in teaching, while 39% worked as ICT teacher coordinators and 10% as ICT coordinators in the past. Regarding the type or school level, 56% worked in primary school education and 44% in secondary school education. The data distribution in terms of educational background shows that the great majority (76%) graduated from faculties of education, 12% from sciences, and the remaining from other academic fields. Regarding working experiences, 40% had more than 15 years of teaching, 37% declared the minimum experience in using ICTs as teaching and learning tools, and 54% declared enough knowledge in the field of education for sustainability. Before conducting the data collection that lasted from March to April 2020, permission was requested from the relevant authorities. Participants were also provided with the aims and objectives of this research, their voluntary participation, and anonymity.

2.2. Instrument and Measures

In this study, resilience, besides referring to strategies, processes, and abilities to succeed in embedding SDGs in educational processes and practice enabled by ICTs and Metaverse learning technologies, can also be understood as a metaphor for learning to transform oneself and society and as a process that could help to promote education for sustainability through the support of ICTs. This is why this study was used as a resource for developing, implementing, and assessing the ICT/MeEfS capacity-building project in Southeast Asia financed by the European Commission in 2019–2022. The constructed resilience scale was based on a 10-item list supported by the literature review. Participants were asked to rate their level of agreement on a 5-point Likert measure from 1 (“strongly disagree”) to 5 (“strongly agree”).

2.3. Type of Analysis

For the validation of the teachers’ ICT/Metaverse-enabled EfS transformative resilience scale, Exploratory Factor Analysis (EFA), and in particular, the principal component analysis (PCA) with varimax rotation, were adopted, including the Kaiser–Meyer–Olkin (KMO) test that is used for checking data sample adequacy and the Bartlett’s Test of Sphericity used for testing the validity of the collected data. A scree plot assessed the number of components/factors to be extracted. Items with factor loading greater than 0.40 were decided to be retained. The internal consistency of the retained items was examined using Cronbach’s alpha reliability statistics. The examination of multicollinearity was carried out using the Variance Inflation Factor (VIF) supplemented by tolerance metrics. Descriptive statistics assessed the data distribution regarding normality, including the kurtosis and skewness. Subsequently, correlation analysis and stepwise multiple regression were used to examine the impact of the hypothesized predictors of ICT self-efficacy and transformative teaching beliefs on ICT/MeEfS teachers’ resilience.

3. Results

3.1. Constructing and Validating the Teacher’s ICT/MeEfS Resilience Scale

One of the key objectives of this research was the construction and validation of the teacher’s ICT/MeEfS resilience scale. Exploratory factor analysis (EFA) with the principal component method was carried out to explore the factor structure of the newly constructed scale. The Kaiser–Meyer–Olkin (KMO) value was found to be 0.91, and the Bartlett’s Test of Sphericity showed a significant result ($\chi^2 = 10,311.50$, $df = 45$, $p < 0.001$), indicating that the data were suitable for carrying out an EFA. The extracted communalities ranged from 0.488 to 0.785, and all the pre-defined items for constructing the teacher’s ICT/MeEfS resilience measurement were retained. The PCA (Principal Component Analysis) revealed a two-factor solution with a direct varimax rotation method and eigenvalues > 1.0 , accounting for a substantial (68.26%) amount of the extracted variance. Factor 1 accounted for 42.41% of the extracted variance, and factor 2 accounted for 25.85%. Looking into Table 1, the seven items composing Factor/Component 1 can be labeled “ICT/MeEfS personal competence”, reflecting mastery and self-reliance in contextualizing ICTs with EfS driven by experiential,

constructivist, and transformative teaching and learning methodologies. Factor 2 can be labeled “reflexive practice”, consisting of three items reflecting a teacher’s capacity for reflection, action (individual and collective), and change.

Table 1. Rotated Component Matrix for the ICT/MeEfS Resilience Scale.

Items, Components, and Loadings	Comp 1	Comp 2
Using ICTs to enhance learners’ local sustainability experiences.	0.823	
Using ICT-enabled cross-cutting sustainability learning resources.	0.796	
Using ICTs for learners’ active involvement with real-life problems.	0.783	
Using ICTs to engage learners in dealing with local/global issues.	0.772	
Using life experiences to develop ICT knowledge and skills.	0.751	
Adjusting educational content for real-life learning.	0.727	
Using ICTs to strengthen outdoor learning activities.		0.698
Reflective practice has led me to rethink, revise, and change.		0.866
Using reflection to change thinking and behavior.		0.840
Reflecting critically on others’ actions increased my co-responsibility.		0.814

According to the results, the two-factor structure seems well-defined, clear, sensible, and theoretically based, with an eigenvalue of 5.39 for factor 1 and 1.43 for factor 2. All the other factors were found to be below 1.00 and thus did not add anything significant to the measurement. Accordingly, the two significant factors are sufficient to express all the characteristics highlighted by the ten stated items. This is made clear in the scree plot graph (Figure 1), which shows that the curve starts to flatten between the two and three components. From factor 3 onwards, the eigenvalue is less than one, indicating that only three factors could be retained, supporting the convergent validity of the construct.

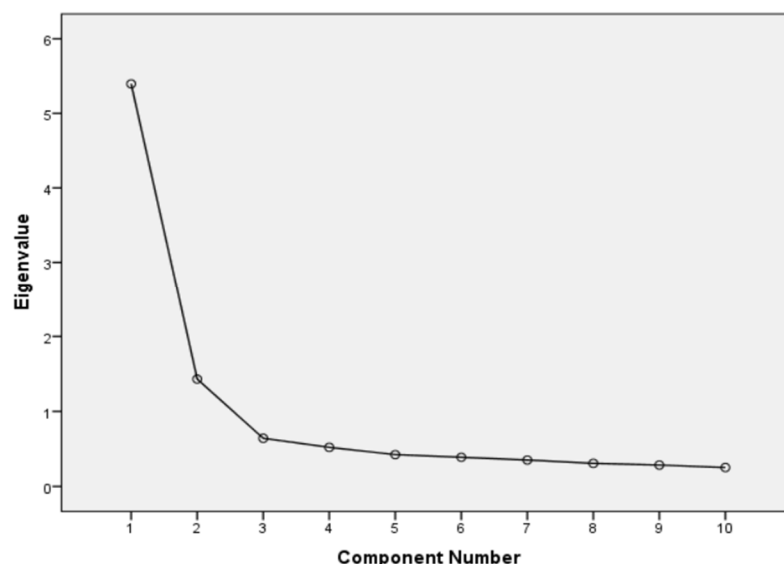


Figure 1. Scree plot.

The results of Cronbach’s alpha reliability analysis of the teacher’s ICT/MeEfS resilience scale, including all ten items, show the value of 0.90, indicating a very high reliability index and excellent internal consistency. The reliability measures for the two components were found to be 0.91 for the “ICT/MeEfS personal competence” component with means of 3.06 and 0.74 for the “reflexive practice” component with a mean of 3.25.

3.2. Multiple Regression Analysis

Before carrying out the multiple regression analysis, it was necessary to check missing data, the normality of the data, and possible outliers. The results showed that only a few

data were missing. The value of standard deviations (SDs) ranged from 0.40 to 1.0, the size of skewness ranged from 0.41 to ± 1.0 , and most of the kurtosis values were within the acceptable range of ± 2.0 [52]. These results show relatively narrow data spread around the mean; the tails somehow deviated from the normality that can be accepted in this type of study and analysis [53,54]. The teacher's ICT/MeEfS resilience average score (mean) was slightly above 3.00, showing a relatively medium ICT/MeEfS resilience score. The results concerning collinearity measured by the VIF metrics for the regressed variables ranged from 1.00 to 1.44, and the tolerance score was between 0.72 and 0.69. There is thus no problem of multicollinearity when carrying out a regression analysis. As shown in the correlation matrix presented in Table 2, there is a positive and significant relationship ($r = 0.83$) between self-efficacy and ICT/MeEfS resilience ($p < 0.01$) and between resilience and transformative teaching beliefs ($r = 0.29$, at $p < 0.01$).

Table 2. Descriptive results and correlation coefficients between dependent and independent variables.

Variables	Mean	S.D.	No	1	2	3
1. ICT/MeEfS resilience	3.14	0.57	1812	1.0		
2. ICT/MeEfS Self-efficacy	3.53	0.44	1813	0.83 **	1.0	
3. Transformative teaching beliefs	3.96	0.40	1814	0.29 **	0.55 **	1.0

** $p < 0.01$.

The stepwise multiple regression analysis revealed that the two hypothesized predictors, regressed self-efficacy (H1) and transformative teaching beliefs (H2), significantly contributed to teachers' ICT/MeEfS resilience. More specifically, the results presented in Table 3 show that both predictors were retained. The total coefficient of determination achieved was $R^2_{adj} = 0.730$, explaining 73% of the variability in the ICT/MeEfS resilience measure. In terms of the predictors' contribution, the regression analysis revealed that teacher self-efficacy in dealing with education for sustainability alone explained 66% of the teacher's ICT/MeEfS resilience ($R^2_{Change} = 0.660$, $F_{Change} (1,1809) = 3522.12$ with a standardized beta = 0.81 at $p = 0.000$) followed up by transformative teaching beliefs, which added 7% ($R^2_{Change} = 0.070$, $F_{Change} (1,1808) = 137.86$, with a standardized beta = 0.26, at $p = 0.000$).

Table 3. Multiple regression analysis results.

Hypotheses Verified	R^2_{Aj}	Df	R^2_{Ch}	F_{Ch}	Beta	T	p
H1: Self-efficacy $\rightarrow$ ICT/MeEfS Resilience	0.660	1809	0.660	3522.12	0.81	59.35	0.000
H2: Transformative teaching beliefs $\rightarrow$ ICT/MeEfS Resilience	0.730	1808	0.070	137.76	0.26	11.73	0.000

4. Discussion

In the last decade, higher educational institutions have been experiencing significant challenges, trends, and changes derived from (a) the accelerated proliferation of ICTs and Metaverse learning technologies across all education domains, largely intensified during the COVID-19 period; (b) the quest for sustainability education; and c) digitization trends. As ICTs are, along with climate change challenges, increasingly integrated across all societal domains, they generate higher expectations in education in general and education for sustainability in particular. In this study, the contextualization of ICTs with education for sustainability (EfS) is conceived as an innovation that promotes sustainability consciousness and action. Moreover, previous studies show that ICTs help learners make informed and conscious decisions for responsible behavior toward the integrity of the four pillars of sustainability justice [46,47]. The quest for new and innovative educational approaches that can promote transformative teaching and reorientate educational curricula to embed SDGs has been highly acknowledged in recent years [51–54]. Developing teachers' resilience in

merging ICTs and Metaverse learning technologies with Education for Sustainability (EfS) was conceived as critical.

Thus, this study focused on constructing and validating a new scale measuring teachers' ICT/Metaverse-enabled Education for Sustainability (ICT/MeEfS) resilience. The principal component analysis carried out in this study showed a two-factor model (factor 1: "personal ICT/MeEfS resilience" and factor 2: "reflexive practice". Personal ICT/MeEfS resilience refers to the teacher's ability to use ICTs and Metaverse learning technologies to enhance learners' local sustainability experiences, exploit the use of cross-cutting sustainability learning resources, encourage learners' active involvement in solving real-life problems enabled by ICTs, especially of regional and global concern, and to strengthen outdoor and place-based learning activities. Reflexive practice, the second component of the scale, seems to be connected to "teacher agency", which can be perceived as a process, context, and practice enabling the teacher to view teaching as ethical and political praxis. This perspective transcends the narrow or surface-level conception of learning and teaching practices by integrating more meaningful features into the broader learning and curriculum ecosystem in which the teaching of SDGs could be embedded. In this context, teacher reflexive practices enabled by ICTs and Metaverse learning technologies can make a difference not only to the teacher's conscious choices of what to teach and how to teach but also to the whys of making confident choices grounding the act of deciding and doing in theory. Conversely, when used with local learning activities, ICTs, especially MOOCs can open up new opportunities for local-global connections [55].

As it has also been pointed out in previous research, "reflexive practice" constitutes a process in which a teacher functioning as an agent of change is engaged not only in questioning his/her theories and practices but also in attempting to transform the structures that provide obstacles to such a function [56–58]. Accordingly, reflexive practice is much more transformative than constructional because it is driven by emancipatory reflection, merging critical reflection and action [59–61]. Navigating through reflecting on action, engaging in critical thinking planning, and taking action can generate transformative teaching and learning [62,63]. To create transformative learning, teachers must be given opportunities to reflect and act. Accordingly, the institutionalization of reflexivity assumes the creation of "reflexive standards and action competencies" for addressing complex sustainability problems [64]. It is also argued that there is a need to develop a comprehensive index of responsible behavior regarding sustainability that can be explained by social/cultural conditions and meta-reflexivity [65].

It may be assumed from the research results that reflexive practitioners should have a higher self-awareness of "who they are" and "what they could become". With reflexive practice, there is a level of responsibility and co-responsibility that is not reached by mere reflective practice. In other words, reflexivity implies critical reflection and action that can shape the ways of being, thinking, and behaving enabled by ICTs and Metaverse learning technologies. This corresponds to previous studies documenting that when ICTs and metaverse technologies are used with local and global sustainability issues, these tools can open up opportunities for building sustainability [66–69]. Moreover, incorporating online digital resources into the learning process, such as wikis, digital storytelling, participatory video, and discussion boards, has been found to enforce student civic engagement and be a starting point for meaningful in-class conversations [70,71].

Other previous research findings related to virtual reality tools and climate change learning issues show a positive impact of such tools on students' awareness and concern for sustainability [72], mainly if supported by ICTs [73]. Applying active learning tools and transformative teaching methodologies grounded in real-life problems, such as widespread poverty, violence, and a widening wealth–poverty divide, can reinforce the notion that education is the cornerstone of sustainable development [74–76]. The results of this study are also substantiated by previous research, which shows that addressing real-world sustainability problems and challenges, complex systems thinking, multiple views of knowledge, and reflexivity can be best achieved by shifting from disciplinarity to interdisciplinarity,

leading toward cross-disciplinarity and trans-disciplinarity [77,78]. Thus, sustaining teachers' resilience in merging ICTs and Metaverse learning technologies with sustainability education becomes imperative, especially in teacher professional development. This is why this research, besides developing and validating the teacher's ICT/MeEfS resilience, investigated the predictive value of the teacher's ICT/MeEfS self-efficacy and transformative teaching beliefs to the teacher's ICT/MeEfS resilience.

The multiple regression analysis results indicated that teacher self-efficacy and transformative teaching beliefs significantly predict teachers' ICT/MeEfS resilience. This implies that these two constructs or predictors should receive more attention in research and teacher professional development. These constructs can affect teachers' resilience in merging ICTs and Metaverse learning technologies with education for sustainability. Specifically, the structure and content of teacher education programs should focus on transformative teaching, reflective teaching and learning practices, and resilience-building strategies to provide future teachers with the knowledge, skills, and action competencies to cope with humanity's sustainability challenges. Similarly, in-service training should focus on training teachers to reorient university study programs and individual courses to embed sustainability and SDGs. This can be achieved through professionalizing academic teaching by merging ICTs and Metaverse learning technologies with education for sustainability. Considering that the ecological structure of human development is at risk, it is essential to focus on reflexive emancipation, which overcomes the contradictions between submission to nature and technical mastery of nature [79]. An international study carried out by Makrakis [80] based on a large sample ($N = 3,080$) of pre-service teachers from Finland, Greece, Sweden, Japan, and Holland documented prevailing no-stance and pessimistic attitudes toward the impact of technology and science on sustainable development. This seemed to be interpreted from the use of technology and science for profit-making at the expense of nature. In the same study, a strong connection was also found between environmental consciousness and attitudes toward the role and impact of science and technology on society. These results indicated a need to place higher critical concerns about the overoptimism of technological progress concerning sustainable development. In another study, it was argued that technology is a historically and contextually diverse phenomenon, which means that technology can serve sustainability. However, to understand it, we have to abandon the prevailing linearity and one-dimensionality in viewing technology and sustainable development [81]. Further elaboration is necessary to capture the complexities of technology, society, and sustainable development, particularly the dialectics of ICTs and Metaverse learning technologies in contextualizing sustainability issues in teaching, learning, and curricula.

5. Conclusions

This study revealed that teacher self-efficacy and transformative teaching beliefs can significantly predict their resilience in ICT/MeEfS. The findings implied that in-service teachers must improve their self-efficacy and transformative teaching capacities to merge ICTs and Metaverse learning technologies to embed sustainability issues in teaching processes, practices, and course curricula. In addition, given that teachers' ICT/MeEfS resilience is predicted by self-efficacy and transformative teaching beliefs, applying strategies to enhance both the two identified components, namely personal ICT/MeEfS and reflexive practices, and the two predictors are pivotal for teachers to manage the challenges associated with the embedment of SDGs in education processes and practices. The results of this study also serve as empirical support for establishing training interventions and constructing and implementing suitable education for sustainability capacity-building models. However, it is necessary to consider the critical importance of teacher-level, system-level, and school-level barriers to implementing ICT/MeEfS [82].

The insights gained from this study provide valuable suggestions for teacher trainers, teachers, and policymakers aiming to integrate ICTs and Metaverse technologies as enablers for embedding education for sustainability in teaching, learning, and curricula. This study also outlines limitations and suggests directions for future research, highlighting the

need for further investigations into the longitudinal impacts and cultural adaptability of Metaverse applications in education.

Despite its merits, the current study has limitations that should be pointed out. One is that this study relies solely on self-reported quantitative data. However, the large number of respondents and the achieved high-reliability indices in terms of consistency and validity minimize this shortcoming. It is recommended that self-reported data be supplemented with qualitative methodologies such as semi-structured interviews that will help illuminate the quantitative results. Moreover, the data were gathered only from a particular sample with specific characteristics (e.g., ICT coordinators), which may undermine the generalizability of the outcomes to other teacher subjects and functions. Additionally, despite the high variance extracted from the two predictors, additional predictors could be added in future studies. Furthermore, as teachers' beliefs and practices are not static, longitudinal research could be applied to investigate and predict possible changes. Notwithstanding these limitations, the results of this study show that teachers' ICT/MeEfS resilience is a reliable and valid construct for assessing teachers' capacity to merge ICTs and Metaverse learning technologies with education for sustainability. This study also identifies factors associated with resilience, which may provide insights into the design, development, and implementation of suitable resilience capacity-building interventions. Another significant contribution from the findings is the importance of transformative teaching and learning contrasted with the transmissive pedagogies and curricula as products. It is also commonly assumed that teachers' resilience is associated with transforming teachers' appraisals [83]. Resilient teachers can thrive in difficult circumstances [30,84,85]. It is, thus, essential to eliminate contradictions in the nexus of ICTs and Metaverse learning technologies and education for sustainability.

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A Systematic Review of Postgraduate Programmes Concerning Ethical Imperatives of Data Privacy in Sustainable Educational Data Analytics

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Abstract: This systematic review, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, investigated the intersection of data privacy, postgraduate educational data analytics (EDA), and sustainability. Existing literature focuses on general privacy concerns in EDA, neglecting the specific data collected and related risks in postgraduate programmes. This review addresses this gap by identifying data types used by higher education institutions in postgraduate initiatives and evaluating the adequacy of current ethical frameworks, particularly for sustainability goals. Recognising the lack of established best practices for balancing data utility and privacy, the review analyses privacy-preserving techniques. Through identifying key data types collected in postgraduate initiatives, evaluating existing ethical frameworks, and exploring privacy-preserving educational data analytics techniques, this study provided practical guidance for higher education institutions to navigate the challenges of balancing data utility and student privacy. The results suggest that higher education institutions can achieve sustainable data use by adopting a comprehensive approach that incorporates best practices, emerging technologies, and continuous monitoring to safeguard student privacy while leveraging the benefits of educational data analytics for achieving the Sustainable Development Goals.

Keywords: educational data analytics; data privacy; learning analytics; sustainability; systematic review



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1. Introduction

The global community faces a significant challenge of achieving the ambitious goals outlined in the United Nations' Sustainable Development Goals (SDGs) by 2030. These multifaceted goals, encompassing issues like poverty eradication and climate change mitigation, necessitate a comprehensive approach [1]. The SDGs emphasise the importance of quality education (SDG 4) and responsible consumption and production patterns (SDG 12) [2]. Higher education institutions (HEIs) play a vital role in achieving these goals, increasingly utilising educational data analytics (EDA) to monitor progress and optimise resource allocation [3]. EDA offers immense potential to enhance educational experiences and contribute to a more sustainable future. For instance, HEIs can leverage EDA to analyse student behaviour patterns related to energy consumption in campus buildings and identify areas for improvement [4]. As such, EDA serves as a crucial tool for informing decision making, measuring progress, and pinpointing areas needing improvement [1]. However, harnessing student data for sustainability initiatives presents ethical concerns regarding data privacy, particularly within the context of postgraduate programmes. Lane [5] highlights the potential for the collection and analysis of educational data to reveal sensitive details about students' learning styles, academic progress, and areas of weakness. Within the realm of sustainable education, where students often grapple with complex social and environmental issues, additional privacy considerations arise. For instance, student data could inadvertently capture personal opinions on controversial topics like environmental

policies [6]. This could potentially lead to a proliferation of self-censorship or a reluctance to fully engage in learning activities [6].

The deluge of big data has propelled data privacy to the forefront of ethical concerns. The collection, storage, and analysis of student data for educational data analytics (EDA) raises concerns about potential misuse and unauthorised disclosure of personal information [7]. Striking a balance between leveraging the power of EDA for sustainability initiatives and safeguarding student privacy is paramount to fostering trust within the educational ecosystem [8]. This is particularly crucial in postgraduate programmes, where students often engage in independent research on sensitive topics. Such research may generate data considered more private than undergraduate studies due to the nature of the inquiry [8]. Additionally, postgraduate students possess greater autonomy over their research direction, highlighting the critical importance of informed consent regarding data utilisation. The legal landscape surrounding student data privacy is a complex and evolving domain. Regulations like the General Data Protection Regulation (GDPR) in the European Union (EU) impose strict limitations on the collection, storage, and use of personal data [9]. Understanding and complying with these frameworks is essential for HEIs to develop responsible and compliant educational data analytics practices. However, the GDPR is not the sole regulation to consider. Broader principles for data protection are established by international regulations like the Council of Europe's Convention for the Protection of Individuals concerning Automatic Processing of Personal Data and its Additional Protocol (Convention 108) [10]. The landscape of African data privacy regulations is still under development, but several countries are enacting comprehensive data protection laws [8]. For HEIs operating in Africa or collaborating with postgraduate students from African countries, understanding these emerging regulations is crucial.

This systematic review aims to address three critical research gaps at the intersection of data privacy considerations, postgraduate EDA, and sustainability. Existing literature on EDA often addresses broad privacy issues but fails to comprehensively explore the specific data points collected within postgraduate programmes and the associated risks for these students. This review identified the types of data commonly utilised in HEI initiatives focused on postgraduate students. Ethical frameworks for educational data use might not fully capture the nuances of postgraduate education, particularly when sustainability is a core objective. This review examined how current frameworks manage the specific needs and sensitivities of postgraduate data within a sustainability context. There is a lack of established best practices for HEIs to balance the benefits of using student data for sustainability initiatives with protecting postgraduate student privacy. To address this, this review systematically analysed existing research on privacy-preserving educational data analytics techniques. By identifying and evaluating these best practices, the study aims to provide HEIs with practical guidance on implementing responsible and privacy-conscious data use in postgraduate EDA projects that contribute to achieving the SDGs, and, as a systematic review, also aims to contribute valuable insights to the evolving field of educational data analytics in a sustainability context. By addressing these research gaps, the study promotes the responsible use of data for achieving sustainability goals while safeguarding the privacy rights of postgraduate students.

Aligned with this overarching goal, the review pursued the following research objectives:

- To categorise the types and dimensions of sustainable educational data typically collected in postgraduate programmes by HEIs.
- To explore the potential privacy risks that may arise from the utilisation of student data for sustainable educational analytics within postgraduate programmes.
- To examine current practices and emerging frameworks employed by HEIs to ensure the sustainable privacy of student data within postgraduate programme educational settings.

2. Materials and Methods

To ensure transparency and methodological rigour, this systematic review adopted the guidelines outlined in the Preferred Reporting Items for Systematic Reviews (PRISMA 2020, Supplementary Materials) statement [11].

2.1. Systematic Search Strategy and Study Selection

A comprehensive search strategy guided the identification of relevant studies for this systematic review. Three academic databases were utilised, including ERIC, Scopus, and Web of Science, alongside two additional databases specifically focused on sustainability research (GreenFILE and Sustainability Science Collection). The search encompassed peer-reviewed journal articles, conference papers, and book chapters published in English. The search terms were carefully chosen to reflect the core areas of sustainability in postgraduate education, educational data analytics, and student privacy. Examples include “postgraduate education”, “masters”, “doctoral”, “sustainable education”, “educational data analytics”, “learning analytics”, “student privacy”, and “data ethics”. Boolean operators (AND, OR) were strategically combined to ensure the search captured relevant literature while maintaining a focus on sustainable data privacy within postgraduate education. This multi-faceted approach aimed to achieve a balance between comprehensiveness and precision in identifying relevant studies for this review.

To ensure a targeted and relevant literature search focusing on data privacy concerns, this review adopted the Population, Intervention, Comparison, Outcome (PICO) framework to develop the search strategy and establish eligibility criteria [12]. Following the PICO elements, studies were selected based on the following criteria:

- Population (P): Focus: Postgraduate students (Master’s or Doctoral programmes) in education. Screening: Studies explicitly mentioning postgraduate students received priority during title and abstract screening. Studies solely focussed on other educational levels or broader student populations were excluded.
- Intervention (I): Focus: Use of educational data analytics in postgraduate education. Screening: Priority was given to studies investigating interventions utilising educational data analytics for student support or learning improvement within postgraduate education. Studies solely focussed on the technical aspects of educational data analytics without an educational application were excluded.
- Comparison (C): Focus: Comparison group or baseline data on student privacy considerations. Screening: Studies that compared the effectiveness of educational data analytics interventions about student privacy were prioritised. This could involve comparisons to traditional methods or control groups without educational data analytics, or studies examining how existing interventions addressed privacy concerns. Studies with baseline data on student privacy practices before the intervention were also considered.
- Outcome (O): Focus: Student privacy considerations and potential risks. Screening: Studies that explored potential privacy risks associated with educational data analytics in postgraduate education were prioritised. This could encompass concerns about data collection methods, storage practices, student anonymity, and the potential for self-censorship due to data analysis. To ensure the retrieved studies directly addressed the research topic, the PICO framework was complemented by the following additional eligibility criteria:
 - To encompass the most recent advancements in educational data analytics and their concomitant privacy concerns, this study included English-language publications spanning the period 2011–2024. The selection of 2011 as the starting point is deliberate, coinciding with the exponential surge in big data collection and analytics capabilities. This period witnessed a demonstrably increased focus by educational institutions on collecting and analysing student data in novel and ever-more comprehensive ways [6].

- Studies that provided detailed information regarding educational data analytics interventions and how they addressed student privacy were prioritised. This includes specifics on data types collected, anonymisation techniques, and student consent procedures.
- Empirical research articles that demonstrated a critical perspective on student privacy within the educational data analytics context of postgraduate education were preferred. These studies employed sound research methodologies and contributed to the understanding of balancing data-driven educational practices with student privacy in this domain.

This refined approach ensured the selection of relevant literature that directly addresses the interplay between educational data analytics, student privacy, and postgraduate education.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Figure 1) depicts the search strategy and selection process for the included studies (adapted from [11]). The initial database search yielded a total of 522 studies. To efficiently manage this extensive corpus and ensure a rigorous selection process, a two-stage approach was adopted. This involved utilising Rayyan [13], a web-based platform designed for systematic reviews, alongside ASReview [14], an open-source software incorporating machine learning functionalities.

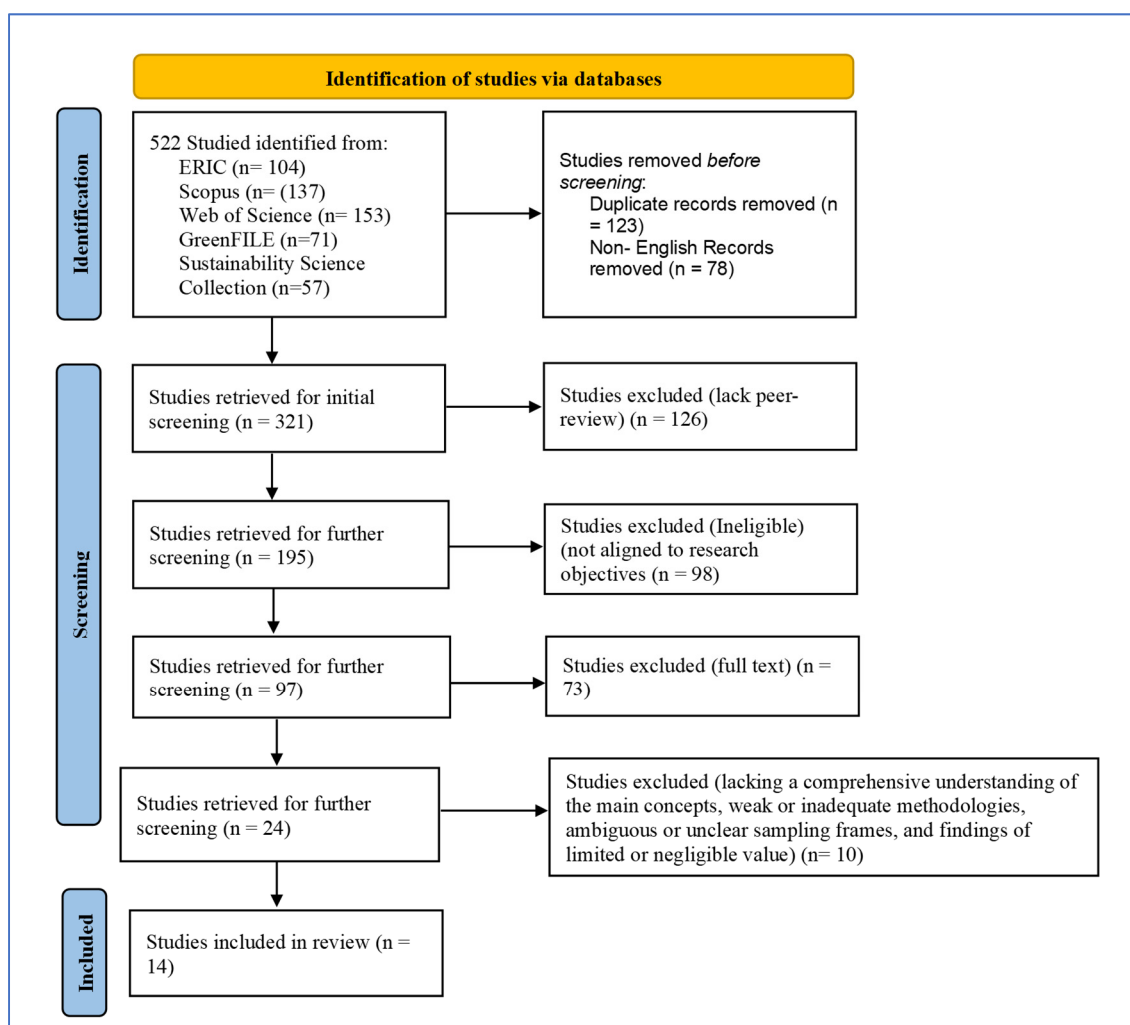


Figure 1. Mapping the Literature Search and Study Selection Process (adapted from PRISMA Statement [11]).

- Stage 1: De-duplication and Machine Learning Prioritisation
 - De-duplication: The initial stage commenced with leveraging Rayyan’s [13] deduplication capabilities. This effectively removed 201 duplicate and non-English studies, resulting in a more manageable pool of 321 articles for further evaluation.
 - Machine Learning Prioritisation: Subsequently, ASReview [14], a tool powered by machine learning, analysed the remaining titles and abstracts. Based on the pre-defined inclusion and exclusion criteria established within the platform, AS-Review prioritised articles for full-text review. This potentially reduced workload by focusing on the most relevant studies first.
- Stage 2: In-depth Review and Selection within Rayyan
 - Rigorous Full-Text Review: Following ASReview’s [14] prioritisation, both researchers (reviewers) independently assessed the full text of the selected articles within the Rayyan [13] interface. This meticulous process involved applying the pre-defined eligibility criteria to identify studies that fully met the research objectives and aligned with the specific focus on data privacy concerns in postgraduate education.
 - Exclusion Based on Eligibility Criteria: Through this in-depth evaluation, 297 studies were excluded for not comprehensively satisfying the established criteria. This rigorous selection process resulted in the identification of twenty-four key studies directly addressing sustainable educational data analytics in postgraduate education with a focus on student privacy considerations.

2.2. Quality Assessment Using the CASP Checklist

The twenty-four studies were retained for a comprehensive quality assessment, focusing on the following key aspects:

- Clarity and Comprehensiveness of Privacy Concepts: The Critical Appraisal Skills Programme (CASP) [15] checklist guided the reviewers in evaluating the authors’ understanding of relevant data privacy concepts, specifically within the context of postgraduate education. The reviewers assessed the introduction and literature review sections for evidence of a clear understanding of student privacy principles, potential privacy risks associated with educational data analytics in this domain, and existing research on mitigating these risks.
- Methodological Rigour in Examining Privacy Concerns: The CASP checklist [15] provided a structured framework for scrutinising the methodology sections. The reviewers examined factors like the appropriateness of research designs for the specific research questions related to data privacy, data collection methods employed (e.g., surveys addressing student concerns about data use), data analysis techniques that ensured student anonymity, and the researchers’ attention to potential bias and its mitigation strategies. Studies employing well-justified and rigorous methodologies for investigating data privacy concerns were prioritised.
- Clear Sampling Frames and Representation: The CASP checklist emphasised the importance of clear sampling frames. The reviewers evaluated whether the authors clearly defined the target postgraduate student population, the sampling method used to select participants for studies on data privacy, and the justification for the sample size and its representativeness of the broader postgraduate student body. Studies with well-defined and representative sampling frames were considered more reliable for informing generalisable conclusions about data privacy practices.
- Valuable Findings on Data Privacy for Sustainable Education: The CASP checklist focuses on the results and discussion sections regarding data privacy. The reviewers assessed the clarity of the presented findings on student privacy concerns related to sustainable educational data analytics in postgraduate education, their alignment with the research questions and methodology, and the depth of discussion regarding their meaning and implications for developing responsible data governance practices.

Articles presenting valuable contributions to the knowledge base on data privacy in this specific context, along with practical recommendations for mitigating privacy risks, were deemed particularly noteworthy.

Through utilising the CASP checklist [15] as a guiding framework, a systematic and thorough evaluation of each article's strengths and weaknesses across these four key quality indicators was ensured. This approach led to the selection of a final collection of fourteen high-quality research articles that formed the foundation for the comprehensive review of data privacy considerations in sustainable educational data analytics for postgraduate education. Leveraging the PRISMA framework, Figure 1 maps the comprehensive search strategy and rigorous selection process implemented to identify pertinent studies for this systematic review.

Following the initial stage of independent article screening using Rayyan ASReview software [14], the reviewers engaged in a consensus-building meeting to address any discrepancies that arose during the selection process. This collaborative approach fostered a balanced and objective evaluation of each study's relevance to the review objectives. To bolster confidence in the consistency of the screening process and minimise potential reviewer bias, measures of inter-rater reliability (IRR) were established. The primary indicator employed was the level of agreement between the reviewers, expressed as a percentage. This resulted in a high concordance rate of 90%, signifying a strong level of initial agreement. Furthermore, to account for the possibility of chance agreement, the reviewers calculated Cohen's kappa coefficient (κ). This more robust measure considers the agreement beyond what could be expected by coincidence. The resulting kappa coefficient of 0.85 indicated a substantial level of agreement between the reviewers, further solidifying the reliability of the screening process. These measures collectively demonstrate the rigour employed to curate a comprehensive and unbiased selection of studies for this systematic review.

2.3. Data Extraction and Coding

Aligned with the principles outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [11], data extraction aimed to systematically collect relevant information from the selected studies regarding data privacy considerations in postgraduate education. To ensure a standardised and efficient process, an open-source online tool called CADIMA [16] was utilised for data extraction. The data extraction form encompassed the following key elements:

- Study Characteristics: Author(s), year of publication, geographical location of the study (focusing on education programmes).
- Research Methodology: Research design employed (e.g., case studies, surveys), data collection methods (e.g., interviews with faculty or students), and approaches to data analysis.
- Sustainable Educational Data Analytics in Education: Specific educational data analytics techniques and tools used in the context of postgraduate education, along with details regarding how these practices addressed student privacy concerns.
- Postgraduate Education Context: Description of the postgraduate education setting (e.g., type of institution, programme focus), including any relevant aspects related to data governance frameworks or privacy policies.
- Data Privacy Considerations: Key findings related to the potential benefits and challenges associated with sustainable educational data analytics in postgraduate education, with a particular focus on student privacy risks and mitigation strategies explored by the studies.
- Research Limitations and Future Directions: Limitations identified by the study authors and potential areas for further research regarding data privacy and sustainable educational data analytics in postgraduate education.

Data coding within this systematic review was a manual process. It involved a thematic analysis approach, focusing on extracting and documenting core information

such as author(s), study design, publisher, and key findings relevant to data privacy considerations in the context of postgraduate education. The extracted data were then systematically organised and presented in Table 1, which offers an overview of the data extraction and coding procedures employed in this review.

Table 1. Data Extraction and Coding.

Author(s)	Title	Source	Findings
[17]	Learning analytics in a shared-network educational environment: ethical issues and countermeasures.	International Journal of Advanced Computer Science and Applications (IJACSA)	Identified ethical concerns surrounding student data privacy in learning analytics, including potential for discrimination, lack of transparency, and student surveillance. Proposed countermeasures such as informed consent, data minimisation, and clear data governance practices.
[18]	Analytics in higher education: benefits, barriers, progress, and recommendations [Research Report].	EDUCAUSE Center for Applied Research	Highlighted the benefits of learning analytics for improving student learning and institutional effectiveness. Also identified are barriers such as faculty resistance, data privacy concerns, and lack of technical expertise.
[19]	A comprehensive AI policy education framework for university teaching and learning.	International Journal of Educational Technology in Higher Education	Proposed a framework for educating university faculty and students on responsible AI use in teaching and learning. This framework emphasises the importance of data privacy considerations within the context of AI-powered learning analytics.
[7]	Big data and the ethical implications of data privacy in higher education research.	Sustainability	Examined the ethical implications of big data analytics in higher education research, particularly regarding student data privacy. Highlighted the need for robust data security measures and adherence to ethical research principles.
[20]	Student perceptions of privacy principles for learning analytics.	Education Tech Research Dev	Investigated student attitudes towards privacy principles in learning analytics. Found that students generally support learning analytics but value transparency, control over their data, and clear communication about data usage.
[21]	A measurement of faculty views on the meaning and value of student privacy.	Journal of Computing in Higher Education	Explored faculty perceptions of student data privacy in the context of learning analytics. The study revealed a diversity of views, with some faculty members emphasising the importance of data privacy and others prioritising the potential benefits of learning analytics.
[22]	Technological barriers and incentives to learning analytics adoption in higher education: insights from users.	Journal of Computer-Assisted Learning	Identified technological challenges that hinder the adoption of learning analytics in higher education. The study also highlighted the need for clear data governance policies and faculty incentives to encourage the wider use of learning analytics tools.
[23]	Identification of ‘at risk’ students using learning analytics: The ethical dilemmas of intervention strategies in a higher education institution.	Educational Technology Research and Development	Examined the ethical considerations of using learning analytics to identify and support at-risk students. The study emphasised the importance of balancing early intervention with student privacy and avoiding potential student stigmatisation.

Table 1. Cont.

Author(s)	Title	Source	Findings
[24]	Privacy concerns and online learning of postgraduate students through the lens of stimulus–organism–response model.	Sustainability	Investigated the relationship between student privacy concerns and online learning engagement in postgraduate programmes. The study found that privacy concerns can negatively impact student engagement, highlighting the need for transparent data practices and strong privacy protections.
[25]	Students’ privacy concerns in learning analytics: Model development.	British Journal of Educational Technology	Developed a model to understand the factors influencing student privacy concerns in learning analytics. The model suggests that factors such as perceived risk, trust in the institution, and awareness of data practices all play a role in shaping student privacy attitudes.
[26]	Revamping the academic library use data capabilities: the Greek library science postgraduates’ perspective.	Library Hi Tech News	Explored postgraduate students’ perspectives on data collection practices in academic libraries. The study identified concerns about student privacy and the need for clear communication about how library data are used.
[27]	Artificial intelligence education for radiographers, an evaluation of a UK postgraduate educational intervention using participatory action research: a pilot study.	Insights into Imaging	Evaluated a pilot study using AI-powered learning analytics in a postgraduate radiography program. While the study focused on the effectiveness of the intervention, it also acknowledged the importance of addressing student privacy concerns related to data collection and usage.
[28].	Supporting higher education with social networks: trust and privacy vs. perceived effectiveness.	Online Information Review	Investigated the relationship between trust, privacy concerns, and perceived effectiveness of social network-based learning analytics in higher education. The study found that student trust in the institution and the perceived benefits of learning analytics can mitigate privacy concerns, suggesting the importance of building trust and transparency around data practices.
[29]	The student expectations of learning analytics questionnaire.	Journal of Computer-Assisted Learning	Developed a questionnaire to measure student expectations regarding learning analytics. The questionnaire identified student concerns about data privacy and a desire for clear information about how their data will be used.

3. Results

This Section undertakes a critical synthesis of the literature review findings, specifically how they illuminate the established research objectives. Table 2 presents the germane findings from the literature review that pertain to the delineation of the types and dimensions of educational data typically collected in postgraduate programmes offered by higher education institutions (HEIs).

Leveraging the taxonomical framework established in Table 2, which dissects the multifaceted nature of postgraduate educational data, this study delves into the privacy concerns contingent upon the implementation of sustainable educational analytics within postgraduate programmes. The ramifications of this inquiry are documented in Table 3.

Table 2. Types and Dimensions of Postgraduate Educational Data.

Category	Dimensions	Scholarly Sources
Student demographics and background	Age, gender, nationality, prior academic background, work experience	[7,21,26–28]
Academic performance	Course grades, assignment performance, research project outcomes, thesis/dissertation quality	[18,21,23,28]
Engagement and participation	Class attendance, discussion participation, group project contributions, online forum activity	[20,23,25]
Learning outcomes	Standardised test scores (sustainability knowledge), applying sustainability principles, critical thinking (sustainability context)	[17,18,21–24,27,29]
Program satisfaction	Course content feedback, faculty effectiveness feedback, program structure feedback, overall satisfaction	[18–23,27,28]
Career outcomes	Employment data (job titles, sectors), career satisfaction (sustainability)	[20,21,24–26,28,29]

Table 3. Privacy Risks of Sustainable Educational Analytics in Postgraduate Programmes.

Risk Category	Description	Potential Consequences	Scholarly Sources
Data breach	Student data (demographics, performance, engagement, career outcomes) are exposed through accidental or malicious breaches.	Identity theft, discrimination, and reputational damage for students.	[7,17,18,20,22,26]
Misuse of data	Collected data are used for unintended purposes (commercialisation, profiling, disciplinary actions).	Student exploitation, and loss of trust in the institution.	[17,20,24,25]
Lack of transparency and consent	Students are unaware of data collection practices, usage, or sharing.	Mistrust between students and HEI, uninformed consent.	[20,21,24,25,29]
Algorithmic bias	Algorithms analysing student data perpetuate existing biases.	Unfair student assessments, and inaccurate program evaluations.	[21,22,24]
Chilling effect on participation	Fear of data misuse discourages participation in discussions, questions, and exploration of controversial topics.	Stifled critical thinking, and hindered learning environment.	[23,25]

The acknowledgement and mitigation of privacy risks through the implementation of appropriate safeguards is paramount. Such efforts will ensure the sustainable utilisation of educational analytics, thereby maximising the benefits for both students and postgraduate programmes. In this vein, the study conducted a comprehensive review of current practices and emerging frameworks designed to promote sustainable student data privacy in postgraduate programmes. These practices and frameworks are given in Table 4.

Table 4. Sustainable Student Data Privacy in Postgraduate Programmes.

Category	Practices	Description	Scholarly Sources
Current practices	Informed consent	Students understand what data are collected, how they are used, and who has access (builds trust and empowers choice).	[20,24,25,29]
	Data minimisation	HEIs collect only relevant data for specific analytics purposes (reduces exposure risk).	[18,22,23]
	Data anonymisation/pseudonymisation	Data are stripped of identifiers (anonymisation) or replaced with codes (pseudonymisation) for analysis.	[7,19,21]
	Secure storage and access controls	Robust security measures protect data storage and limit access to authorised personnel.	[17,21,26]
	Data retention policies	Clear policies specify how long data are stored before secure deletion (prevents unnecessary accumulation).	[18,23,27]
Emerging frameworks	Privacy-enhancing technologies (PETs)	Technologies like differential privacy (adding noise) and homomorphic encryption (analysing encrypted data) allow data analysis while protecting privacy.	[7,19,28]
	Data governance frameworks	Principles and practices are outlined for responsible data collection, use, and sharing (ensures compliance with regulations).	[17,18,24]
	Focus on student privacy rights	Frameworks emphasise student rights like access and control over their data (empowers students in data management).	[20,25,29]

4. Discussion

Table 2 provides an overview of the various types and dimensions of educational data typically collected in postgraduate programmes offered by HEIs. The table is accompanied by relevant scholarly sources that inform the understanding of each data category. The first category, ‘student demographics and background’, presents a demographic profile of the student body. This encompasses characteristics such as age, gender, nationality, prior academic background (e.g., undergraduate major), and work experience in given fields. Analysing these demographics allows HEIs to understand the programme’s student composition and identify enrolment trends [20,21,25]. For instance, a programme might attract a higher proportion of students with backgrounds in environmental science. This information can be valuable for programme development and targeted recruitment efforts. Academic Performance data, another category in Table 2, focuses on measuring a student’s achievements within the programme. It comprises course grades, performance on assignments, research project outcomes, and the quality of the thesis/dissertation. By analysing academic performance data, HEIs can identify strengths and weaknesses within the curriculum, as well as track individual student progress [18,21,23,28].

Table 2 also includes a category for ‘engagement and participation’. These data capture a student’s active involvement in the learning process, encompassing factors like class attendance, participation in discussions, contributions to group projects, and online forum activity. Analysing engagement and participation data allows HEIs to assess student engagement and identify areas where students might require additional support [20,23,25]. Learning Outcomes data, as presented in Table 2, assess the extent to which students

have achieved the programme's core learning objectives. This might involve standardised tests measuring sustainability knowledge, evaluating a student's ability to apply sustainability principles to real-world problems, and assessing critical thinking skills within a sustainability context. Analysing these data helps determine the programme's effectiveness in achieving its learning goals [17,18,22]. 'Programme satisfaction' data gauge student feedback on various programme aspects. It includes feedback on course content, faculty effectiveness, programme structure, and overall satisfaction with the learning experience. Analysing programme satisfaction data allows HEIs to identify areas for improvement and enhance the student experience [18–20]. The final category in Table 2, Career Outcomes, tracks student career trajectories after graduation. This might include data on employment details (job titles, sectors), and self-reported career satisfaction. These data provide valuable insights into programme effectiveness in preparing graduates for careers [20,28]. Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

The utilisation of educational analytics in postgraduate programmes offers valuable insights into student learning and programme effectiveness. However, this data collection raises concerns regarding student privacy (Table 3). Educational institutions collect a comprehensive range of student data, encompassing demographics, academic performance, engagement metrics, and potentially even career outcomes. A data breach, whether accidental or malicious, could expose this sensitive information to unauthorised parties. This could have significant repercussions for students, including identity theft, job market discrimination, and reputational damage [24]. Student data collected for educational analytics could also be misused for unintended purposes. This encompasses commercialisation (e.g., targeting students with advertisements based on their programme or performance) or student profiling based on academic performance or engagement. Additionally, data could be used for disciplinary actions in ways students do not anticipate [17].

Furthermore, students might not be fully aware of the types of data being collected about them, how they are being used, or with whom they are shared. This lack of transparency can erode trust between students and the institution. Even if consent is obtained, it is crucial to ensure it is truly informed consent, meaning students understand the potential risks involved and can freely choose to participate [20,21,24,25,29]. Educational analytics often relies on algorithms to analyse student data. These algorithms can perpetuate existing biases, leading to unfair assessments of students or inaccurate programme evaluations. For example, an algorithm might unfairly penalise students from non-traditional backgrounds or learning styles [22]. Finally, if students fear their data will be used against them, they might be less likely to participate in online discussions, ask questions in class, or take risks in their learning (e.g., exploring controversial topics). This could stifle critical thinking and hinder a healthy learning environment [23].

Table 4 outlines a comprehensive set of practices and emerging frameworks employed by HEIs to ensure sustainable student data privacy within postgraduate programmes. Current practices focus on building trust and transparency with students. Informed consent, as supported by research from Ifenthaler and Schumacher [20], Majeed et al. [24], Mutimukwe et al. [25], and Whitelock-Wainwright et al. [29], empowers students by informing them about the data collected, their purpose, and who has access. This transparency fosters a sense of control and encourages student participation in data-driven initiatives. Data minimisation, highlighted by Bichsel [18], Klein et al. [22] and Lawson et al. [23], is another crucial practice. HEIs should collect only the data necessary for specific analytics objectives. This mitigates the risk of student exposure and ensures data utilisation aligns with its intended purpose. Data protection techniques such as anonymisation (removing identifiers) and pseudonymisation (replacing identifiers with codes) are also employed. Chan [19], Florea and Florea [7], and Jones et al. [21] discuss these methods, which permit data analysis while safeguarding student privacy. Robust security measures for data storage

and access control are essential, as emphasised by Adejo and Connolly [17], Jones et al. [21], and Sant-Geronikolou and Kouis [26]. Limiting access to authorised personnel and implementing strong security protocols minimises the risk of data breaches. Finally, data retention policies, as discussed by Bichsel [18], Lawson et al. [23], and van de Venter et al. [27], specify data storage duration before secure deletion. This prevents unnecessary data accumulation and reduces privacy risks for students.

Looking beyond current practices, the table highlights emerging frameworks that further enhance student data privacy. Privacy-enhancing technologies (PETs) play a crucial role. Chan [19], Florea and Florea [7], and Wang et al. [28] discuss PETs like differential privacy and homomorphic encryption. These technologies allow data analysis while protecting sensitive information, offering a promising approach for future educational data analytics practices. Data governance frameworks, as highlighted by Adejo and Connolly [17], Bichsel [18], and Majeed et al. [24], outline principles and practices for responsible data collection, use, and sharing. These frameworks contribute to achieving compliance with relevant data privacy regulations (e.g., GDPR). Emerging frameworks also increasingly emphasise student privacy rights, including access to and control over their data [20,25,29]. This empowers students and fosters a culture of data ownership within the educational environment.

5. Conclusions

Educational data analytics (EDA) has emerged as a powerful tool for HEIs, enabling them to collect a wide range of data within postgraduate programmes. These data encompass student demographics and background, academic performance, engagement and participation, learning outcomes, programme satisfaction, and even career outcomes. However, for HEIs to achieve sustainability through educational data analytics, they must grapple with a range of student privacy risks. These risks include data breaches, misuse of student information, lack of transparency and informed consent, algorithmic bias, and a potential “chilling effect” on student participation due to privacy concerns. To mitigate these issues, HEIs can employ a multi-layered approach to ensure sustainable student data privacy in postgraduate programmes.

Building trust and reducing privacy risks can be achieved through informed consent procedures, data minimisation techniques (collecting only the essential data), and anonymisation or pseudonymisation of student data. Additionally, robust data security measures, such as secure storage, access controls, and data retention policies, are crucial for guaranteeing both physical and temporal data protection. Furthermore, the emergence of Privacy Enhancing Technologies (PETs) and data governance frameworks suggests a growing focus on both technological solutions and regulatory compliance within the context of student data privacy. However, striking a balance between maximising the benefits of data utilisation and protecting student privacy remains a significant challenge. HEIs must navigate this intricate balance by fostering open communication with students regarding data use, continuously evaluating and improving their data privacy measures, and staying abreast of evolving regulations. This ongoing effort is crucial for achieving long-term student data privacy within postgraduate programmes.

5.1. Limitations of the Current Analysis

This analysis prioritised the quality of evidence by focusing on peer-reviewed studies. While this approach ensured robustness, it inherently limited the scope of the review. Potentially valuable unpublished research (grey literature) on student data privacy practices in postgraduate programmes might have been excluded. Additionally, publication bias, where studies with statistically significant positive findings are more likely to be published, could have been introduced. However, the review mitigated these limitations to some extent by employing a comprehensive search strategy across multiple electronic databases to maximise the capture of relevant peer-reviewed studies. Furthermore, the review methods explicitly justified the rationale behind the inclusion/exclusion criteria,

particularly the decision to exclude grey literature. The review was inherently limited by the specific inclusion/exclusion criteria used for selecting studies. This may restrict the generalisability of findings to all postgraduate education settings. However, by outlining the inclusion/exclusion criteria, the review allows readers to assess the applicability of the findings to their specific context.

5.2. Future Research Directions

The current review has established a solid foundation by analysing existing research on student data privacy in postgraduate programmes. Building on this knowledge base, future research can delve deeper into the practical application of educational data analytics while maintaining student privacy and fostering a sustainable approach to data use. In-depth case studies of educational data analytics implementation in diverse postgraduate programmes could offer valuable insights. These studies could examine the implementation process, focusing on how institutions balance data utility with student privacy while establishing sustainable practices. Exploring the effectiveness of specific techniques, identifying challenges encountered in real-world settings, and evaluating long-term data management strategies would provide practical guidance for other institutions seeking to achieve sustainable student data privacy. Quantitative research methods could shed light on the relationships between educational data analytics interventions, various student outcomes, and the long-term sustainability of data practices. Studies investigating correlations between educational data analytics initiatives and factors such as academic achievement, student engagement, programme satisfaction, and responsible data collection/storage practices would be valuable. This research could also explore the potential impact of educational data analytics on student trust and continued participation in data-driven initiatives.

Future research could delve deeper into the efficacy of specific techniques within the context of student privacy and data sustainability. Longitudinal studies could track the impact of a particular technique (e.g., learning analytics dashboards, social network analysis) on student learning over time, examining both academic outcomes and potential privacy concerns. Additionally, comparative studies could explore the relative effectiveness of different techniques for achieving specific learning objectives within different postgraduate programmes, while also considering their long-term data management requirements and impact on student trust. This would offer valuable insights into how institutions can optimise educational data analytics practices for diverse student cohorts and learning environments while prioritising sustainable student data privacy.

To gain a more comprehensive understanding of student data privacy and its sustainability, future research could utilise qualitative methods to explore the lived experiences of students and educators involved with educational data analytics initiatives. Conducting semi-structured interviews and focus groups with stakeholders would help capture their perspectives on the impact of educational data analytics on teaching, learning, the overall learning environment, and long-term data management practices. This would provide valuable insights into potential challenges, ethical considerations, and areas for improvement around sustainable data privacy practices. By pursuing these directions for future research, individuals can not only enhance the effectiveness of educational data analytics in postgraduate programmes but also ensure it is implemented in a way that safeguards student data privacy and fosters a culture of responsible data use for the long term.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su16156377/s1>.

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Article

Innovative Professional Learning Communities and Sustainable Education Practices through Digital Transformation

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Abstract: Education is the most important part of sustainable society development. Traditional approaches to permanent lifelong educator training often fail to produce lasting changes in teaching practices (UN, Goal 4). This paper examines how educator involvement in a professional learning community (PLC) ensures equitable quality education and promotes lifelong learning opportunities for all and a sustainable digital transformation of the teaching and learning process. Participation in PLC and the use of contemporary learning environments positively impact the quality of educators' work, thereby enhancing the overall educational process. This study utilised a quantitative methodology, employing both descriptive and inferential statistics to analyse the data. Results indicate that a balanced integration of formal PLC structures and guidance, combined with elements of a non-formal, broader PLC and external incentives and support (such as projects), can surpass mere exchanges of best practices, foster innovation, and support the sustainable digital transformation of educators. This approach leads to a sustainable shift in pedagogical paradigms. The PLC_IP model (focused on including digital technologies and effective teaching strategies) enhances collective educator efficacy, contributing to improved teaching quality. For PLCs to achieve sustainability, they must be dynamic entities that adapt to the evolving educational landscape, ensuring their continued relevance and impact with rising completion rates over time. Our findings underscore the importance of innovative PLCs in driving sustainable educational development and improvement and provide a framework for future research and practical applications in educational settings. In addition, PLCs can strengthen the means of implementation and revitalise the global partnership for sustainable development (UN, Goal 17).

Keywords: professional learning communities; ESD; training; sustainable change; sustainable education; education practices; schools



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1. Introduction

The rapid advancement of digital technologies has required a significant shift and growing transformation in educational methods, demanding innovative approaches to professional development for educators. Traditional educator learning approaches frequently fail to promote sustainable changes in teaching practices, which reduces their efficacy and diminishes the quality of education that students receive [1–3]. Inclusive and quality education promotes lifelong learning opportunities, which are essential for achieving sustainable development. According to [4], the achievement of educational goals is slowly progressing, facing several shortcomings, which, among others, include a lack of educators and a lack of professional development opportunities for educators. Strengthening the means of implementation and revitalising the global partnership has been vital for

achieving Sustainable Development Goals [1]. Effective partnerships leverage resources, knowledge, and technology, fostering a collaborative approach to global challenges.

The UNESCO report on *The Digital Transformation of Education: Connecting Schools, Empowering Learners* [5] identifies educators as important factors in the digital transformation of education, provided that modernising and renewing educators' professional development ensures that they are able to take advantage of technology in support of the educational process. The emphasis, therefore, is not on technology and connectivity alone—they are merely conditions that, alongside a competent educator, enable students to participate in learning opportunities as part of an inclusive and effective learning process that promotes quality education and reduces inequalities.

The way teaching and learning take place today is very different from what it was a few decades ago since technology has made a considerable impact on teaching and learning methodologies. Digital technologies provide multiple benefits in order to improve teaching and learning by introducing new emerging pedagogical approaches. Today, educators need to be competent to make a transformation in their teaching. As schools strive for sustainable digital transformation, it becomes imperative to support and assist educators through their digital transformation practices. According to [6,7], educators require assistance and support in reframing educational concepts, creating educational platforms, selecting relevant materials, using digital tools and applications, and therefore, they need to proceed through a series of necessary educator training.

Research Scope and Aim

One practical approach to mapping the research gap and defining the scope of this study would be to gather and critically evaluate the literature from reputable search databases like IEEE, Scopus, and WoS and to develop a quantitative measurement. Two practical considerations led to the dissolution of such an approach: 1. PLC research in conjunction with SDGs is a relatively new phenomenon without a long history to serve as a longitude variable for the literature; 2. despite its recency, most of the studies show significant normative, narrative, and restrictive findings. Hence, in order to close the gap and define the parameters of the current study, a narrative discourse was employed instead. Nevertheless, the writings that follow justify the study's applicability in the era of SDGs.

PLCs are instrumental in fostering continuous, reflective, and collaborative professional development among educators [8,9]. The inclusivity and scope of PLCs significantly influence their effectiveness, but for these communities to have a long-lasting impact, sustainability is a key factor that must be considered. Sustainable PLCs for educators differ significantly from traditional ones in several key aspects, primarily in their approach to collaboration, leadership, and continuous improvement [8]. Sustainable PLCs are genuine PLCs which emphasise transparency and active participation, fostering an environment where educators collaboratively analyse student data, share teaching strategies, and reflect on their practices to improve student outcomes [10–12]. Sustainable PLCs ensure that the benefits of collaborative learning and professional growth are maintained over time, leading to sustained improvements in teaching practices and student outcomes [13–15].

Our goal is to promote sustainable education in line with the objectives of the UNESCO Agenda 2030 and, in particular, with the Sustainable Development Goals (SDGs) 4 and 17 by providing insights from an innovative PLC model [1]. These goals focus on high-quality education and multi-stakeholder partnerships, including the integration of modern technologies in education for digital transformation. There are limited studies in the literature on how to sustain and lead a PLC over time after other incentives are gone [8,12,13].

The inclusion of digital technology in education is an ongoing process that can transform education in the future. Technology in education is a relatively new phenomenon [16,17]. Yet, an explicit model with a particular reference to PLC for ensuring sustainable education and learning is unexplored [17–20]—a directive of this study.

In this study, we propose a new framework for PLC—a professional learning community model for Innovative Pedagogy (a PLC_IP model) that incorporates sustainable educators’ professional development, where educators more frequently use innovative teaching strategies supported by digital technology, and which is also sustainable over time. The PLC_IP model was implemented through project activities of the project Innovative Learning Environments Supported by ICT (2017–2022), in which 75 Slovenian primary and secondary schools took part. Schools were divided into development schools (20) and implementation schools (55) based on the intensity of the PLC_IP implementation and their contribution to the project activities that focus on improving teaching strategies supported by digital technology. The project itself focuses on equipping educators with digital competencies that can be easily included in teaching activities. The PLC_IP model is a result of knowledge-sharing activities between external stakeholders (faculties and institutes) and educators in primary and secondary schools, along with the guidance of the project coordinator and funder.

A quantitative study was employed using a questionnaire for educators to evaluate the characteristics of the joint collaboration intensity of educators, their inclusion in different PLSs, their transformation of teaching strategies to foster higher cognitive levels of students, and engagement and diversity between different types of schools. The purpose of this study was to present a model that is ongoing and effective in sustaining non-formal and formal PLCs in schools. The PLC_IP model contains several overlapping formal and non-formal PLCs, which contribute to sustainable professional development. The PLC_IP model synergy fosters a fundamental shift in pedagogical paradigms, aligning with the goals of sustainable education and the digital transformation of teaching practices. Unlike other PLCs, the PLC_IP integrates formal structures with elements of a broader, non-formal community of educators, fostering a culture of continuous improvement, multi-stakeholder involvement and innovation with the inclusion of digital technology. Innovation is a facilitator of change and does not happen in isolation since innovation always emerges in specific social, economic, and technological contexts, the creation, diffusion, and application of which are influenced by the organisation and culture of these contexts [21]. Therefore, the focus is on demonstrating how the PLC_IP model helps to create an effective and genuine PLC that supports sustainability goals.

2. Literature Review

After highlighting the research scope and aim, this section explores the concept of PLC and how it relates to sustainable quality education.

2.1. Sustainable Change in Education through PLCs

It is necessary to dispel common misconceptions about three buzzwords—sustainability in education, education for sustainable development (ESD), and sustainable education—in order to outline the purpose and scope of this study [18,19]. While ESD refers to education linked to advancing the Sustainable Development Goals (SDGs) set forth by the United Nations, sustainability in education refers to those courses, activities, and research that aim to contribute to the development of the sustainability of the planet [18]. All initiatives, studies, and projects aimed at guaranteeing best practices in education and developing a sustainable education and learning system and these methods are together referred to as sustainable education [18,19]—the core connotation of this initiative—which also seeks to advance ESD.

If we want to achieve sustainable change and improvements in education, we must approach restructuring systematically and comprehensively. This aligns with the principles of Education for Sustainable Development (ESD) and Sustainable Education, both of which are rooted in the United Nations’ Sustainable Development Goals (SDGs) and are part of global sustainability. It refers to educational practices that contribute to a continually evolving, healthy learning ecosystem in which knowledge is co-created and shared in a community, including society, economy and environment. Sustainable education covers a wider

spectrum in education “such as curriculum and instructional technology, teacher education, technology and innovation in education, school settings, education policy, best practice in education, international education and development, educational segmentation” [16,17,19].

The UN vision for Transforming Education, “*Transforming Education: An Urgent Policy Imperative for Our Common Future*”, is the official outcome of the Transforming Education Meeting held in 2022 [22]. The UN vision recognises that education is one of the most important factors of unification, while in many cases, it is also an important factor that separates us [1]. This UN vision further notes that education is in crisis and requires immediate, medium and long-term responses, including a fundamental rethinking of the purpose and content of education.

Education content must be based on two principles of the new social contract for education: *ensuring the right to quality education throughout life* and *strengthening education as a source of public common good in society*. Education for sustainable development is increasingly internationally recognised as an integral element of quality education and a critical factor in sustainable development [22]. This UN vision is closely related to international discussions on sustainable development, which have grown in scope and importance since the publication of *Our Common Future* in 1987 [23], which provided the first widely used definition of sustainable development: “*development that meets the needs of the present without jeopardizing the ability of future generations to meet their own needs.*”

One of the most effective ways to implement sustainable education practices and achieve sustainable improvements in schools is through the establishment of PLCs. These communities are increasingly being adopted in schools to foster sustainable change through collaboration [15]. To cultivate an effective and lasting PLC, it is crucial to grasp and implement several foundational concepts: a unified set of shared values and a common vision, supportive leadership, collaborative learning, the practical application of new knowledge, school capacity, collective practices, and an infrastructure that supports and nurtures positive relationships among all stakeholders involved [15,24].

ESD merges educational goals with sustainable development, making it a key component of educators’ professional development. Ongoing self-improvement is essential for sustainable professional growth in teaching; without it, the quality of education suffers. Sustainability is a vital element in the educator development model, and the PLC process provides a sustainable approach to professional development [14].

2.2. Quality Education and Professional Development

We perceive quality education as being closely linked to competent and high-quality educators who impart relevant knowledge in conducive and supportive learning environments. Numerous studies have confirmed the generally accepted view that educators are the most significant school-related contributors to improving the quality of teaching and learning [25,26]. Ref. [27] assumes that the quality of teaching and the involvement of educators in PLC are the two key factors in raising the quality of the school. In this spirit, Ernest Boyer wrote: “When you talk about school improvement, you are talking about people. That’s the only way to improve schools” [28]. Ref. [29] found that the collaboration of a group of quality educators could go a long way in filling the achievement gaps for different groups of students. If an educator is ineffective, students who benefit from their teaching process will progress more slowly, regardless of the cognitive differences between them [30]. Ref. [30] notes the link between educator training and student performance in vocational schools in Slovenia: “the less often educators have attended in-service training, the higher the number of students repeating a school year”. Ref. [25] identified the educator as the single most important school-related input to improve student achievement. Ref. [14] also corroborates these findings. According to [31], collective educator efficacy is the number one factor influencing student achievement. Similarly, [32] believes that collective educator efficacy is one of the most important factors for the quality of teaching. Ref. [32] introduced “A Model for Leading Collective Educator Efficacy”, in which they highlight the direct correlation between student achievement and collective educator efficacy.

As [33] states: “Today, it is understood that professional development is no longer a choice of motivated individuals but a necessity for every educator”. To empower educators to attain the knowledge and competencies that are necessary for educator effectiveness, in addition to high-quality university educator education, an effective system of lifelong educator training is also needed. The traditional approach to permanent educator training is a form of training in which the organiser of education (most often, a school) organises educator training by inviting an expert who conducts training for educators in their area of expertise according to a predetermined time frame [34]. In such a time-limited transfer of knowledge from an expert to a group of educators, the internalisation of new knowledge and, thus, the transfer into practice occurs rarely. If placing the student in an active role is an important tenet of constructivism, then the same could be argued for educators as well. When educators are only passive participants in informal forms of training, they are unable to construct their own knowledge, and at the same time, they are also not internalising external knowledge. This means that such traditional approaches to permanent educator training do not (sufficiently) affect concrete educator practices. They also have no measurable effect on student achievement [35]. According to a study by [36], traditional approaches to educator training have a detrimental effect on changing the educator’s approach to teaching since less than 10% of participants in such training use new knowledge/competencies in the classroom permanently. This is further supported by [37], who believes that traditional approaches to permanent educator training are inefficient and need to be improved in terms of economy, quality, efficiency and continuance so that by raising the quality of educators’ professional and pedagogical skills, we can indirectly raise the quality of teaching and improve the knowledge and competencies of students. It is, therefore, necessary to create a new, more effective model for permanent educator training. To undertake this, the concept of permanent educator training needs to be modified and brought into line with the constructivist learning theory. Educators, too, should be placed in an active role in the training process; they should be given the opportunity to construct their own knowledge and internalise that knowledge by taking part in professional learning communities (PLCs).

The distinctive connection between quality education and ESD has significantly shaped the overall understanding of quality education. The ESD perspective emphasises lifelong learning, and it prioritises equipping learners with the skills and values necessary to tackle global sustainability challenges [10].

2.3. Digital Transformation in Education

Digital transformation in education is one of the current discourses on technology in education and goes beyond the introduction of digital technology. Most of the studies in the literature in this field examine how technology, particularly digitalisation, may support the long-term growth of education. These initiatives have been able to highlight both advantages and disadvantages. Models are created and then promoted for use in practice to mitigate the negative consequences of digitalisation in education [16,17].

When we think about the meaningful use of technology in education (the process of teaching and learning), the emphasis is on the learner. Technology here is not only a means for distance communication or the display/illustration of certain phenomena and motivation, but it must also support the learning process and the active role of the learner. When judging the meaningful use of technology in the educational process, it is expedient to use the SAMR model [38]. The SAMR model includes four phases (substitution, augmentation, modification and redefinition), referring to improvement in the first two phases and transformation in the last two. The educator must be able to judge when it makes sense to use digital technology in order to improve the quality of the learning process. Otherwise, it is only a substitution or replacement of the traditional form of activity implementation without added value to the improvement and promotion of the development of higher cognitive processes [38].

An educator needs different kinds of skills and knowledge to successfully incorporate technology into teaching. The TPACK (Technological Pedagogical Content Knowledge) model includes, in addition to knowledge of content and pedagogy, a technological component of knowledge and their interactions with content and pedagogy. The educator is the one who, in order to achieve set goals (assimilation of knowledge, development of competencies, attitudes, etc.), plans the learning process and, in doing so, thoughtfully combines content and different pedagogical approaches and uses learning resources (e.g., digital technology) [39]. With all these complex interactions in mind, educators need structured and systematic training and support to incorporate digital technology into their teaching strategies and ensure quality education to students—e.g., by implementing the PLC_IP model.

2.4. Professional Learning Communities

A PLC is defined as a group (of educators) sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented and growth-promoting way [40]. For instance, student learning can only be improved through educator learning. The goal of PLCs is not just mutual and shared learning but to bring about sustainable changes for the benefit of students and all stakeholders involved. Ref. [41] explained that sustained change through PLCs can be developed with both individual and group learning activities to continually enhance educators' teaching methods and own teaching practice.

The impact of a PLC on student achievement is schematically shown in Figure 1.

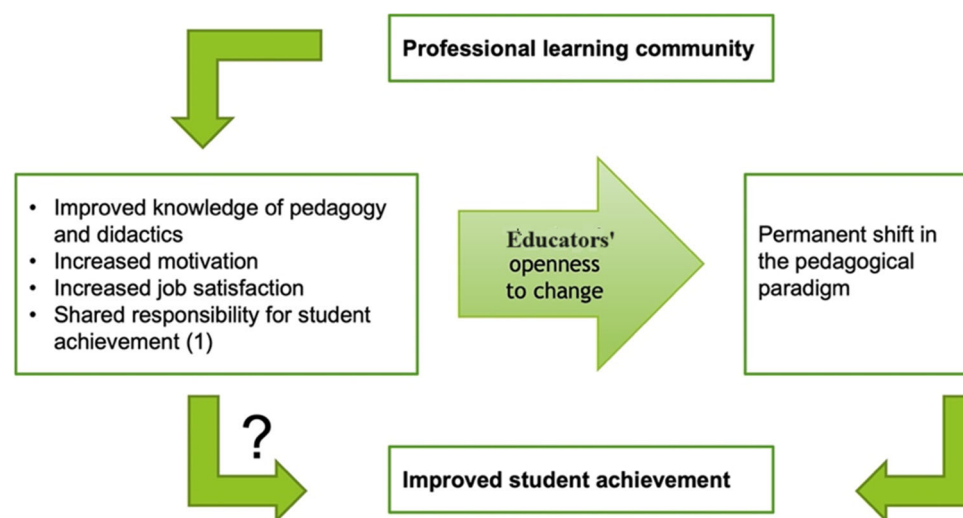


Figure 1. The impact of professional learning communities.

Ref. [40] suggests five major attributes of an effective professional learning community of educators:

- Shared values and visions with real-world application put into practice by the community;
- Collective responsibility for student learning;
- Reflective professional inquiry, including the frequent examining of educators' practice through mutual observation and case analysis, joint planning and curriculum development, joint seeking and sharing of knowledge, and applying new ideas to problem-solving;
- Collaboration beyond superficial exchanges of help or support, which develops into a sense of interdependence in achieving a common goal: improving student achievement;
- Promotion of individual and group learning.

This raises the question of *what inclusive and sustainable professional learning communities should be like* in order to effectively enable/support the achievement of set goals? It raises

the following further questions: Do PLCs involve just educators or other school staff as well? Do they involve all educators in a school, or can they operate at the level of a subject area? Can PLCs operate between different schools? All these questions are relevant to consider when setting up a sustainable PLC in a particular school supported by the organisational culture. Although PLCs are often defined within a school and depend on its size, level, leadership, structure and established culture, [40,41] there are also the key PLC characteristics of list openness, networking and partnerships, which allow them to look beyond the school for sources of learning, educator training, and new ideas. Similarly, [42,43] suggests that collaboration between schools can be a possible solution in training educators to use new technologies.

The quality of an educator's work is conditioned both by the knowledge and experience that future educators gain during their education, as well as permanent on-the-job training [44]. International research shows that the methods educators use depend more on their environment and the culture of teaching in which they grew up than on their education. Few educators outgrow the way in which they themselves were taught [45]. This is why the collaborative culture of educators is so important for introducing change in education. According to the constructivist theory, mutual interaction is an essential part of the learning process, as "learning is a social process in which an individual forms an opinion in interaction with others and the environment" [46].

An educator, an adept professional who receives education within familiar frameworks, must transform into an innovative lifelong learning professional seeking inspiration, knowledge and support. The development of a strong professional identity is the first step towards successful participation in a relevant professional network, where educators draw on new ideas and, in collaboration with others, look for answers to new challenges, translating them into a local context. An innovative educator [46] is the following:

- A competent and passionate professional who, in collaboration with others, realises the best education for his/her students;
- Has a positive attitude towards research and lifelong learning;
- Participates wilfully in various professional networks and returns to the classroom with valuable insights;
- Is related to developments in society, especially its digital transformation, but at the same time appreciates cultural diversity.

A well-organised PLC, supported by school management, with a clear and internalised vision, as part of which planned training takes place and which at the same time acts as a safe space for reflection, doubt and collaboration, enables lifelong teacher training, with the aim of introducing sustainable change to improve learners' achievements [47].

2.5. Conceptual PLC_IP Model Development and Implementation

The PLC_IP model was developed based on the activities of a national project entitled *Innovative Learning Environments Supported by ICT*, co-funded by the Ministry of Education and Sport of the Republic of Slovenia and the European Social Fund. It included four higher education and research institutions as external stakeholders to provide knowledge-sharing processes to educators: the Faculty of Natural Sciences and Mathematics of the University of Maribor, the Faculty of Education of the University of Maribor, the National Education Institute of the Republic of Slovenia, and the Educational Research Institute. In addition to these, the project coordinator—the Institute of Anton Martin Slomšek—led the project activities, in which 75 primary and secondary Slovenian schools collaborated. The project started in May 2017 and ended in October 2022. As part of this project, PLCs were created gradually over the course of three years, as shown in Figure 2. The implementation of the PLC_IP model started in the first year in development schools and gradually expanded to implementation schools in the second and third years. In the fourth year, the PLC activities, as well as teaching strategies with digital technology inclusion, were evaluated with a quantitative survey (Figure 2).

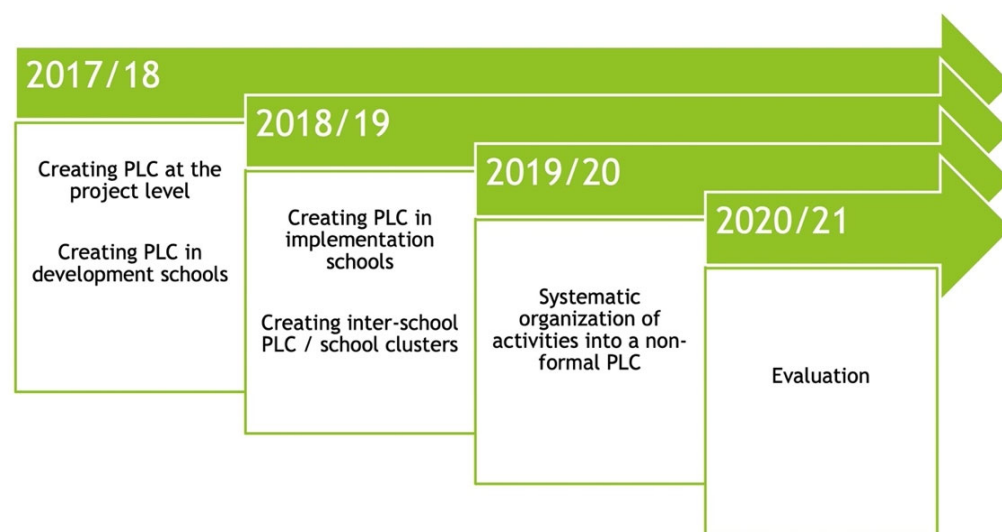


Figure 2. Model of PLC_IP's inclusion in schools.

According to [48], effective teaching strategies are instructional methods and approaches that have been proven to have a positive impact on student learning. They promote student learning and engagement, create a supportive classroom climate, incorporate peer learning and collaboration, differentiate instruction, use research-based learning strategies, provide effective feedback, and reflect on the impact of teaching on student learning. By employing innovative teaching strategies, educators are able to foster higher cognitive levels among students.

Schools were divided into two groups in this study—20 development and 55 implementation schools. Development schools serve as the catalysts for educational change. They act as engines of change, driving the evolution of teaching practices by sharing best practices and documenting and disseminating knowledge about successful teaching strategies and lessons learned supported by digital technologies. Implementation schools benefit from the groundwork laid out by development schools and other forms of knowledge sharing provided by the external stakeholders involved. These schools adopt and adapt the proven practices and digital technologies developed by their counterparts. The spillover effect from development schools to implementation schools ensures that innovative practices are scaled and integrated more broadly across the education system.

The PLC_IP consists of five interrelated clusters (see Figure 3). Level 1 represents the PLC cluster of a single school. The Level 1 cluster is led by top management and authority staff in single schools, namely principals and/or educator coordinators from those schools. A Level 1 PLC represents the core of the PLC_IP model. The second cluster is the Level 2 (L2) cluster that covers the PLC of development schools (PLC_R), which, in this case, includes all 20 development schools. When L1 and L2 are strong and stable enough, integration can begin at the third cluster of Level 3 (L3). A Level 3 cluster involves a PLC of development and implementation schools that have similar interests and contents or are locally connected. The work of these communities is guided by an experienced PLC development school coordinator. All PLCs of development and implementation schools together are connected at Level 4 (L4), where the work is guided and synchronised with experts from four higher education and research institutions. In this way, activities at all levels of the PLC are precisely defined and coordinated. Finally, the fifth cluster—Level 5 (L5)—represents the opening of the PLC_IP to the wider public: interested educators from other schools in the country become part of a non-formal social (virtual) PLC cluster monitored by school coordinators.

Additionally, the structure of the PLC_IP model enables the design of activities in such a way that educators are included *gradually* according to the level of their interests, as shown in Figure 4. Educators teaching in innovative classes (10–12 educators in development

schools and 3–4 in implementation schools) comprise the core of the PLC in each school at Level 1. In addition, other interested educators in each school are regularly involved in the practices of the school's PLC.

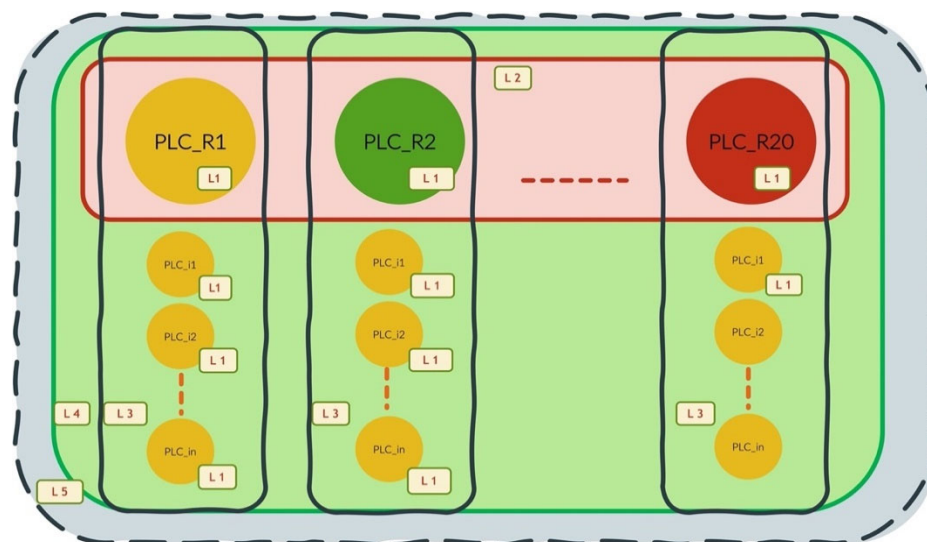


Figure 3. The clusters of PLC_IP model. Key: PLC_R—development schools (altogether covering 20 development schools), PLC_I—implementation schools (altogether covering 55 implementation schools); L1—Level 1 PLC covers one school; L2—Level 2 PLC cluster of development schools; L3—Level 3 PLC cluster of schools that are connected in certain way (locally or by content), L4—Level 4 PLC cluster connects all 75 schools involved, L5—Level 5 cluster involves broader non-formal PLCs including virtual community.

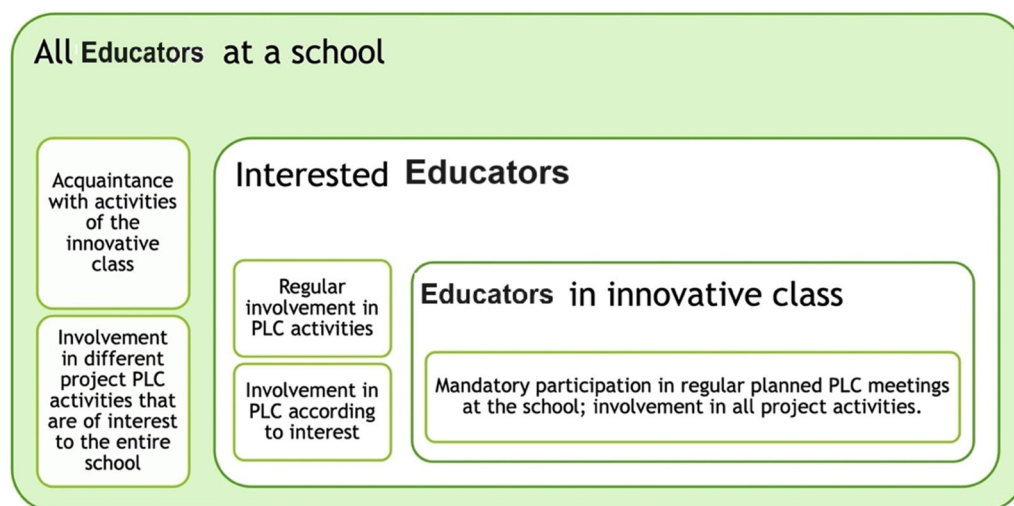


Figure 4. Involving educators in the PLC_IP.

3. Research Questions

Based on the theoretical and conceptual presentation of the PLC_IP model, the following research questions drove this research:

RQ1. *How does length of service, i.e., occupational seniority, correlate and differ in regard to educators' involvement in PLCs?*

RQ2. *To what extent does the implementation of the PLC_IP model in schools affect their participation in other PLCs?*

RQ3. *How do educators participating in the PLC_IP model report the frequency of using effective teaching strategies with digital technology-supported student work?*

4. Research Methodology

4.1. Research Instrument and Methods

A quantitative methodology was used to answer the research questions. The questionnaire was based on the report [49] covering the frequency of selected effective teaching strategies and inclusion in different PLCs. This cross-sectional study was conducted at the end of the project. Questions were prepared with a four-point Likert scale. The questionnaire was sent to 75 schools (participants of the project), and we received 1065 valid responses from educators. Prior to distribution through an online application, the questionnaire was piloted with a small group of educators to refine the questions and ensure clarity and reliability. Content validity was established through an expert review.

Both descriptive and inferential statistics were employed to analyse the data and to answer the research questions. We analysed PLC_IP's implementation and development in schools. A *t*-test for independent samples was used to provide statistically significant differences between two groups of schools to draw final conclusions. Effect sizes were calculated using Cohen's *d* to assess the practical significance of the observed differences.

The chosen methods best provided the answers to our research questions, as we were interested in the characteristics of educators and their involvement in the PLC_IP (formal and non-formal PLCs) and in the transformation of their teaching strategies across different types of schools.

4.2. Ethical Considerations

Informed consent was obtained from all participants included in the project, ensuring they were aware of the study's purpose, procedures, and their right to withdraw at any time. Confidentiality and anonymity were maintained by assigning unique identifiers to each respondent and storing data securely.

4.3. Research Sample

The conceptual model was tested in 75 primary and secondary schools from across Slovenia. Of these, 20 were development schools, while PLCs were created for the 55 implementation schools. All educators participated in the PLCs on a voluntary basis. A total of 1,065 educators were included in the research, including 235 male and 830 female. Their length of service (years of teaching experience) is shown in Table 1.

Table 1. Structure of respondents according to the number of years of teaching experience (length of service).

Length of Service	Frequency	Percentage
1. (0–5 years)	139	12%
2. (5–10 years)	82	7%
3. (10–17 years)	124	11%
4. (over 17 years)	720	70%
Total	1065	100%

5. Results

First, following the RQ1, the relationship between educators' length of service and their involvement and participation in PLCs was examined. We were interested in whether educators with more years of working experience were more often involved in different PLCs.

The average length of service for Slovenian educators was 17 years [38]; therefore, we selected 17 years as a dividing line. According to their length of service, educators were divided into two groups. Group 1 included educators with less than 17 years of work experience, and Group 2 included educators with 17 or more years of work experience. The descriptive statistics show that educators with less than 17 years of service are, on average, more often engaged in alternative PLCs (National Education Institute, social networks, projects) than in school PLCs. (See Table 2).

Table 2. Length of service—descriptive statistics.

Participation in PLCs according to Years of Experience as an Educator	Length of Service	N	Mean	Std. Deviation
Q1. I participate in the PLC at the school.	<17 years	347	1.60	0.491
	>17 years	790	1.62	0.486
Q2. I participate in the PLC of the National Education Institute.	<17 years	347	1.20	0.402
	>17 years	790	1.19	0.393
Q3. I participate in the PLC on social networks.	<17 years	347	1.33	0.469
	>17 years	790	1.23	0.420
Q4. I participate in the PLC as part of the project.	<17 years	347	1.47	0.500
	>17 years	790	1.42	0.516

Next, statistically significant differences between the two groups (according to length of service) were tested with a *t*-test for independent samples, as displayed in Table 3.

Table 3. Independent sample *t*-test: *t*-test of educator participation in PLCs according to years of experience as an educator.

Equal Variances Assumed		Levene's Test for Equality of Variances		<i>t</i> -Test for Equality of Means			
		F	Sig.	<i>t</i>	df	Sig. (2-Tailed)	Mean Diff.
Q1	Yes	1.875	0.171	−0.715	1135	0.475	−0.022
	No			−0.712	654.273	0.477	−0.022
Q2	Yes	0.681	0.410	0.415	1135	0.678	0.011
	No			0.412	648.285	0.681	0.011
Q3	Yes	41.379	0.000 **	3.488	1135	0.001 **	0.098
	No			3.339	599.382	0.001 **	0.098
Q4	Yes	0.217	0.641	1.658	1135	0.098	0.055
	No			1.678	680.023	0.094	0.055

Note: ** sig. less than 0.01.

The *t*-test for independent samples provides evidence of whether the arithmetic means of the two groups showed a statistically significant difference. The value of Sig in questions 1, 2 and 4 is greater than 0.05 ($p > 0.05$); therefore, the assumption of a homogeneity of variances was maintained. The value of Sig (2-tailed) for all these items is also less than 0.05, meaning that there are no statistically significant differences according to the distinction for length of service. Q3 (“participation in PLCs on social networks”), however, provides a statistically significant difference between the two observed groups: educators with less than 17 years of work experience (younger educators) participate more often in PLCs on social networks than those with longer lengths of service.

Furthermore, we tested how educators’ lengths of service correlated with their participation in PLCs. We found that a minor negative statistically significant correlation exists between years of service and participation in social networks PLCs and also the project’s PLCs. This confirms that educators with fewer years of teaching experience (younger) participate more frequently in social network PLCs as well as project PLCs. This negative correlation suggests that the more years of teaching experience educators have, the less likely they collaborate in the PLCs. Correlation is statistically significant for PLCs in social networks and PLCs in projects.

Next, we tested differences in participation for PLCs between the educators in development schools (DSs) and in implementation schools (ISs). The total number of educators in DSs and ISs was 511 and 554, respectively. The calculated arithmetic mean values in Table 4 show that the arithmetic mean is higher for educators in DSs for all data items. The next step was to examine whether there were statistically significant differences between the groups, providing insights on understanding educator involvement in PLC. (See Table 5).

Table 4. Pearson correlation for educator participation in PLCs according to years of experience as an educator.

		Q1	Q2	Q3	Q4
Length of service (teaching experiences)	Pearson Correlation	0.002	−0.023	−0.102	−0.060
	Sig. (2-tailed)	0.934	0.417	0.000 **	0.036 *
	N	1221	1221	1221	1221

Note: * sig. less than 0.05, ** sig. less than 0.01.

Table 5. School status—descriptive statistics.

A Comparison between the Involvement of Educators in PLCs according to School Status.			Mean	Std. Deviation
	N			
Q1	DS	511	1.72	0.448
	IS	554	1.56	0.497
Q2	DS	511	1.24	0.427
	IS	554	1.17	0.379
Q3	DS	511	1.31	0.461
	IS	554	1.24	0.426
Q4	DS	511	1.65	0.500
	IS	554	1.29	0.464

For all questions, the *p*-value (2-tailed) was less than 0.05, meaning that there are statistically significant differences between educators in DSs compared to those in ISs. Educators from DSs participate more often in different learning communities than those from ISs, and there is a statistically significant difference between the groups. (See Table 6).

Table 6. Independent samples' *t*-test—independent *t*-test of educator involvement in PLCs according to school status.

Equal Variances Assumed		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-Tailed)
Q1	Yes	108.411	0.000	5.649	1063	0.000 **
	No			5.672	1062.476	0.000 **
Q2	Yes	28.264	0.000	2.651	1063	0.008 **
	No			2.639	1022.611	0.008 *
Q3	Yes	24.043	0.000	2.465	1063	0.014 *
	No			2.457	1036.987	0.014 *
Q4	Yes	12.940	0.000	12.470	1063	0.000 **
	No			12.432	1037.609	0.000 **

Note: * sig. less than 0.05; ** sig. less than 0.01.

The next set of questions tested whether DS educators involved in the PLC_IP model exhibited a higher frequency of using effective teaching strategies with the support of digital technologies compared to IS educators.

The arithmetic values in Table 7 show that the frequency of using effective teaching strategies is, on average, higher for all data items for DS educators included in the PLC_IP model. Statistically significant differences between the groups were examined next. A *t*-test for independent samples was used to compare the differences once again for the arithmetic mean values of both groups (DS and IS).

The *p*-value for questions Q5, Q6, Q9, and Q10 was greater than 0.05 ($p > 0.05$), which means that there were no statistically significant differences between the groups. For half of the questions (Q7, Q8, Q11, and Q12), however, there were statistically significant differences between the groups. Educators from DSs are more likely to use effective teaching strategies (critical thinking, small groups, project work, and use of digital technology) that also enhance students at higher cognitive levels. (See Table 8).

Table 7. The group’s descriptive statistics—a comparison of the frequency of using effective teaching strategies.

		N	Mean	Std. Deviation
Q5: I explain how new topics are related to the old.	IS	554	2.75	1.387
	DS	511	2.95	1.060
Q6: I present the tasks, for which there are no obvious solutions.	IS	554	1.93	1.117
	DS	511	2.15	0.907
Q7: I assign tasks that require critical thinking from the students.	IS	554	2.32	1.184
	DS	511	2.66	0.949
Q8: I arrange students into small groups, so they can come up with a collective solution to a problem or task.	IS	554	2.00	1.087
	DS	511	2.30	0.919
Q9: I instruct students to choose their own procedures in order to solve complex tasks.	IS	554	1.96	1.103
	DS	511	2.21	0.874
Q10: I provide an example of a real-life problem to demonstrate the usefulness of new knowledge.	IS	554	2.58	1.328
	DS	511	2.85	0.998
Q11: I assign students with a project-type task that requires at least one week to complete.	IS	554	1.65	1.012
	DS	511	1.93	0.953
Q12: I encourage students to use digital technology for project work or work in the classroom.	IS	554	2.33	1.264
	DS	511	2.81	1.048

Table 8. Independent sample *t*-test: independent *t*-test of educator involvement in PLCs regarding the use of effective teaching strategies.

Equal Variances Assumed		Levene’s Test for Equality of Variances		<i>t</i> -Test for Equality of Means		
		F	Sig.	<i>t</i>	df	Sig. (2-Tailed)
Q5	Yes	10.326	0.002	−1.137	187	0.257
	No			−1.104	152.104	0.271
Q6	Yes	2.269	0.134	−1.520	187	0.130
	No			−1.486	158.463	0.139
Q7	Yes	6.384	0.012	−2.164	187	0.032 *
	No			−2.112	157.129	0.036 *
Q8	Yes	0.252	0.616	−2.023	187	0.044 *
	No			−1.986	162.669	0.049
Q9	Yes	2.283	0.133	−1.706	187	0.090
	No			−1.663	155.936	0.098
Q10	Yes	12.453	0.001	−1.562	187	0.120
	No			−1.514	150.410	0.132
Q11	Yes	1.127	0.290	−1.942	187	0.044 *
	No			−1.929	173.082	0.045 *
Q12	Yes	6.487	0.012	−2.831	187	0.005 **
	No			−2.773	160.586	0.006 **

Note: * sig. less than 0.05; ** sig. less than 0.01.

6. Discussion

Assuming that an active and open PLC with a strong collaborative culture is the foundation for introducing sustainable changes to education with the ultimate goal of improving student achievement, creating effective and sustainable PLCs is the key to ensuring sustainable results even after external incentives have ended [50]. For school-level activities, this means that a lot of energy and planning needs to be focused on expanding the PLC and involving the entire teaching staff in the school’s vision. These findings coincide with the findings of [51], which emphasise the importance of the autonomy of the individual educator. The applied Australian model of distributed leadership, where individuals (school development team, coordinators, etc.) develop new roles within the school and establish new relationships, proved very effective [51].

In the first research question, the impact of educators’ length of service on their involvement and participation in different PLCs was examined. The idea was to test whether educators with more years of working experience at schools were more often involved

in different PLCs. This would suggest, namely, that the existing system of permanent educator training sufficiently promotes educators' awareness about the importance of involvement in different PLCs and indirectly encourages the sharing of good practices, collaborative work among educators, etc., which can have a major impact on the way teaching is conducted in the classroom (a sustainable permanent change). Based on the results, it was concluded that this was not the case and that there were no statistically significant differences according to the length of service and inclusion of teachers in PLCs. However, there was an inclination that educators with less work experience are more often involved in alternative non-formal PLCs (National Education Institute, social networks, projects) than only in-school PLCs. Moreover, statistically significant differences according to the length of service were observed with respect to involvement in a non-formal PLC on social networks. A negative statistically significant correlation was proven for social networks and project PLCs, meaning that educators with fewer years of experience are more frequently included in alternative non-formal PLCs. Educators with more years of work experience were less likely to participate in social network PLCs, which is probably related to the generational attitude towards social networks and digital technology usage. Since the social network PLC is a non-formal learning community, it operates mainly at the level of exchanging good practices but does not provide space for reflection, synchronisation and building a common vision, and therefore, has a minimal impact on introducing sustainable and lasting changes to teaching practices.

Consequently, innovative teaching practices can be expected from educators with fewer years of experience who are striving to develop quality teaching with the use and promotion of digital technologies. Educators with fewer years of experience have more enthusiasm for digital tools, leading the way for others and demonstrating how technology can be used to create more engaging and effective learning experiences for students. PLCs, therefore, not only help educators refine their digital teaching strategies but also foster a culture of continuous improvement and innovation.

In the next step, the extent of PLC_IP implementation in schools and their participation in different PLCs provided an answer to RQ2. It was found that DS educators participated more often in other learning communities than IS educators. There was a statistically significant difference between the groups according to the school type. This means that the implementation of the PLC_IP model encourages awareness about the importance of participation in all PLCs. Educators who participate in the PLC_IP from the start are aware of the importance of sustainable lifelong training and participation in all PLCs. This means that they seek to achieve sustainable changes in quality teaching and, thus, in the knowledge of their students. Research has shown that the involvement of educators in PLCs, particularly those focused on innovative pedagogy, correlates positively with the quality of teaching and the overall educational process [40]. By participating in PLC_IP, educators are more likely to adopt and implement contemporary learning environments and digital tools, which are critical for the digital transformation of schools and are crucial for ESD. This involvement not only enhances individual educator efficacy but also improves collective efficacy, leading to more significant and lasting impacts on student learning outcomes.

The inclusion of digital technologies aligns well with the goals of PLCs and ESD. In PLCs, educators collaborate to share best practices, discuss challenges, and support each other's professional growth. Furthermore, ESD emphasises the integration of sustainable practices into education, preparing students to tackle global challenges related to society, the economy, and the environment.

The PLC_IP model showed that it is reasonable to create a PLC systematically, with a clear vision, and gradually, through the step-by-step involvement of clusters of educators who, according to their own pace and under the guidance of school leadership and management, can adopt a shared vision and culture of collaboration with the aim of raising the quality of teaching and learning and improving student achievements with digital technologies. Such an approach includes a top-down implementation of changes with a clear direction and support from school management, which organises, enables and

supports the PLC at the school. At the same time, school management is the authority that allows the opening up of the bubble while connecting and collaborating effectively with other schools, projects and external experts. Research from different countries [20,52,53] has shown that the approach to a PLC's creation also strongly depends on individual schools and the autonomy and position of the educators in it. In addition to the top-down approach (school management) and "external incentives" (project activities), the bottom-up approach (autonomy of educators) is an element of balance in the creation of the PLC_IP. In this way, the PLC_IP model became a democratic space of trust, in which not only the exchange of good practices took place but also constant reflective practice and internalisation of a shared vision, improving students' learning achievements and developing their competencies.

By utilising the principles and practices of the PLC_IP, there is a strong connection to the pursuit of Sustainable Development Goal (SDG) No. 4, which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. By leveraging digital technologies, educators can create more inclusive educational environments that foster accessibility, regardless of their geographical or socio-economic background.

The effectiveness of the PLC_IP model was determined by comparing the frequency of introducing teaching strategies in which students develop critical thinking competencies, small group discussions and collaboration, digital competencies, and project work. The results showed that DS educators organise learning opportunities for students through which they develop their competencies more frequently than IS educators. DS educators consistently showed the more frequent use of all effective pedagogical strategies, and statistically significant differences were observed with regard to promoting higher cognitive taxonomy levels.

Additionally, our findings refer to SDG No. 17, which emphasises the importance of partnerships and multi-stakeholder involvement. SDG no. 17 calls for strengthening the means of implementation and revitalising the global partnership for sustainable development. In the context of education, leveraging digital technologies within PLCs can foster partnerships at multiple levels, including local partnerships between schools, private-public partnerships between companies and schools, fostering community engagement with parents and local businesses or organisations, and, lastly, international partnerships between schools and international communities.

The effectiveness of the PCL_IP is further supported by the report of the international survey [54], which stated that these are precisely the teaching strategies from which Slovenian educators deviate regarding the OECD average [54,55]. Educators involved in the innovative PLC_IP training model make sensible use of digital technologies that allow them to teach at higher levels of the SAMR model, thereby allowing students to gain knowledge of higher taxonomic levels.

The didactic and methodological knowledge that educators acquire through such an approach is a precondition for the meaningful use of digital technology in the classroom. Educators with such knowledge are able and empowered to lead digital transformation and lasting change aimed at raising the quality of the school and student achievement. As one of the educators wrote in the annual report for the school year 2019/20: "Only now, after we've learned how to use digital technology to improve classroom activities and see the meaning of its use, do we realise what we really need for contemporary school lessons that allow students to develop their competences and become actively integrated into the modern society."

7. Conclusions and Implications

Participation in PLCs needs to undergo a shift from the simple exchange of good practices (within the school and wider) and synchronisation (at the class level) in educator training to co-creating knowledge by developing a culture of reflection and peer feedback. The suggestion for the future is to keep in mind that the goal of a PLC is to move beyond simple exchanges (of good practices and materials) and synchronisation (e.g., planning

work in the class) and to move to a culture of collective knowledge building and problem-solving. Therefore, in further research, more attention should be paid to the quality of educator participation in PLCs and to the factors that influence the quality of such involvement. Only an educator who is actively involved in an effective, stable PLC with a shared, internalised vision will be able to participate within the local ecosystem as a key element of the digital transformation of education [9].

Thus, sustainable PLCs not only support continuous professional growth for educators but also lead to enduring improvements in student learning outcomes and increasing completion rates [14].

It also tempts to demonstrate how a balance between formal PLCs and non-formal PLCs, coupled with external incentives (such as project-based initiatives), can transcend mere exchanges of best practices, foster innovation, and support educators' sustainable development while delivering high-quality education and working together with multiple stakeholders.

Bearing in mind that the sustainability of introducing changes to the pedagogical paradigm is mainly influenced by educators' openness to change—the balance between the voluntary and non-formal participation of educators in PLCs and a formalised PLC with a strong structure (supported by school management, operating continuously to achieve the outlined vision, and regularly updated in line with the changes in society and the school)—this should also be explored. It should be pointed out, however, that without a formal moderator (principal and/or coordinator who drives the change), the PLC will not survive and will eventually move away from the initial goal or start recycling already established patterns.

An analysis of the participation of educators involved in the PLC_IP model could also serve as a starting point for introducing new approaches to teaching and learning. It was proved that an effective and sustainable school PLC is one of the elements that can ensure a permanent shift in the pedagogical paradigm towards adopting innovative teaching and learning practices. We suggest that an innovative PLC_IP model is a good solution for upgrading the existing model of lifelong teacher training in Slovenia and can have a positive impact on the quality of teaching.

The PLC_IP model contains elements of a formal PLC in terms of its structure (shared vision, planned activities by project management, support of the principal in individual schools, appointed coordinators, regular meetings, appointed membership) and also elements of a non-formal, wider community of educators brought together by the challenges of integrating modern technology into the classroom and concern for the development of the (digital) competences of students and educators. To achieve sustainability, PLCs must be seen as dynamic entities that evolve with the changing educational landscape, ensuring that they remain relevant and impactful for years to come.

8. Limitations and Future Research

This research presents how an innovative PLC_IP contributes to the sustainable professional development of educators. The study relies on self-reported data, which can introduce biases, such as response biases, affecting accuracy. In addition, the cross-sectional design captures data at a single point in time, limiting the ability to track changes or establish causality. The sample's representativeness is limited to participants of the project, affecting generalisability and introducing potential selection bias. Although the project activities were shown to be extensive and effective, in this research, only specific teaching strategies were evaluated regarding the improvements of the teacher work.

Future research could include longitudinal studies to track changes over time and assess long-term impacts, establishing causal relationships between PLC_IP participation and teaching practices. Combining quantitative surveys with qualitative methods, such as interviews and classroom observations, could also be another way of exploring teaching strategies and contextual factors. Another method would be to establish a control group in experimental or quasi-experimental research and test for the effectiveness of specific

measures and interventions when applying the PLC_IP model. These are all options to further our study efforts.

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Review

Policies, Projects, and Initiatives for Sustainable Higher Education with Gender Equity: Literature Review and Case Study—Universidad de La Frontera

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Abstract: Today, sustainability in higher education is a key factor for our society, and women play a fundamental role. However, gender faces a series of inequalities in this field of action, and from this point of view, university education is not left out. It is necessary to incorporate strategies and initiatives to reduce these inequalities within the classroom, supported mainly through public policies, which represents a challenge. It is a practical and essential challenge for public and private universities to ensure that their students are prepared for a globalized, sustainable, and gender-sensitive world. In the 2030 Agenda, two Sustainable Development Goals are proposed to address these issues, targeting SDG 5 gender equality and SDG 4 inclusive education. This study considers that to address this issue, it is necessary to identify initiatives that aim to propose measures for sustainable education and reduce the gender gap, to know which and what types of policies or strategies aim to address these issues in higher education in the same way of identifying good practices focused on inclusive policies, models, and teaching styles, also considering scientific research for sustainable education. This study considers the review of policies to reduce gaps in the STEM areas of university education and whether these measures address the goal of sustainable development. As main findings and conclusions, this study highlights the initiatives and good practices found in the literature review since 2007 but concentrated during the last five years. In addition to the literature review, this bibliographic review is complemented by presenting a practical case study with real data from a public, state, and regional university in the south of the country of Chile that takes on this challenge and shares it. The PRISMA protocol guided this study, finding 341 relevant articles to be analyzed, which mainly show how it is possible to implement measures and improve sustainable education with a gender focus through policies and initiatives within a university in the short term.

Keywords: sustainability; gender gap; gender equality; policies; strategies; higher education; STEM; gender-sensitive pedagogy; Sustainable Development Goals



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1. Introduction

The purpose of the UNESCO Chair on Sustainable Development and Environmental Education is to promote applied research, teaching, and specialized studies on Sustainable Development and Environmental Education topics from an interdisciplinary perspective encompassing both natural social and technical sciences. Education is considered the single most important tool that supports the achievement of a nation's sustainable development [1]. In recent years, there has been a growing awareness of sustainability and regulations to address gender inequalities in STEM-related programs and the need to

overcome them, thus closing the gender gap in these academic disciplines. Various initiatives have emerged, including gender equality policies, regulations, and programs [2]. It is recognized that equal and open access to education facilitates the advancement and empowerment of women and girls. The World Bank has reported that 94% of girls in the Caribbean attend school, and, in the context of tertiary education, women outnumber men at the University of the West Indies (UWI) by 63% to 37%. If graduation statistics reflect a similar trend, the number of professionally qualified women will consistently outnumber men attaining tertiary education [3]. While these data suggest progress for gender diversity in the workplace, educational and training enrollment in certain professions are still heavily dominated by men [3].

As indicated in the study “Integrating education and research on the transversality of the SDGs: gender and health, essential dimensions of sustainability” [4], universities, with their vast responsibility in the generation and dissemination of knowledge, play an essential role in the achievement of the Sustainable Development Goals through teaching and research [4]. Education and research are crucial in designing and overseeing how we should manage the planet. This involves providing policy leaders with effective tools from diverse disciplines and recognizing and building on socioecological cultures and traditions that have proven sustainable systems in interacting with the environment [5]. Many regulations, initiatives, good practices, and strategies worldwide have successfully increased women’s participation in science and engineering; however, only a few efforts have been made to share these practices worldwide. Despite their successes, no nation has found the magic formula for achieving gender parity [6]. Unfortunately, women’s participation remains low, although there are differences from one country to another [7], and gender inequality in STEM careers has proven to be a global problem, leading to the question of whether to avoid prejudice and not maintain the gap. Education and policies aligned with the SDGs can certainly be a solution and make a difference [8].

It is essential, when analyzing this issue, to consider the role that universities play in promoting sustainability in education and gender equity. Therefore, several studies have emphasized the importance of teaching innovation and empowering faculty by incorporating these competencies. This involves not only providing online tools and resources but also offering teacher training with a gender perspective, enabling them to design activities and strategies specifically tailored to progressively address and improve the problem [8].

On the other hand, studies have shown that women in STEM present a higher average perception of achievement in systemic and critical thinking, and men have a higher perception of scientific thinking [9]. From this, social and cultural elements influence the perception of achievement that men and women develop in thinking and problem solving. Therefore, governments and higher educational institutions must establish training programs that do not follow gender stereotypes and equally promote reasoning skills by complexity in men and women. It is necessary to create more scientific and academic spaces and projects that involve women in science [9]. In highly masculinized disciplines, the inclusion of a gender perspective is essential for future sustainability whenever the content, results, or applications of a subject may directly or indirectly affect human beings. Technological advances affect men and women differently, especially in technology-related disciplines where it is widespread [10].

By way of introduction, female and male STEM graduates play a key role in the sustainable development of society, contributing to the economy’s productivity, competitiveness, and progress. However, the number of students enrolled in STEM courses is low despite the high demand and valuation by the labor market. This reality is even more striking when analyzing the figures related to the presence of women in STEM fields, particularly in engineering careers [11]. This is why, at the international level, there are initiatives and programs to reduce the gender gap and bet on gender equality, such as UN Women [12] (and also with a Latin American focus) and the achievement of the Sustainable Development Goals (SDG) of the 2030 Agenda. Olavarria (2011) told us that

women had higher graduation rates and lower dropout rates and graduated more than men in undergraduate programs. This is an important factor in encouraging women to study for higher education [13]. Gender-sensitive education is essential because education, in general, is widely recognized as a key factor for the progress and stability of nations. Both international organizations, governments, researchers, and education experts have highlighted the crucial role of education in building a democratic, participatory, and diverse society. Education is considered a basic human right, essential for sustainable development, and vital for citizen inclusion in social and economic systems [14]. The economic vitality of a country depends on the expansion of education; if a country has more inhabitants prepared to contribute, then the economy and effective participation in democracy will improve. This is when it takes value to empower women in higher education to enhance economic growth [15].

Students need to comprehend the gender disparities within their society and culture concerning global regulations while respecting cultural differences. This entails acknowledging how gender intersects with other social categories such as disability, religion, and race. Moreover, they should recognize the advantages and opportunities that full gender equality offers and understand the importance of engaging in legislative and governance processes, including the allocation of public resources, the labor market, and decision making in both public and private spheres. Lastly, students should grasp the critical roles of education, technology, and legislation in empowering and ensuring equal participation for all gender identities [16].

This article includes a systematic mapping summarizing proposals, good practices, and initiatives for sustainability and gender equality in higher education. In addition, the practical and political changes generated at the Universidad de La Frontera, Chile, aligned with the 2030 Agenda, are presented as a case study. It is necessary to mention that the contribution of this article is crucial to show how some goals of the 2030 Agenda are successfully addressed in the framework of the generation of policies and strategies in state university education. Then, this paper is divided as follows: Section 2 covers the general essential concepts related to the research. Section 3 details the methodology of the systematic mapping Study and the results of the article selection process. Section 4 presents the study's main results. Section 5 analyzes the main challenges of this research. Section 6 explains this study's limitations. Section 7 presents the actual case study and identifies good practices for sustainability and their implementation from 2018 to the present within the Universidad de La Frontera. The challenges, measures, policies, laws, initiatives, and projects of the case study applied for sustainability and reducing the gender gap are considered. Finally, Section 8 presents the conclusions, implications, and possible future research.

2. Background

2.1. Sustainable Development Goals (SDGs)

On 25 September 2015, global leaders adopted a series of international objectives aimed at eradicating poverty, safeguarding the planet, and fostering prosperity for everyone as part of a fresh sustainable development initiative. Each objective delineates specific targets to be accomplished within the following 15 years. Specifically, Objectives 4 and 5, relevant to this study, pertain to ensuring inclusive, equitable, and high-quality education to promote gender equality for all and to empower women and girls universally [17].

2.2. Education for Sustainable Development ESD

Education for Sustainable Development (ESD) equips people of all ages with the knowledge, skills, values, and agency necessary to address interrelated global challenges, such as climate change, biodiversity loss, unsustainable resource exploitation, and social disparities. It enables individuals of all ages to make informed decisions and act individually and collectively to transform society and protect the planet. ESD is a continuous educational process that is an integral part of quality education. In addition, it enhances

the cognitive, socio-emotional, and behavioral dimensions of learning, covering both its content and results, pedagogy, and the learning environment [18]

2.3. Gender Inequality

Gender inequality represents a sociocultural phenomenon that regulates social relations by considering people as inferior or superior based on their gender, which is also linked to categories such as race, class, and sexuality, among others. It implies that social inequalities and discrimination are justified on the basis of sexual differences, giving men what is considered a masculine level of superiority and privileges. [19].

2.4. Gender Gap

This is an indicator that shows the distance between the position or condition of men, women, and LGTBQIA+ people concerning the same area. It translates into inequalities about autonomy, access to resources, participation, opportunities, exercise of rights, and access to spaces of power, among others. They are a consequence of the gender discrimination present in society [19].

2.5. STEM

The National Science Foundation of the United States refers to science, technology, engineering, and mathematics (STEM) disciplines. The word's literal meaning in English stems from the notion that new solutions could emerge from these four disciplines to boost the country's competitiveness as a world leader in innovation and development. STEM education is an educational movement followed to improve student learning regarding knowledge and skills. Both perspectives coexist and have enriched each other, giving rise to different interpretations of STEM education's content, methods, and objectives [20].

2.6. Gender Equity

This involves the means, processes, or programs aimed at achieving gender equality, considering the diversity of the experiences of women and different social groups in their insertion in the social structure, belonging to native peoples, age differences, and living conditions; seeking fair treatment toward people about their specific needs and the recognition of the differences leading to the complete development and the exercise of their human rights; taking into consideration the distribution of opportunities, resources, and benefits, in addition to areas such as wealth, power, and time [19].

3. Materials and Methods

Systematic mapping is a research methodology used mainly in fields such as computer science and medicine to review and synthesize the existing literature on a specific topic in a structured way. Its main objectives are to identify, categorize, and present an overview of the current state of knowledge in a given area of study [21].

This technique involves conducting a comprehensive search for relevant publications and then classifying and analyzing these studies to identify trends, gaps in existing research, and possible areas for future studies [21]. Unlike systematic reviews, which focus on answering specific research questions through the detailed analysis of a limited number of studies, systematic mapping seeks to provide a broader picture of the field of study, highlighting the amount and type of research conducted, as well as the methodologies used and the results obtained.

This study applied Petersen's proposal as a methodological guide, implementing the stages described in Figure 1 (adapted from [22]).

The activities that make up the systematic mapping process are described in the following sections.

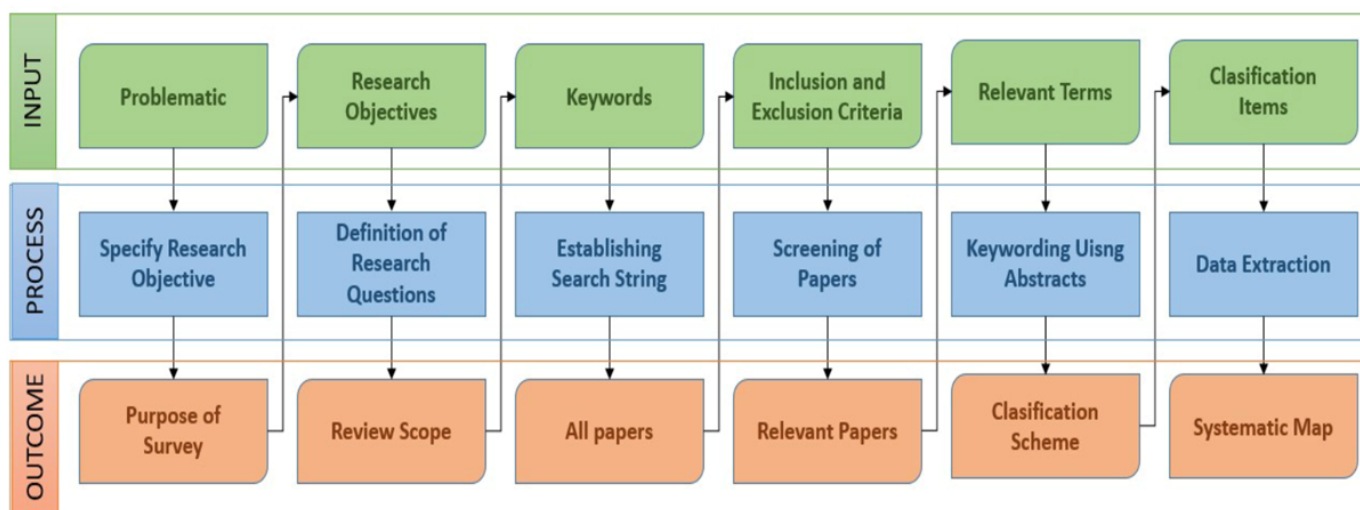


Figure 1. Stages of the systematic mapping process, adapted from [22].

3.1. Goal and Research Questions

This systematic mapping sought to examine and categorize the strategies and policies predominantly utilized over the past five years to diminish the gender gap (since 2017). It also aimed to document how these practices can be implemented in higher education classrooms to advance sustainable education as proposed by the 2030 SDGs. These initiatives will specifically target the gender gap in policies and strategies within higher education, particularly in STEM fields, taking into account both pedagogical and research aspects.

According to the Methodology of a systematic mapping, the research questions were first developed, which constitute the central foundation of the mapping by providing an overview of the specific area [21].

Table 1 presents the research questions and their rationale. These questions guided the selection and classification of the information found.

Table 1. Research questions.

Question	Objective
RQ1: Is it possible to generally identify initiatives and strategies to reduce the gender gap that contributes to sustainable development?	Recognize and generically identify current initiatives and strategies to reduce the gender gap or inequality.
RQ2: Is it possible to identify policies and strategies to reduce the gender gap in higher or tertiary education that contribute to sustainable development?	Recognize and identify policies and strategies focused on higher education to reduce the gender gap.
RQ3: Is it possible to identify good practices in pedagogy or teaching with a gender perspective to achieve Objectives 4 and 5 of the 2030 Agenda?	Recognize and identify pedagogical or teaching practices to achieve Objectives 4 and 5 of the 2030 Agenda.

3.2. Data Sources and Keywords

The search for the most comprehensive literature on the research topic was systematically conducted in the following databases: WoS, Scopus, IEEE, and ACM. The review encompassed studies published in about five years, covering from 2017 to 2023. A combination of keywords related to “Higher Education”, “Tertiary Education”, “Policies”, “Strategies”, “Projects”, “Initiatives”, “STEM”, “Gender Gap”, “Gender Equality”, “Gender Inequality”, “Gender-sensitive Pedagogy”, “Gender-sensitive Teaching”, “Gender-sensitive Research”, “Goal 5”, and “SDG 5” was used. Keywords were searched for in the follow-

ing order: abstract, title, and then the keywords in the selected articles as long as they were available.

3.3. Search String

To create a search string, keywords were extracted from the research questions and objectives and connected using logical operators. This search string was utilized in the search engines and verified by the researchers. The final string was the following:

("Gender Gap" OR "Gender Equality" OR "Gender Inequality") AND ("Policies" OR "Strategies" OR "Projects" OR "Initiatives") AND ("Tertiary Education" OR "Higher Education") AND ("STEM" OR "Gender-sensitive Pedagogy" OR "Gender-sensitive Teaching" OR "Gender-sensitive Research" OR "Goal 5" OR "SDG 5").

3.4. Data Extraction

Searching and extracting data included using databases and websites that provide access to digital libraries. These platforms were selected for their ability to perform searches using tailored search strings, allowing for the retrieval of many pertinent papers. The selected data sources included WoS, Scopus, IEEE, and ACM.

3.5. Inclusion and Exclusion Criteria

The studies found through the academic search engines mentioned earlier were selected based on the following inclusion/exclusion criteria.

The inclusion criteria included the following:

- Papers in English.
- Journals and conferences.
- Full papers.

The exclusion criteria included the following:

- Technical reports, abstracts, editors' comments, state-of-the-art reviews.
- Studies before 2017.
- Documents that do not reflect higher education environments.

3.6. Search Execution

The sources were chosen utilizing the search string, resulting in an initial collection of 341 papers (refer to Table 2). The data were gathered using the export functionalities provided by each digital library. After a search to eliminate the papers that were doubly indexed, it was found that it was possible to reduce the number because there was duplicity, and 252 papers were retained; after filters 1 and 2, 183 articles were selected for analysis.

Table 2. Electronic data sources considered.

Electronic Data Sources	URL	Resources
Web of Sciences	www.webofknowledge.com (accessed on 25 March 2024)	34
SCOPUS	www.scopus.com (accessed on 25 March 2024)	94
IEEE	ieeexplore.ieee.org (accessed on 25 March 2024)	28
ACM	www.acm.org (accessed on 25 March 2024)	185

Initially, duplicates were eliminated from the 341 papers, reducing the count to 252. Subsequently, reviewing the titles based on the inclusion/exclusion criteria narrowed the number to 183 papers. These papers were then reviewed based on their abstracts, confirming the selection of the same 183 papers, as the process was complete. (Refer to the

summary in Figure 2). The complete list of selected articles is available in Appendix A, Table A1.

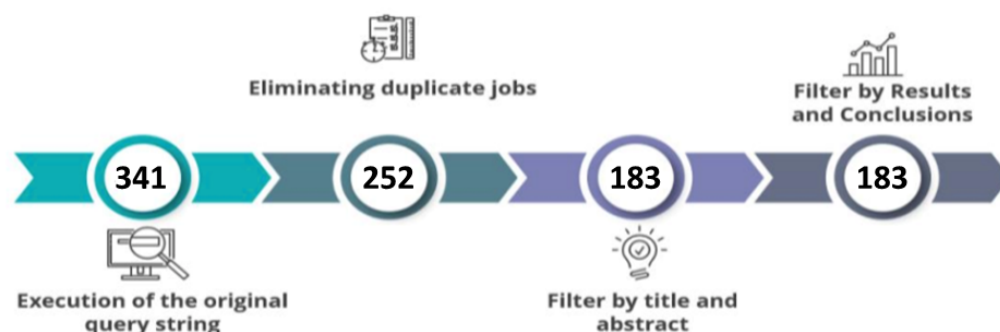


Figure 2. Consolidation of selected publications.

3.7. Classification Scheme

Publications were categorized across three dimensions: temporal, database type, and content (keywords). The temporal dimension organized the papers based on their publication year, focusing primarily on the past five years, covering from 2017 to 2023. This also included a selection of articles from preceding years, identified through a snowballing process applied to the items selected in earlier steps.

The database type dimension pertains to the publication's origin or source. Regarding the content dimension, the focus is primarily on categorizing topics relevant to the gender gap. This includes policies and strategies implemented to reduce the gap, as well as projects and initiatives connected to higher education in STEM fields and aspects related to gender-sensitive pedagogy and research. Additionally, this dimension aligns with Goal 5 of the 2030 Agenda.

3.8. Map Development

The outcome of the systematic mapping phase was the creation of a map designed to aid in representation and analysis. Subsequent sections will detail and analyze each of the graphs derived from this study.

4. Results

This section is structured with subheadings for clarity, aiming to provide a concise and precise representation of the experimental results along with their interpretation. Additionally, it will delineate the experimental conclusions drawn from these findings.

Figure 3 displays the classification of papers based on pertinent keywords or items. The right side of the figure presents the categorization of publications by year range. It is important to note that some articles address multiple topics illustrated in the graph, resulting in them being counted more than once. Table 3 shows in more detail how the topics are distributed in the articles.

It should be noted that articles before 2017 were grouped into a single classification to facilitate visualization. If individual years of publication were considered, the graph would expand too much. In addition, this graph seeks to show the evolution of the topics considered in the most recent years.

In this context, a considerable increase in the number of articles published from 2019 onward can be seen. The topics that presented the most significant increases in publications are gender gap or gender equality, associated policies or initiatives, and STEM and tertiary education or higher education.

On the other hand, the topics associated with gender sensitivity in the context of pedagogy, teaching, or research, as well as proposals that consider SDG 5, do not present a significant variation concerning previous years.

Table 3. Papers encompassing multiple categories.

Cases	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Total
One thematic area	✓	-	-	-	-	-	-	-	3
	-	-	-	✓	-	-	-	-	5
	-	-	-	-	✓	-	-	-	4
	-	-	-	-	-	-	✓	-	1
Two thematic areas	✓	-	✓	-	-	-	-	-	2
	✓	-	-	✓	-	-	-	-	5
	✓	-	-	-	✓	-	-	-	13
	✓	-	-	-	-	✓	-	-	1
	-	✓	-	-	✓	-	-	-	6
	-	-	✓	-	✓	-	-	-	4
	-	-	-	✓	✓	-	-	-	5
	-	-	-	✓	-	-	-	✓	1
Three thematic areas	✓	✓	-	✓	-	-	-	-	5
	✓	✓	-	-	✓	-	-	-	2
	✓	-	✓	✓	-	-	-	-	2
	✓	-	✓	-	✓	-	-	-	5
	✓	-	-	✓	✓	-	-	-	8
	✓	-	-	-	✓	✓	-	-	1
	✓	-	-	-	✓	-	✓	-	3
	✓	-	-	-	-	✓	✓	-	1
	-	✓	✓	-	✓	-	-	-	1
	-	✓	-	✓	✓	-	-	-	8
	-	✓	-	✓	-	-	-	✓	1
	-	✓	-	-	✓	✓	-	-	1
	-	-	✓	✓	✓	-	-	-	8
	-	-	✓	✓	-	-	✓	-	1
	-	-	-	✓	-	✓	✓	-	1
	-	-	-	-	✓	✓	✓	-	3
Four thematic areas	✓	✓	✓	✓	-	-	-	-	1
	✓	✓	✓	-	-	-	-	✓	1
	✓	✓	-	✓	✓	-	-	-	26
	✓	✓	-	✓	-	-	-	✓	6
	✓	✓	-	-	✓	-	-	✓	1
	✓	-	✓	✓	✓	-	-	-	11
	✓	-	✓	✓	-	-	-	✓	2
	✓	-	-	✓	✓	-	-	✓	1
	✓	-	-	-	✓	✓	✓	-	3
	-	✓	✓	✓	✓	-	-	-	2
	-	✓	✓	✓	-	-	✓	-	1
	-	✓	✓	✓	-	-	-	✓	1
	-	✓	-	✓	-	✓	✓	-	1
	-	-	✓	-	✓	✓	✓	-	1
	-	-	-	✓	✓	✓	✓	-	1
Five thematic areas	✓	✓	✓	✓	✓	-	-	-	15
	✓	-	-	✓	✓	✓	✓	-	3
	-	✓	✓	✓	✓	-	✓	-	1
Six thematic areas	✓	✓	✓	✓	-	✓	✓	-	1
	✓	-	✓	✓	✓	✓	✓	-	3
Total	125	81	63	126	140	21	25	14	

(1) Gender Gap or Gender Equality. (2) Policies or Strategies. (3) Projects or Initiatives. (4) Tertiary Education or Higher Education. (5) STEM. (6) Gender-Sensitive Pedagogy or Gender-Sensitive Teaching. (7) Gender-Sensitive Research. (8) Goal 5 or SDG 5.

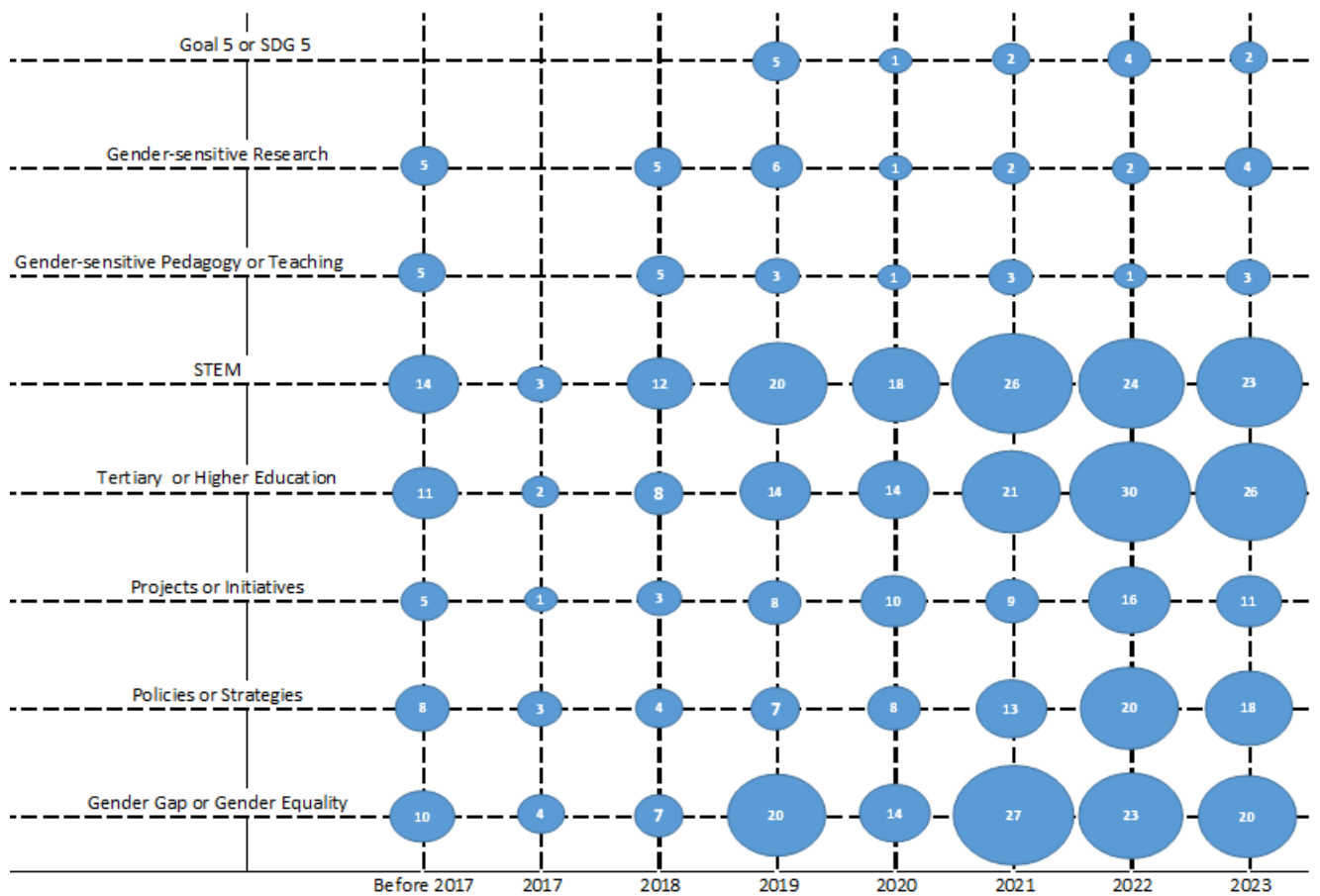


Figure 3. Bubble map.

The table illustrates that the majority of the analyzed works encompass more than one thematic area. The highest concentrations of works are observed in three and four thematic areas, with 52 and 58 works, respectively. Moreover, the thematic areas most frequently addressed in the works are STEM (140 papers), tertiary education or higher education (126 papers), and gender gap or gender equality (125 papers). Conversely, the least addressed topics include gender-sensitive research (25 papers) and Goal 5 or SDG 5 (14 papers).

Out of the total (each concept relative to the 183 selected articles), when analyzed concerning the topics covered in this study, the following findings were observed: 125 for gender gap or gender equality, 81 for policies or strategies, 63 for projects or initiatives, 126 for tertiary education or higher education, 140 for STEM, 21 for gender-sensitive pedagogy or gender-sensitive, 25 for teaching gender-sensitive research, and 14 for Goal 5 or SDG 5.

The classification is not one-to-one, as some of the works encompass multiple of the analyzed concepts. Consequently, the total sum of these classifications surpasses the overall count of 183 publications.

4.1. Overall Results

Regarding categorizing the 183 publications, the number of publications per year can be identified, as illustrated in Figure 4.

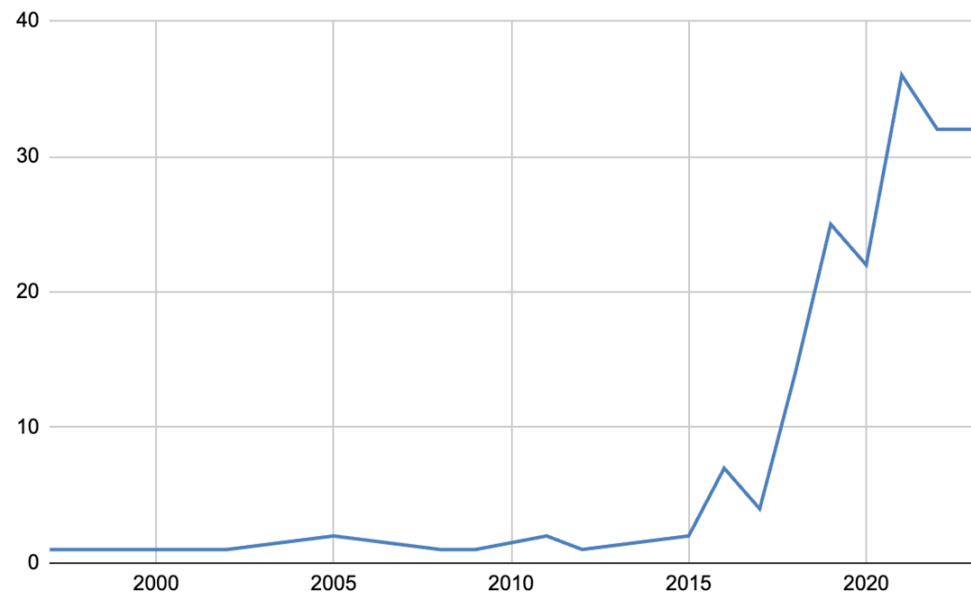


Figure 4. Number of articles per year of publication.

Concerning the classifications of the 183 publications, the distribution by publication category, in terms of percentage, can be seen as depicted in Figure 5.

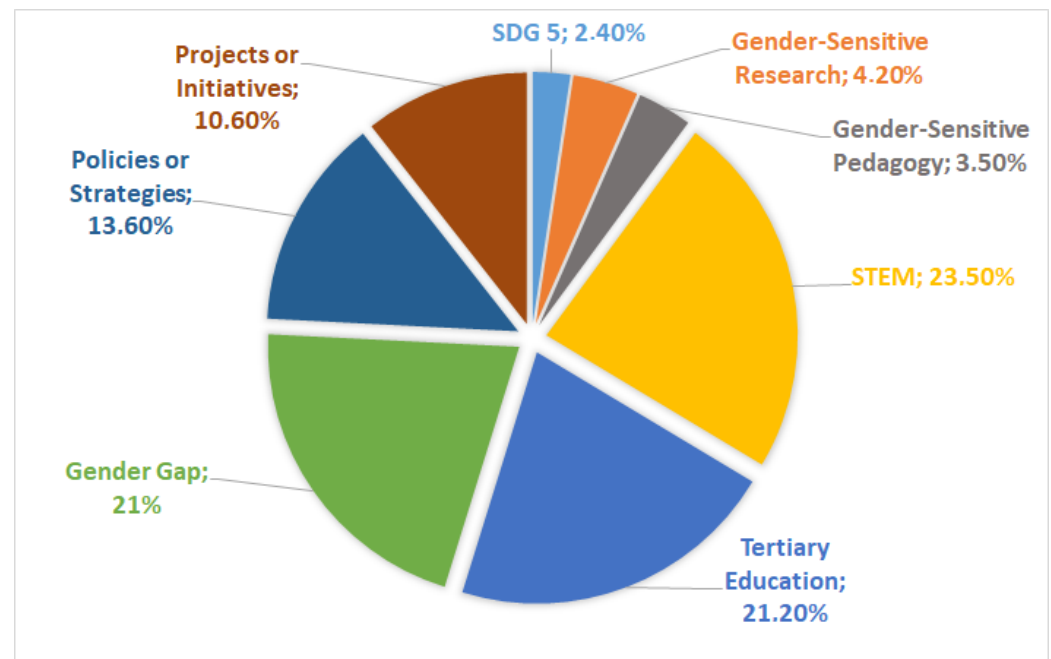


Figure 5. Number of publications by category.

The graphs indicate that the subject matter of this study has become increasingly relevant and has gained significant momentum since 2018. This research aimed to showcase various initiatives. Ultimately, it will emphasize noteworthy initiatives, strategies, and projects in higher education. This includes considering policies, laws, teaching, and research focusing on gender.

4.2. Results Aligned with the Research Questions

Results for RQ1: Is it possible to generally identify initiatives and strategies to reduce the gender gap that contributes to sustainable development?

Three keywords of the papers on the topic were analyzed to answer this research question (policies or strategies, projects or initiatives, gender gap or gender equality). This yielded a total of 269 hits for each. Table 4 shows the articles dealing with the topics analyzed under this research question.

Table 4. Articles by topic for RQ1.

Topics	References
Gender Gap or Gender Equality	[23–29], [2,3,6,7,9,11,30–127], [128–130], [131–141]
Policies or Strategies	[2,3,6–9,11,23–25,27–42,45,46,49–52,54–57,59,61–63,65,69,70,72,73,76–78,81,83,102,104,133–136,138,139,141–163]
Projects or Initiatives	[2,6–9,11,25–28,35,38,43,44,48,53,58,60,61,66,69,71,74,77,79,83,86–88,90,93,96,104,109,112,114,116,119,120,133,135,137,139,140,147,150,157,158,163–177]

Regarding sustainable development for education and equality, the gender gap implies unequal access between women and men to resources, well-being, power, and benefits, manifested in every one of the objectives of sustainable development. Progress in eliminating it works as a catalyst for sustainability, and all goals must include gender indicators, which is far from reality [178]. We provide below a list of the most notable cases along with descriptions of the publications that characterize the initiatives that contribute to this research:

1. Studies in Kenya, Rwanda, and Uganda show a disconnect between stated policy objectives and actual student outcomes, which limits institutional success and economic development. Despite having policies, they need to be more consistent [38]. A study for a Latin American university indicates that creating more scientific and academic spaces and projects involving women in science is necessary; countries should emphasize this to improve their scientific competence [9].
2. The selected articles mention the W-STEM project, which works to reduce the gender gap in STEM fields in Latin America. This project works based on possible actions, policies, and strategies that universities could develop to reduce the mentioned gap in higher education [25]. It has been shown that female participation in STEM is decreasing at all educational stages. In Ireland, the focus is on initiatives for addressing the gender gap in the early years through to the end of secondary education (18/19 years). However, this strategy in higher education is limited, and gender equality policies are mainly directed at staff and the institution in general [28]. On the other hand, it can be recommended that the capability approach (CA) helps analyze gender inequalities in higher education, and it has also been used to examine the impact of the crisis on specific groups and situations [35].
3. Among the studies examined, they highlight significant initiatives designed to address key actions, such as establishing centers of excellence for gender equality and implementing affirmative measures to correct the gender imbalance in the upper echelons of Ireland's higher education system [69]. Another chapter in the study provides an in-depth review of the gender equality strategies and policies of Ireland's foremost research funding organizations, Science Foundation Ireland (SFI) and the Irish Research Council (IRC) [69].
4. The W-STEM (Women in STEM) project, a collaborative effort between Europe and Latin America, was initiated to address gender disparities in STEM fields. This project has led to developing a model aimed at modernizing the governance, management, and functioning of higher education institutions in Latin America. The primary goal is to enhance women's attraction, access, and retention in STEM programs. This model has been rigorously implemented in eleven institutions across Chile, Colombia, Costa Rica, Ecuador, and Mexico, encompassing both public and private institutions with varying levels of gender equality [9].

- Finally, it is worth mentioning the Make a Lab project, which aims to address the significant gender gap in STEM subjects. A key target of this project is to ensure that at least 70% of the participants in its activities are women. The project seeks to foster interest in science and technology among high school students by employing creative, experimental, and exploratory methods [11].

Figure 6 presents a word cloud for RQ1. This illustrates the initiatives linked to the results of the research question. The form is random and only aims to show a consolidated concept that resulted from the analysis of the associated research question.



Figure 6. Word cloud linked to the outcomes related to RQ1.

Results for RQ2: Is it possible to identify policies and strategies to reduce the gender gap in higher or tertiary education that contribute to sustainable development?

Two keywords in the papers on the topic were analyzed to answer this research question (higher education or tertiary education; STEM). This yielded a total of 266 hits for each. Table 5 shows the articles dealing with the topics analyzed under this research question.

Table 5. Articles by topic for RQ2.

Topics	References
Tertiary Education or Higher Education	[2,3,6–9,11,23–25,28–45,47–63,65,66,68–70,72–75,77–81,83,85,86,88,92–94,96,98,99,102–104,106,108–110,115–117,119–121,126,133–136,138–140,142–147,149,150,152,158–161,163,164,166–169,173–175,177,179–191]
STEM	[2,6–11,25,26,28,29,31,33–43,45–58,61–69,71,72,74–80,82–99,101,104,105,111,114,117–128,131,132,134–136,140–145,148–157,160–176,179,180,186,188,189,191–197]

We present a compilation of the most significant cases, accompanied by descriptions of publications that illustrate the initiatives contributing to this research:

- In a policy study about the research question, one study indicates that the findings confirm a disconnect between stated policy goals and actual student outcomes, which limits institutional success and economic development [38]. One of the studies on higher education indicates that social and cultural elements influence the perception of achievements that men and women develop in thinking and problem solving [9], which is of utmost importance for designing gender-sensitive curricula.

2. The Agency for the Quality of the University System of Catalonia (AQU Catalunya) initiated a mandate for the integration of the gender perspective in all tertiary education and master's programs in Catalonia by 2021 [2]. To adhere to this mandate and foster a culture of equity and equal opportunities for women, the Universitat Politècnica de Catalunya (UPC) implemented various projects within its community. One notable project, led by the Gender Equality Commission of the Barcelona School of Nautical Studies, involves creating a web platform that provides resources for faculty to integrate this cross-cutting gender perspective competence into the nautical, marine, and naval engineering syllabi [2]. Additionally, the previously mentioned W-STEM project notably includes a self-evaluation tool for gender equality in higher education institutions in Latin America, a protocol for interviewing female role models, and a mobile application to showcase these role models [7].
3. Gonzalez highlighted that developing and applying various tools, such as questionnaires, canvas models, and rubrics, is feasible. These instruments can be used for self-assessment and restructuring curricula, content, practices, specific learning outcomes, and methods. They also aid in creating balanced learning environments regarding gender and sex, promoting equity within the sphere of higher education [8]. Similarly, initiatives like developing guides by the University Network "Vives" for university teaching in Spain focus on various aspects such as objectives, content, evaluation, learning environments, organizational methods, teaching techniques, and didactic resources. They aim to bring visibility to women scientists within the discipline and counteract the androcentric perspective prevalent in sciences and engineering [150].
4. The University of Basque Country stands out for its defined objectives to address sustainability [198], which include the following: (1) train expert teachers in sustainability, as well as in conceptual and methodological approaches; (2) offer basic training on sustainable development to undergraduate and postgraduate students, with the possibility of expanding it to other actors external to the university, such as managers, among others; (3) develop teaching material on sustainable development aimed specifically at the university environment, including publications and interactive online programs; (4) produce teaching material on sustainable development aimed at dissemination in society in general, through publications and interactive online programs. Regarding the learning methodology, the importance of practice being a fundamental part of the educational process is emphasized. The aim is for learning to be based on experiences and actions closely related to reality, both at a global and local level.
5. Finally, it should be noted that despite having policies in place at universities, these policies apply primarily to staff hired by the university. One of the studies indicates that, before entering university, participants had a high self-concept and interest in STEM; however, the research found that unconscious gender bias in the university made female students feel undervalued by their male peers [28].

Figure 7, displaying the Word Cloud for RQ2, illustrates the initiatives linked to the results of the research question. The form is random and only aims to show a consolidated concept that resulted from the analysis of the associated research question.

Results for RQ3: Is it possible to identify good practices in pedagogy or teaching with a gender perspective to achieve Objectives 4 and 5 of the 2030 Agenda?

Three keywords of the papers on the topic were analyzed to answer this research question (Goal 5 or SDG 5; gender-sensitive pedagogy or gender-sensitive teaching; gender-sensitive research). This yielded a total of 60 hits for each. Table 6 shows the articles dealing with the topics analyzed under this research question.



Figure 7. Word cloud linked to outcomes related to RQ2.

Table 6. Articles by topic for RQ3.

Topics	References
Gender-sensitive Pedagogy or Gender-sensitive Teaching	[10,117–123,126,129,130,132,139,140,159,162,176,187,191,192,195]
Gender-sensitive Research	[10,117–127,129,139,140,158,159,163,176,177,187,191,192,195,199]
Goal 5 or SDG 5	[3,27,32,44,47,59,60,70,73,76,81,146,147,190]

We provide a detailed list of the most exemplary cases, along with descriptions of the publications that highlight the initiatives contributing to this research, as follows:

1. This analysis evaluated selected articles related to the Sustainable Development Goals (SDGs) of the 2030 Agenda, focusing on a content analysis of the sustainability reports from the top 50 global business schools. A study generated a Code Frequency Report emphasizing Goal 4: quality education (concerning scholarships and grant allocation) and Goal 5: gender equality. It explored correlations with the schools' ranking positions, the cost of MBA programs, the percentage of MBA students, and the number of female faculty and board members across various geographical regions, including Europe, the United States, and Asia. The findings indicate that gender equality issues contribute positively to the reputation and legitimacy of top business schools [27]. The study also focused on SDG 5 in developing countries, specifically Vietnam. Despite the introduction of the Gender Equality Law in 2006 by the Vietnamese government, aimed at promoting equal opportunities for women and reducing the 70% Gender Gap Index score in Vietnam, the representation of women in leadership roles across various sectors, including higher education, remains low. The research identified the main obstacles to women's professional advancement: work-life imbalance, perceptions of women leaders by subordinates, social networks, and personal factors. These findings could catalyze achieving the United Nations' Sustainable Development Goal 5 on gender equality in Vietnam, one of the fastest-growing economies in the world [32].
2. Another article investigated, in terms of the development of various activities by academics, the relationship between (1) the target age group, (2) the gender of the participants in activities, and (3) the gender of the leading experts of the activity (the content and the main objective of the activity). The results show that the gender and age of the participants and the gender of the activity-leading experts are associated with the underlined content and the activity goal. The findings show that all these

- items are part of patterns and that it is possible to measure implications and their value for informal and non-formal learning communities [195].
3. Similarly, in a study in the field of Artificial Intelligence (AI), where the majority of professionals are men, their experiences shape and dominate the creation of algorithms. As a result, this indicates that to recognize the existence of discriminatory gender biases in algorithms and limit their consequences in the offline world, it is necessary to introduce the gender perspective in these studies. The study focused on analyzing the degree of introducing a gender perspective in AI degrees from the faculty and how to improve the gender competencies of the student body [10].
 4. A recent study in the field of computer science examined the outcomes of an intervention involving an innovative interdisciplinary online course on data science. This course was designed to engage girls in computer science and programming, contributing to the broader objective of addressing colony collapse disorder in biology and geocology. The findings highlight the effectiveness of such programs in generating interest among girls in programming. Additionally, the study revealed significant insights regarding the learning environment. Interestingly, it was found that girls in single-gender classes (SGCs) exhibited a noticeably greater openness to computer-related subjects. Moreover, the intervention elicited more positive responses from girls in SGCs than those in mixed-gender classes (MGCs) [122].
 5. Maritime education (MET) also reflects a gender disparity. Data from MET programs, specifically in navigation at the University of Trinidad and Tobago (UTT), show a female-to-male ratio of 1:5 at the tertiary level. This trend is also observed in other Caribbean regions. Consequently, the low enrollment rates of females lead to a similarly low number of female graduates entering the navigation field. This situation calls for considering policies, laws, relevant international instruments, human development reports, and the extent to which the Sustainable Development Goals (SDGs 4 and 5) are implemented. Given the various challenges that the shipping industry faces, excluding women from opportunities in this sector is not viable. Therefore, fostering inclusive education is seen as a vital strategy to promote gender equality and enhance the maritime sector's performance [9].
 6. A fascinating study focused on actions for gendered research to determine factors related to the assignment of author order in collaborative publications. The results, after applying interviews, reported metrics of interest for a bibliometric analysis of gender and collaboration in research articles published between 1996 and 2016 in three major HCI and ML conferences: based on the findings, it is recommended to take special care in the allocation of credits in multi-author articles and the interpretation of author order, particularly on how this area affects women [140].
 7. The results of a survey aimed at assessing the awareness, attitudes and actions of Thai teachers regarding sustainable education and gender, revealed that the overall average percentages of attitudes (90%) and actions (91%) were higher compared to awareness (69%). It should be noted that the aspects with the lowest scores in the attitude and action categories corresponded to SDG 5 of the 2030 agenda, which focuses on gender equality. The survey also found that pre-service teachers in their second year showed significantly higher levels of awareness than their counterparts in the first, third, fourth, or fifth year of the program. Without a doubt, these aspects are key to achieving SDGs 4 and 5. Curiously, no marked differences were observed between the different types of programs [60].

Figure 8, displaying the Word Cloud for RQ3, illustrates the visual representation of the initiatives linked to the results of the research question. The form is random and only aims to show a consolidated concept resulting from the associated research question analysis.



Figure 8. Word cloud linked to the outcomes related to RO3.

5. Reflections on the Findings

Based on the information presented in the previous section, the main challenges of the research are discussed, and explaining every detail is not easy since it is impossible to generalize arbitrarily. The cultural aspects of each country mean that each environment has its characteristics of how to promote and implement measures aimed at improving the gender aspect of sustainable education at all levels.

The results of the articles suggest a significant influence on the collective capabilities of change agents within institutions. This impact is mainly due to factors such as insufficient institutional commitment to the SDGs and gender issues and limitations on mobility and restricted social interactions. However, the findings are not lapidary and also highlight positive aspects, particularly the remarkable ability of teams to adapt to challenging future situations such as sustainability [35].

6. Study Limitations

Our aim with this study was to conduct a comprehensive literature review and present a practical case study addressing sustainability aspects in higher education, with a specific focus on devising future strategies related to gender gap issues, policies aimed at reducing the gap, and initiatives within STEM fields of higher education. These initiatives encompass pedagogy, teaching, and research with gender awareness, while also aligning with Goal 4, but primarily Goal 5 of the 2030 Agenda. It is crucial to acknowledge potential limitations of our study, such as the manual selection of scientific articles from databases using search engines. Relying on specific keywords for literature filtering could introduce certain extraction risks, necessitating careful consideration to ensure the reliability of our conclusions. Our methodology focused predominantly on academic publications in English as of 2018, excluding potentially valuable contributions in other languages. This approach led us to obtain articles primarily from academic journals and conferences, emphasizing recent years to maintain the relevance of the information.

However, this method of selecting studies based on their publication date and language might result in biases related to time and geography [200].

7. Case Study: Universidad de La Frontera

In order to complement this bibliographic review study, a real practical case is presented, where you can visualize how several of the measures analyzed are applied in the results of the bibliographic review. In addition, real data are provided on how it is possible to apply and promote the SDGs for the 2030 Agenda. Since 2018, the University of La Frontera—UFRO, has joined 18 other state universities in Chile to form the “Commitment to Sustainable Development” network of the Consortium of State Universities of Chile (CUECH). The main purposes of this network are to promote sustainable development in all areas of institutional management and operation and to become agents of transformation both locally and globally. By signing this commitment, participants reaffirmed their

understanding of the importance of current challenges and are convinced that public higher education must play a fundamental role in building an equitable, inclusive, prosperous, and environmentally regenerative society. On this path toward 2030, the University of La Frontera is committed to being an example and leader in promoting sustainability in all its aspects. The “Declaration of Commitment to the Sustainability of State Universities” presents six priority areas. The first focuses on “Education for Sustainability”, with the objective of educating conscious, critical, and committed individuals, who can act as agents of change and lead innovation to transform production and consumption patterns toward sustainable practices. The priority areas are: (1) Education for Sustainability, (2) Research and Innovation with a Sustainable Approach, (3) Sustainable Campus Management, (4) Contribution to Global Sustainable Development, (5) Commitment to Carbon Neutrality, and (6) Networking for Sustainability. Sustainability is part of the university Strategic Development Plan 2030.

7.1. Creation of the Sustainability Policy

Starting from 2017, the University of La Frontera initiated the formulation of strategic directives related to sustainability. The institution understands sustainability as the collective construction through which the community, gradually and consciously, aspires to the possibility that people and their environment prosper in a balanced, inclusive, and efficient manner, considering and safeguarding the availability of resources and the preservation of the environment for future generations [201].

Since 2022, the University of La Frontera has had a Sustainability Policy that provides strategic guidelines on sustainability and the environment for the institution, and is part of interuniversity networks such as the Commitment to Sustainable Development Network, the Sustainable Campus Network, and the MetaRed, Exempt Resolution 2706/2022. The objectives of this policy are three: (1) generate institutional guidelines, strategic orientations, and guidelines to promote sustainability in the work of the university; (2) incorporate the principles of sustainability in the areas of action of the university; (3) promote a sustainable culture in the university community and its territory [201].

Once the Sustainability Policy was approved, the phase of developing corresponding plans, procedures, and instruments began, in collaboration with the relevant academic and administrative units, as well as with the Sustainability Committee, which has triestamental representation and will play a technical role, consultative to guiding decision making in this area. During the first year, a body will be established in charge of defining priorities, responsibilities, deadlines, and resources for the implementation and monitoring of the policy. To obtain feedback during this initial period, a prior analysis was carried out through a voluntary survey directed at the different university levels, composed of 16 questions related to sustainability in various university aspects, which was answered by 642 participants (Citizen Consultation Results). The operation of the policy will be evaluated and updated in a participatory manner every three years, in line with the relevant public policies, institutional policies, and the strategic planning of the university. Management tools will be used to establish a baseline of indicators that allow measuring and evaluating progress in institutional sustainability. This policy is complemented by good practices, laws, and projects associated with the case study in relation to the particular policy to reduce the gender gap within the university at all levels.

In Chile, Law N° 21.369, governing sexual harassment, violence, and gender discrimination in higher education [202], has been enacted. This law mandates that higher education institutions implement comprehensive policies for preventing, investigating, punishing, and eradicating sexual harassment, violence, and gender discrimination. The objective is to establish safe and inclusive environments, ensuring the safety and respect of all individuals, regardless of their sex, gender, sexual identity, and orientation.

According to article 3 of this law, higher education institutions mentioned in article 1 must implement a comprehensive policy to address sexual harassment, violence, and gender discrimination. This policy will include both a prevention model and a sanction

model for such behaviors. This approach has been developed at the University of La Frontera through tri-state commissions and public and participatory processes that involve all sectors of the university community. On 12 August 2021, members were appointed to the commission in charge of preparing the gender policy proposal of the University of La Frontera, and specialized units and specific procedures have also been established in this area. The Gender Equality Directorate at the University of La Frontera was established through Exempt Resolution No. 0813, dated 3 April 2019, which includes an approved organic regulation. Article 7 of this regulation acknowledges the presence of the Advisory Council as an advisory body, outlining its composition and responsibilities. Each appointed member of this council is required to uphold confidentiality by signing an agreement to this effect as a fundamental requirement for their role. In alignment with the above, the university delegated to the institutional Gender Equality Department the task of developing and formulating a proposal for a gender equality and equity policy, as per its functions delineated in article 2, letter a, of Exempt Resolution No. 0813 of 2019. These functions encompass suggesting to the relevant authorities and organizations policies, plans, regulations, and measures aimed at fortifying the institution's efforts to achieve gender equality at the University of La Frontera.

7.2. Creation of the Directorate of Gender Equity (DEG)

The Gender Equality Directorate (DEG), a unit attached to the Rectorate of the University of La Frontera, has the purposes of proposing and managing the application and the execution, monitoring, and constant improvement of the gender approach in the institution. This is carried out in accordance with the guidelines of the Institutional Strategic Plan and current policies and protocols aimed at preventing violence, eliminating arbitrary discrimination and promoting good practices to achieve gender equality in all areas of university activity [203].

The work of the DEG is based on suggesting policies, plans, regulations, and measures to the corresponding authorities and organizations to strengthen the institutional framework and achieve gender equality at the University of La Frontera. In addition, it is responsible for implementing, monitoring and evaluating compliance with the Gender Equality Policy in university activities to guarantee continuous improvement.

In collaboration with the relevant macro-units, it promotes the training, education, and awareness of all members of the university community so that they respect the principles of equality, as well as the dignity and right to privacy and equitable treatment of all people, regardless of their sexual orientation or gender identity and expression. In addition, the management teams of each faculty agree to create gender units to facilitate the coordination and implementation of protocols and actions aimed at raising the awareness, training, education, extension, and continuous development of activities related to gender—this matters. Likewise, through the coordination of studies and the observation, development, and continuous improvement of gender equality, in collaboration with the corresponding institutional units, the generation of knowledge and the implementation of activities and academic content in teaching are promoted, as well as undergraduate and graduate research, linkage, and extension from a gender equity perspective.

The DEG is responsible for carrying out evaluations and reports to design action plans aimed at promoting gender equality in various aspects of university life, such as human and personal resources, undergraduate and graduate teaching, research, and community participation, through its coordination of studies and the observation, development, and continuous improvement of gender equality.

Ultimately, the Gender Equality Directorate (DEG) advocates for policies and actions promoting social responsibility, facilitating the balance between family obligations and the academic and work performances of university community members. This effort aims to diminish gender gaps and foster cultural transformation. Additionally, as part of its responsibilities, the DEG is tasked with representing the University of La Frontera in official institutional contexts, both internally and externally, concerning gender equity matters. It

also works to establish networks and collaboration agreements, both within and outside the institution, to reinforce its gender-focused initiatives.

7.3. Gender Equity Diagnosis

In 2020, the study ‘Gender Situation and Relations Diagnosis at the Universidad de La Frontera’ began [204]. This study aimed to provide a reference base that will contribute to formulating a gender policy at the university to achieve substantive gender equality within the institution. The study’s general objective was to analyze, at a triestamental level, the situation and gender relations present at the university, identifying the gaps, inequalities, and discrimination between men and women in the work, academic, and relational spheres.

The study focused on several thematic areas, including (a) the gender perspective and university management; (b) differences in academic and labor access to resources; (c) hierarchy, leadership, and relational power; (d) widespread discrimination and exclusion; and (e) gender violence. The main findings of the study were the following:

- The institution faces invisible barriers (a glass ceiling) in career paths and authority structures, which is attributed to a combination of individual, organizational, and social factors. However, feminist movements have highlighted gender issues, promoting their inclusion in the institutional agenda.
- There is no institutionalized and agreed-upon vision of gender perspective within the university community. Instead, the concept of gender is perceived as a constitutive element of relationships based on sexual differences, highlighting the need for an institutional gender policy that integrates a gender perspective in all social interaction spaces.
- There is no consensus on how to address the gender perspective in the university community. Instead, the concept of gender is understood primarily as an inherent component of relationships between the sexes, highlighting the urgency of an institutional gender policy that incorporates a gender perspective in all areas of social interaction.
- The study identified cases of sexual, psychological, and symbolic violence within the university. However, the concern lies in the normalization and lack of visibility of these violent situations, which leads to a reluctance to report due to the feeling of impunity or the fear of reprisals that could affect the academic or professional progress of the complainants.
- The conclusions of the diagnosis point out the gaps, inequalities, and gender discrimination present in the UFRO, which have been accepted and transmitted without criticism under patriarchal and androcentric visions. It was observed that, although merit criteria exist, they tend to ignore the unequal conditions faced by women and men.

In summary, the study highlighted the importance of establishing a gender policy at the institutional level that promotes a culture of gender equality and equity at the University of La Frontera.

7.4. Gender Equality and Equity Policy

The main purpose of the policy is to establish strategic guidelines and guidelines to promote a culture of equality and gender equity in all areas of university management and activity. This aligns with article 3 of Law 21,369, which requires the university to implement a comprehensive policy against sexual harassment, violence, and gender discrimination [205].

Based on the established framework, the university commits to the following:

1. Integrate the principles of gender equality and equity transversally in the institutional practices and structures that organize university life.
2. Develop research, undergraduate and postgraduate teaching, community engagement, and knowledge transfer, incorporating a gender perspective and/or gender criteria.

3. Include the co-responsibility and reconciliation of personal, family, work, student, and academic life in the institutional structure. This determination must not affect the respect for the fundamental rights of the university community members, especially their right to privacy, private life, and honor.
4. Incorporate gender criteria in the academic and work conditions for access, permanence, and graduation from the university.
5. Promote balanced gender representation in academic and administrative structures and the university's decision-making unipersonal and collegial bodies.
6. Develop an intercultural gender perspective at the university, particularly considering the Mapuche People.
7. Prevent, eradicate, and sanction the different forms of violence and gender discrimination at the university, including sexual harassment, violence, and gender discrimination.
8. Develop training actions for university community members on gender issues and the repercussions of gender-biased behaviors.

The foundations of the gender equality and equity policy cover the following aspects: gender equity; gender equality; the integration of the gender perspective; the recognition of diverse gender identities, sexual orientations and gender expressions; co-responsibility and the conciliation of personal, family, academic, student, work, and other aspects of people's lives; equitable and protected participation with a gender perspective; and the non-discrimination and prevention of gender violence. All of these principles are based on human rights, interculturality, and inclusion.

7.5. South Austral Macrozone Gender STEM Network Project

In October 2022, four universities in the South Austral Macrozone began a STEM Project aimed at promoting the education and participation of women in scientific careers. The project arose from a pilot plan with the purpose of promoting the education and participation of women in areas of science, technology, engineering and mathematics. This initiative focuses on regional development and technological innovation in the South Austral Macrozone, which covers La Araucanía, Los Lagos, Aysén, and Magallanes (<https://deg.ufro.cl/proyecto-stem-genero/> (accessed on 5 June 2024)).

This thematic network proposal seeks to establish a collaboration program between four universities located in the South Austral Macrozone of the country. The objective is to execute an action plan focused on closing the gender gaps identified in areas such as access, education, knowledge generation, and job placement in the STEM field within the region.

This project includes four state universities in the southern part of the country. It collectively encompasses nearly 2 million inhabitants, with variations in the human development index, demographic density, and per capita income. These regions share challenges in strategic regional development guidelines and areas of technological innovation, such as food production (livestock, agriculture, fishing), forestry, energy industry, and emerging mining in the Austral Region. The Regional Development Strategies highlight the challenge of explicitly incorporating the transition of the region toward a knowledge-based society and economy, in addition to strengthening the attraction and retention of advanced human capital, along with the need for stronger articulation between educational institutions, research entities, the public sector, and the private sector.

The project focuses on the articulation of three levels of action in this thematic network proposal. Increasing access opportunities for women in STEM careers by intervening in secondary education (second and fourth year), supporting the educational process through various awareness and promotion initiatives in high schools, and providing tutoring or mentoring.

In the university context, the project aims to support the educational process of female students and strengthen and promote the participation of women in STEM areas through recruitment, promotion, positioning, and productivity, addressing gender barriers. This includes a system of support, inter-university internships, competitive funding,

and affirmative actions to reduce gaps and ultimately contribute to regional development and technological innovation (employability) and the R&D+i+e (research, development, innovation, and entrepreneurship) system, defining areas of technological insertion and innovation and identifying challenges presented by each priority productive sector for STEM professionals and researchers.

7.6. InES Gender Project

In September 2023, the University of La Frontera was awarded the InES Project for Gender Equality in the scientific and technological field. This achievement is another example of the university's commitment to major global issues. The recently awarded project, titled "Gender in Scientific and Technological Culture: Mainstreaming the Gender Perspective in the R&D+i+e Ecosystem of the University of La Frontera," is expected to promote gender equality in this area significantly (<https://www.ufro.cl/index.php/noticias/12-destacadas/6695-ufro-se-adjudico-proyecto-ines-para-la-igualdad-de-genero-en-el-ambito-cientifico-tecnologico> (accessed on 5 June 2024)).

The plan encompasses three major objectives. The first is the creation of institutional strategies to ensure women's access, development, and leadership in the R&D+i+e ecosystem at the Universidad de La Frontera. The second is to promote the generation of knowledge integrating a gender perspective to strengthen this ecosystem. Thirdly, institutional capacities will be developed to execute and monitor the mainstreaming of the gender perspective from a procedural and normative standpoint.

According to the authorities of this educational institution, this institutional initiative will ensure the continuous promotion of female participation and leadership in R&D+i+e, as well as foster an entrepreneurial culture among postgraduate students. Additionally, and importantly, it will involve setting up an observatory for institutional data in R&D+i+e with a gender perspective, which will aid in making evidence-based decisions for the future.

This project was awarded through the Higher Education Innovation Competition (INES), a competition for projects aimed at developing institutional capacities for innovation based on research and development in higher education. The Ines de Género project has recently implemented affirmative measures, interim actions designed to reduce gender disparity. These measures seek to benefit women as a way to counteract the discrimination they have faced in the past and still face today. Through strategic collaboration, actions will be promoted that cover both institutional policies and individual experiences to mitigate the gender gap in the field of research and scientific culture. This project aims to strengthen institutional capacities at the University of La Frontera to implement and supervise actions to integrate the gender perspective from a procedural and regulatory approach. One of the achievements of this project will be the implementation of a Gender and Science Observatory and the contribution to the strengthening of institutional capacities by supervising initiatives to integrate the gender approach in the research, development, and scientific-technological innovation processes in the institution, from both a procedural and normative perspective.

The Ines Género Team, in collaboration with the Vice-Rector for Research and Postgraduate Studies, has extended an invitation to the inaugural event of the Network of Academics. The network's focus areas include research groups, seminars and workshops, mentoring programs, joint publications, and innovation projects. All project efforts will directly aim to achieve SDGs 4 and 5 of the 2030 Agenda.

7.7. First Congress of Universities and Gender

In 2023, the Gender Equity Directorate of the University of La Frontera, along with the Gender STEM Thematic Network Project and in collaboration with the Gender Equality Commission of the "Council of Rectors of Chilean Universities" (CRUCH, by its acronym in Spanish), organized and conducted the First Gender and Universities Congress on 24–26 October 2023, at the Universidad de La Frontera, Temuco, Chile (<https://deg.ufro.cl/wp-content/uploads/2023/06/congreso-genero-universidades.pdf> (accessed on 5 June 2024)).

The call was directed to faculty members, researchers, graduates, undergraduate and postgraduate students, members and staff of public and private institutions, civil society organizations, and national and international foundations.

The rationale for this initiative stems from the context in which the country is globally developing and promoting reducing the gender gap in public universities. Universities are not exempt from relationships of domination and hegemonic social models. Thus, it is argued that universities are masculinized, meaning that a patriarchal logic prevails in them, permeating their functions, organizations, and routines. Universities have their own “gender regime,” as they express differences between men and women regarding remuneration, recognition, scientific productivity, significant decision making, or access to resources, to name a few. Also, forms of violence toward women, sexual diversities and dissents, and other socially excluded groups are present.

The denunciation of these acts of discrimination and violence was captured under the well-known “feminist tide” that has shaken several university spaces, both inside and outside the Chilean campuses and classrooms. In this particular context, articulations have been produced between these spaces, public and private institutions, and civil society organizations, which deserve and need theoretical and practical reflections to contribute to a more democratic and inclusive society, thereby reinforcing and validating that universities are transformative engines and have a positive impact on their communities and territories.

The main objective of the congress was to promote the exchange of knowledge and practices among university spaces, public and private institutions, and civil society organizations to articulate a more democratic and inclusive society. It aimed to motivate the dissemination of research with theoretical and practical reflections on gender in university spaces and their territory.

The congress focused on the following axes or lines of work:

1. Policies for gender equality in the educational system;
2. Gender and territory;
3. Intersectional violence and trajectories of resistance in the educational context;
4. Care, co-responsibility, and conciliation;
5. Sex and gender diversities and dissidence;
6. Gendered curricula and non-sexist education;
7. Women in STEM and masculinities in educational institutions.

8. Conclusions

The authors for this study analyzed recent publications (since 2007, but mainly from the last five years) that evaluate measures, policies, laws, initiatives, and projects in the case study applied to sustainability in higher education with a focus on the gender gap. This study highlights significant initiatives and a practical case study that demonstrates that it is possible to make consistent and effective progress in promoting and adopting actions for sustainability in higher education, along with reducing the gender gap from various perspectives (students, academics, and university culture). This work makes a significant contribution to the field of research and application of the Sustainable Development Goals, focusing on university education with inclusion, policies, strategies, and a gender approach. This work also looked at how these strategies could be linked to SDGs 4 and 5 of the 2030 Agenda.

The main conclusion drawn from the results obtained through the research questions of this research is the vital importance of active university participation in the treatment of these issues by national and local authorities and the entire university community. Education for sustainability is an evolving concept that implies a new educational perspective. Its objective is to empower individuals of all ages to take responsibility for creating a sustainable future, promoting changes in values, behaviors, and lifestyles [198].

As indicated by UNESCO [18], in response to the results, it is necessary for countries to develop and expand educational activities focused on sustainability issues such as climate change, biodiversity, disaster risk reduction, water, oceans, sustainable urbanization,

and sustainable livelihoods through ESD. UNESCO promotes Global Citizenship Education (GCE) in all areas of study and all aspects of life to equip people with knowledge, skills, and attitudes that foster tolerance, respect, and a sense of belonging to a global community. The ultimate goal is to ensure human rights and promote peace, SDG 4 [206].

According to the results, and if we focus on SDG 5, projects such as the European initiative “Building the future of Latin America: involving women in STEM” (W-STEM) have been fundamental. W-STEM has created a model to update the governance, management, and operational processes of higher education institutions in Latin America. This model was designed to improve the attractiveness, accessibility, and retention of women in STEM programs [61].

As a result, regarding the gender gap, it is important to note that it is not limited to Latin American countries; it is a global challenge. Consequently, the outcomes and strategies developed in the W-STEM project have worldwide applicability, albeit with some minor modifications. This approach is relevant to both public and private institutions, each facing varying conditions in terms of gender equality.

One of the key conclusions drawn from the study results is the identification of statistically significant evidence showing differences in the perceived mastery of complex reasoning competencies between men and women. Specifically, the results indicate that women generally have a higher average perception of attaining systemic and critical thinking skills, while men perceive themselves as better at scientific thinking [9]. This finding is particularly significant for curriculum and subject design, highlighting the potential for incorporating gender-focused approaches in classroom settings.

Unfortunately, one of the conclusions of this study is that, despite the national and international efforts shown by the results, there is a noticeable gap between the stated political goals and the actual achievements of students, which hampers both institutional success and economic development. Furthermore, the analysis of this study highlighted various degrees of commitment to gender equality in political mandates. This discrepancy is a crucial issue that warrants more focused attention and further research [38]. It is necessary to point out that the gender gap continues to be very high in STEM, and according to the analyses, special attention should be paid to technology careers, since the highest gap is in them.

In addition to the results presented in the bibliographic review, this article presents, as an example of good practices, the case of the University of La Frontera as a practical and real case. It is shown that it is possible to promote, within its organizational structure, the development and promotion of policies and initiatives for sustainability and reductions in the gender and inclusion gaps in the university context of a state higher education institution. Thanks to these formal policies and initiatives, it is evident that the university has made significant progress in making the issue visible and promoting a set of activities to advance sustainable education and overcome gender gaps in accordance with SDGs 4 and 5 of the 2030 Agenda.

An instance of this effort is the establishment of collaborative work environments for crafting and assessing policies, alongside fostering their endorsement, thereby encouraging engagement and involvement in significant nationally funded projects. Moreover, initiatives have been undertaken to foster networking and organize events addressing sustainability in higher education and the gender gap, exemplified by the inaugural university conference on gender.

Based on the aforementioned, the University of La Frontera serves as a practical example, showcasing its commitment to spearheading a transition toward a more sustainable future. Recognizing the magnitude of this endeavor, the university underscores its belief that public higher education plays a pivotal role in forging a fair, inclusive, prosperous, and environmentally regenerative society. In this pursuit, the university is dedicated to setting an example and assuming leadership in advancing sustainability across all dimensions, thereby contributing to the realization of the Sustainable Development Goals outlined in the 2030 Agenda. In conclusion and as a recommendation from the results of this study, it

is clear that greater efforts must be made to promote sustainability with a focus on gender diversity: addressing it as a human resources issue to promote dialogue among broader audiences, such as national engineering societies [6]. This action makes a lot of sense since putting these issues on the table of managers and in the general consciousness of an institution provides “visibility” and, in some way, creates a collective awareness of their importance.

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Conflicts of Interest: The authors state that there are no conflicts of interest.

Appendix A

Table A1. Articles used to Analysis and Results of systematic mapping.

Num.	Title	Cite	Year
1	A structured review of reasons for the underrepresentation of women in computing	[131]	1996
2	Parents’ and students’ satisfaction with the use of information technology in government schools in Queensland, Australia	[196]	2002
3	Successful international initiatives promoting gender equity in engineering	[6]	2005
4	Women, ICT and the information society: global perspectives and initiatives	[176]	2005
5	ADDRESSING THE GENDER GAP: A TEACHING AND LEARNING STRATEGY IN UNDERGRADUATE SCIENCE COURSES	[85]	2008
6	University Leaders and the Public Agenda: Talking About Women and Diversity in STEM Fields	[67]	2009
7	The STARS Alliance: Viable Strategies for Broadening Participation in Computing	[194]	2011
8	Engaging Women in Computer Science and Engineering: Promising Practices for Promoting Gender Equity in Undergraduate Research Experiences	[135]	2011
9	Underrepresented groups in gender and STEM: the case of black males in CISE	[121]	2012
10	Mentoring for women starting a PhD: a “free zone” into academic identity	[56]	2015
11	Encouraging Women to Become CS Teachers	[159]	2015
12	The leadership role of college deans and department chairs in academic culture change	[39]	2016
13	Women planning to major in computer science: Who are they and what makes them unique?	[84]	2016
14	The Internet of Women sm Accelerating Culture Change	[154]	2016
15	Gender and Performance in Computer Science	[106]	2016
16	Investigating Factors Influencing Students’ Intention to Dropout Computer Science Studies	[183]	2016
17	Advancing Diversity and Inclusivity in STEM Education	[156]	2016
18	Gender Equity in Computing: International Faculty Perceptions and Current Practices	[120]	2016
19	Organizational Patterns for Increasing Gender Diversity in Computer Science Education	[161]	2016
20	Organized Advocacy for Professional Women in Computing: Comparing Histories of the AWC and ACM-W	[137]	2016

Table A1. Cont.

Num.	Title	Cite	Year
21	Solving a Career Equation: The First Doctoral Women in Computer Science	[163]	2016
22	Latin American Perspectives to Internationalize Undergraduate Information Technology Education	[139]	2016
23	Towards Equal Opportunities in MOOCs: Affirmation Reduces Gender & Social-Class Achievement Gaps in China	[133]	2017
24	FollowBias: supporting behavior change toward gender equality by networked gatekeepers on social media	[141]	2017
25	Looking Beyond Academic Performance: The Influence of Instructor Gender on Student Motivation in STEM Fields	[64]	2018
26	Patterns of gender parity in the humanities and STEM programs: The trajectory under the expanded higher education system	[68]	2018
27	Attraction and retention of women in engineering	[153]	2018
28	Towards gender equality in software engineering: The NSA approach	[92]	2018
29	Gender gap in the STEM sector in pre and university studies of Europe associated with ethnic factors	[99]	2018
30	Reinforcing gender equality by analysing female teenagers' performances in coding activities: A lesson learned	[155]	2018
31	How do Gender, Learning Goals, and Forum Participation Predict Persistence in a Computer Science MOOC?	[110]	2018
32	Barriers to gender diversity in software development education: actionable insights from a danish case study	[117]	2018
33	The Role of Historically Black Colleges and Universities in American STEM Education	[188]	2018
34	The Unexpected Entry and Exodus of Women in Computing and HCI in India	[192]	2018
35	Challenges and lessons learned by applying living labs in gender and IT contexts	[191]	2018
36	Using Social Cognitive Career Theory to Understand Why Students Choose to Study Computer Science	[162]	2018
37	Understanding Gender Equity in Author Order Assignment	[140]	2018
38	Acciones, políticas y estrategias para el balance de género en el ámbito STEM: Resultados de una dinámica World Café	[25]	2019
39	Gender Equality and UN Sustainable Development Goals: Priorities and Correlations in the Top Business Schools' Communication and Legitimation Strategies	[27]	2019
40	Forging ahead: leveraging inclusive and equitable education to bridge the gender gap in the Caribbean	[3]	2019
41	Sustainability awareness, attitudes and actions: A survey of pre-service teachers	[44]	2019
42	Sustainable development goals in mining	[47]	2019
43	World-Class Universities and Female Leadership in the Academic Profession: Case Studies of East Asian Higher Education	[51]	2019
44	Gender and Education at Makerere University, Uganda	[76]	2019
45	Higher education and science: problems of gender equality	[80]	2019
46	Engaging women into STEM in Latin America: W-STEM project	[7]	2019
47	Trends in studies developed in Europe focused on the gender gap in STEM	[93]	2019
48	Analysis of instruments focused on gender gap in STEM education	[95]	2019
49	Bridging the diversity gap in STEM	[104]	2019
50	Gender balance in computer science and engineering in Italian universities	[109]	2019
51	The Underrepresentation of Women in the Software Industry: Thoughts from Career-Changing Women	[113]	2019
52	Increasing gender diversity in STEM: A tool for raising awareness of the engineering profession	[186]	2019
53	Investigating the Role Choice of Female Students in a Software Engineering Team Project	[174]	2019
54	Multiplatform MOOC Analytics: Comparing Global and Regional Patterns in edX and Edraak	[189]	2019
55	The role of age and gender on implementing informal and non-formal science learning activities for children	[195]	2019
56	Psychologically Inclusive Design: Cues Impact Women's Participation in STEM Education	[123]	2019
57	Implicit Gender Biases in Professional Software Development: An Empirical Study	[124]	2019
58	Countering the negative image of women in computing	[125]	2019
59	Factors influencing women entering the software development field through coding bootcamps vs. computer science bachelor's degrees	[126]	2019
60	An Investigation of Gender Differences in Computer Science Using Physiological, Psychological and Behavioural Metrics	[127]	2019
61	RoboSTEAM—A Challenge Based Learning Approach for integrating STEAM and develop Computational Thinking	[197]	2019
62	A Case Study About Gender Issues in a Game Jam	[128]	2019
63	European Proposals to Work in the Gender Gap in STEM: A Systematic Analysis	[26]	2020

Table A1. Cont.

Num.	Title	Cite	Year
64	Women leadership in Vietnamese higher education institutions: An exploratory study on barriers and enablers for career enhancement	[32]	2020
65	Gender, achievement, and subject choice in English education	[37]	2020
66	STEM: A help or a hinderance in attracting more girls to engineering?	[165]	2020
67	Gender equality and ICT in the context of formal education: A systematic review	[50]	2020
68	Gender equality in STEM programs: A proposal to analyse the situation of a university about the gender gap	[63]	2020
69	Looking into the Educational Mirror: Why Computation Is Hardly Being Taught in the Social Sciences, and What to Do About It	[170]	2020
70	Interviews of Spanish women in STEM: A multimedia analysis about their experiences	[65]	2020
71	Towards increasing of STEM-women professionals by implementing projects that reduce the gender gap: a study case in Universidad de Guadalajara	[71]	2020
72	Facilitating Access to the Role Models of Women in STEM: W-STEM Mobile App	[171]	2020
73	Participation of Women in STEM Higher Education Programs in Latin America: The Issue of Inequality	[77]	2020
74	Strategies to introduce gender perspective in Engineering studies: A proposal based on self-diagnosis	[8]	2020
75	Female Computer Scientists Needed: Approaches For Closing The Gender Gap	[86]	2020
76	Initiative to Increment the number of Women in STEM Degrees: Women, Science and Technology Chair of the Public University of Navarre	[87]	2020
77	A Comparative Study on the Support in Engineering Courses: A Case Study in Brazil and Spain	[91]	2020
78	Work-in-Progress: Encouraging Girls in Science, Engineering and Information Technology	[180]	2020
79	E-learning Material on Gender Equality in Information System Professions	[94]	2020
80	The Gender Gap broad the path for Women in STEM	[97]	2020
81	Pilot study on university students' opinion about STEM studies at higher education	[98]	2020
82	SAPerI: Approaching gender gap using Spatial Ability training week in high-school context	[100]	2020
83	Is helping to bridge the gender gap in STEM considered as transfer of knowledge?: Transfer of Knowledge in STEM	[101]	2020
84	Bridging the diversity gap: Actions and experiences fostering diversity in STEM	[105]	2020
85	Sense of Belonging: The Intersectionality of Self-Identified Minority Status and Gender in Undergraduate Computer Science Students	[185]	2020
86	What prevents finnish women from applying to software engineering roles?: A preliminary analysis of survey data	[115]	2020
87	Political-pedagogical contributions to participatory design from Paulo Freire	[187]	2020
88	The ATHENA European University model for Sustainable Education: Mainstreaming good practices for all-inclusive life-long sustainable learning in the digital era	[175]	2020
89	Gender perspective in Artificial Intelligence (AI)	[10]	2020
90	Promoting Diversity-Inclusive Computer Science Pedagogies: A Multidimensional Perspective	[157]	2020
91	Tenacity of gender inequality in south africa: A higher education perspective.	[24]	2021
92	Introducing and Evaluating the Effective Inclusion of Gender Dimension in STEM Higher Education	[29]	2021
93	Two Perspectives on the Gender Gap in Computer Engineering: From Secondary School to Higher Education	[31]	2021
94	How culture, institutions, and individuals shape the evolving gender gap in science and mathematics: An equity provocation for the scientific community	[40]	2021
95	Institutional betrayal and sexual harassment in STEM institutions: Evidence from science and technology universities of Ethiopia	[41]	2021
96	'I don't Study Physics Anymore': A Cross-Institutional Australian Study on Factors Impacting the Persistence of Undergraduate Science Students	[166]	2021
97	Halloween Educational Robotics	[167]	2021
98	Analyzing Enrollment in Information & Communication Technology Programs and Use of Social Networks Based on Gender.	[46]	2021
99	Centro De Pensamiento Para El Fortalecimiento Del Liderazgo Y Empoderamiento De La Mujer Colombiana En STEM	[54]	2021
100	Women in Engineering: Developing Entrepreneurial Intention through Learning by Doing Approach	[55]	2021
101	Higher Education For Sustainability: A Global Perspective	[59]	2021
102	Competency assessment and learning results in tourism internships: is gender a relevant factor?	[60]	2021
103	Educational initiatives for bridging the diversity gap in STEM	[169]	2021
104	Reflections on women in internationalization	[146]	2021
105	Women's Motivation to Mentor Young Women Students in STEM Areas: A Study Case in Mexico	[66]	2021

Table A1. Cont.

Num.	Title	Cite	Year
106	Women's Empowerment as a Tool for Sustainable Development of Higher Education and Research in the Digital Age	[70]	2021
107	Mentoring program: women supporting women	[74]	2021
108	Multimedia Analysis of Spanish Female Role Models in Science, Technology, Engineering and Mathematics	[75]	2021
109	Gender Distribution in Academic Leadership: An Exploratory Study of Top Universities of Bangladesh	[151]	2021
110	The experience of women students in engineering and mathematics careers: A focus group study	[83]	2021
111	STEM & Gender equity: empowering women in vulnerable environments	[88]	2021
112	Gender Gap in STEM: A Cross-Sectional Study of Primary School Students' Self-Perception and Test Anxiety in Mathematics	[89]	2021
113	Initial performance analysis in the evaluation of computational thinking from a gender perspective in higher education	[182]	2021
114	Strategies to gender mainstreaming in Engineering studies: A workshop with teachers	[102]	2021
115	A pilot study about the perception of experts in engineering education	[103]	2021
116	Using Facebook Ads Data to Assess Gender Balance in STEM: Evidence from Brazil	[111]	2021
117	CreaSTEAM. Towards the improvement of diversity gaps through the compilation of projects, best practices and STEAM-Lab spaces	[112]	2021
118	A Model for the Development of Programming Courses to Promote the Participation of Young Women in STEM	[114]	2021
119	A Survey on the Current Situation and Influencing Factors of Selection of Subjects in Stem Field in China	[193]	2021
120	Computer Science Communities: Who is Speaking, and Who is Listening to the Women? Using an Ethics of Care to Promote Diverse Voices	[199]	2021
121	Dynamics of gender bias in computing	[130]	2021
122	Breaking one barrier at a time: how women developers cope in a men-dominated industry	[132]	2021
123	"It's a Bit Weird, but it's OK"? How Female Computer Science Students Navigate being a Minority	[136]	2021
124	Gender Stereotypes and Women Strategies in STEM: A Multidisciplinary Review	[33]	2022
125	Mathematics Anxiety and Self-Efficacy of Mexican Engineering Students: Is There Gender Gap?	[34]	2022
126	Hack4women: un paso hacia la equidad de género	[36]	2022
127	La opinión de mujeres en STEM sobre lo que impulsa su inclusión.	[164]	2022
128	On the Design and Validation of Assessing Tools for Measuring the Impact of Programs Promoting STEM Vocations	[43]	2022
129	Interpersonal and academic self-efficacy and its relationship with employment of food industry engineering students: A gender perspective	[143]	2022
130	Equality for all? Support for equal opportunity among professors in Europe	[144]	2022
131	Engaging Women in Engineering-Training Mentors to Make a Difference (iTEST 1849735): Transforming Curriculum and Mentor Training in a Highly Successful Natural Science Program	[48]	2022
132	Diversity for a Sustainable Space Future-Opportunities and Challenges for promoting diversity in the space sector	[49]	2022
133	Women in Engineering: Myths, Measures and Policies	[52]	2022
134	Women Retention in STEM Higher Education: Systematic Mapping of Gender Issues	[57]	2022
135	A Model for Bridging the Gender Gap in STEM in Higher Education Institutions	[61]	2022
136	The role of universities in the inclusion of refugees in higher education and in society from the perspective of the SDGS	[147]	2022
137	New challenges for women workers in Brazil facing the wave of Industry 4.0 technologies	[148]	2022
138	A Review of Irish National Strategy for Gender Equality in Higher Education 2010–2021	[69]	2022
139	Towards Inclusive Higher Education: A Multivariate Analysis of Social and Gender Inequalities	[73]	2022
140	Making and Taking Leadership in the Promotion of Gender Desegregation in STEM	[149]	2022
141	Preparing Early Years Practitioners in Mauritius	[78]	2022
142	Reflections on Selected Gender Equality in STEM Initiatives in an Irish University	[79]	2022
143	Gender Perspective in STEM Disciplines in Spain Universities	[150]	2022
144	Women's Empowerment as a Tool for Sustainable Development of Higher Education and Research in the Digital Age	[81]	2022
145	Pragmatic, Persistent, and Precarious: The Pathways of Three Minority Ethnic Women in STEM Higher Education	[152]	2022
146	A UPC innovation teaching project for the incorporation of the gender perspective in nautical, marine and naval engineering	[2]	2022

Table A1. Cont.

Num.	Title	Cite	Year
147	Make a Lab—A Project Focused on the Gender Gap in STEM Fields	[11]	2022
148	Bridging the Gender Gap through Problem-Based Learning in STEM Labs: What can we learn from Biotechnology?	[90]	2022
149	Role Modeling as a Computing Educator in Higher Education: A Focus on Care, Emotions and Professional Competencies	[181]	2022
150	Challenges and opportunities when deploying a gender STEM intervention during a pandemic	[173]	2022
151	Retaining women in computer science: The good, the bad and the ugly sides	[108]	2022
152	Gender parity in peer assessment of team software development projects	[116]	2022
153	An Early Measure of Women-Focused Initiatives in Gender-Imbalanced Computing Programs	[119]	2022
154	Women's Participation in Open Source Software: A Survey of the Literature	[158]	2022
155	The World is in My Hand Now: Smartphones for Empowering Rural Women in Developing Countries: Smartphones for Empowering Rural Women in Developing Countries	[177]	2022
156	The Integration of Gender Equality (SDG 5) into University Teaching: The View from the Frontline	[23]	2023
157	Navigating a male dominated domain: experiences of female STEM students in higher education in Ireland	[28]	2023
158	Gender gap in STEM pathways: the role of secondary curricula in a highly differentiated school system—the case of Chile	[30]	2023
159	The impact of the COVID-19 pandemic on institutional change processes and the collective capabilities of higher education and research institutions	[35]	2023
160	Gender and higher education in African universities: A critical discourse analysis of key policy mandates in Kenya, Rwanda, and Uganda	[38]	2023
161	Gender gap in the perceived mastery of reasoning-for-complexity competency: An approach in Latin America	[9]	2023
162	The underrepresentation of women in STEM disciplines in India: A secondary analysis	[142]	2023
163	Student Perception of the Level of Development of Complex Thinking: An Approach Involving University Women in Mexico	[42]	2023
164	Professional development for STEM educators: A bibliometric analysis of the recent progress	[45]	2023
165	Scratch4All Project—Educate for an All-inclusive Digital Society	[168]	2023
166	Gender Diversity, Sustainable Development Goals and Human Resource Management Practices in Higher Education	[145]	2023
167	A 360° perspective of women in soil science focused on the U.S	[53]	2023
168	Male perspective in relation to the gender gap in STEM careers	[58]	2023
169	Higher education expansion and women's access to higher education and the labor market: quasi-experimental evidence from Turkey	[62]	2023
170	Indigenous Women in Higher Education in STEM: A Case Study in Oaxaca	[179]	2023
171	Green transition and gender bias: An analysis of renewable energy generation companies in Latin America	[72]	2023
172	Inclusion of the gender equality sustainable development goal in engineering teaching and research	[82]	2023
173	On Designing A 3d Imaging Summer Project For Ontario's High School Students During COVID-19 Pandemic	[172]	2023
174	Understanding the Gender Gap in Digital Technologies Education	[96]	2023
175	Monitoring Gender Gaps via LinkedIn Advertising Estimates: The case study of Italy	[107]	2023
176	Student Sense of Belonging: The Role of Gender Identity and Minoritisation in Computing and Other Sciences	[184]	2023
177	Cross-Country Variation in (Binary) Gender Differences in Secondary School Students' CS Attitudes: Re-Validating and Generalizing a CS Attitudes Scale	[118]	2023
178	Engaging Girls in Computer Science: Do Single-Gender Interdisciplinary Classes Help?	[122]	2023
179	SDGs Like You Have Never Seen Before!: Co-designing Data Visualization Tools with and for University Students	[190]	2023
180	What do women in IT want?: Women in IT Networking and their experience working from home during the COVID-19 pandemic.	[129]	2023
181	Characterizing Women's Alternative Pathways to a Computing Career Using Content Analysis	[160]	2023
182	"I Can Do That Too": Factors Influencing a Sense of Belonging for Females in Computer Science Classrooms	[134]	2023
183	Crossing the Threshold: Pathways into Makerspaces for Women at the Intersectional Margins	[138]	2023

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Article

Values-Based Education for Sustainable Development (VbESD): Introducing a Pedagogical Framework for Education for Sustainable Development (ESD) Using a Values-Based Education (VbE) Approach

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Abstract: It is widely recognized that quality and sustainable education is a key enabler for all the SDGs, and that affective education significantly enhances such education. However, while certain pedagogical approaches have been found to support the competencies and skills within Education for Sustainable Development (ESD), there is no tangible framework to facilitate ESD in classrooms. This paper introduces and demonstrates Values-based Education for Sustainable Development (VbESD): a comprehensive, replicable, and actionable pedagogical framework that explicitly and holistically fosters sustainability as an intrinsic value by using the principles of Values-based Education (VbE) in an ESD context. The VbESD framework presents eight pillars—modelling, Inner Curriculum, reflection, atmosphere and ethos, curriculum, leadership, ethical vocabulary, and sustainable school operations (MIRACLES)—that holistically facilitate the development of intrinsic positive values into quality education for sustainable development. Using a deductive-inductive approach with two mixed-method surveys and 157 responses, VbESD was developed and validated with significant interest in, support for, and willingness to implement the framework. All surveyees responded neutrally or positively to valuing sustainability, believing it is important as an intrinsic value, incorporating sustainability into the educational system, and implementing the VbESD framework. This study proposes VbESD as a potential method for primary educational institutions and educators to nurture resilient, ethically intelligent change-leaders who can champion the social change needed for a peaceful, prosperous, and sustainable world.

Keywords: Education for Sustainable Development; Values-based Education; affective education; sustainability education; education for sustainability; e-learning



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1. Introduction and Background

1.1. Context and Importance of Sustainability Education and Education for Sustainable Development (ESD)

The movement for Education for Sustainable Development (ESD) was commenced in 1992 at the United Nations Conference on Environment and Development to nurture students to become engaged, responsible citizens who can create the needed social change for a peaceful, prosperous, and sustainable world. In light of such momentum, there are various terms used often interchangeably for ESD and related pedagogy, such as environmental education, sustainability education, and education for sustainability. For the context of this article, ‘sustainability education’ will be used as the collective term for any educational approach or pedagogy that focuses on teaching about the environment, climate change, sustainability and sustainable development, and Education for Sustainable

Development as a type of sustainability education with a specific roadmap [1] and defined competences and outcomes as outlined by UNESCO and UNECE [2,3].

It is thoroughly recognized that ESD is crucial for the Agenda 2030 and the Sustainable Development Goals, the global framework to achieve a sustainable future for our planet. According to UNESCO [4], “Education for Sustainable Development (ESD) empowers learners of all ages with the knowledge, skills, values, and attitudes to address the interconnected global challenges we are facing, including climate change, environmental degradation, loss of biodiversity, poverty, and inequality”. This growing recognition of the need for sustainability education now needs to be paired with concrete action and visible results, alongside various issues present in the education system to not only deliver sustainability education, but also to achieve sustainable education [5–7]. There exists substantial literature around recommendations for sustainability education, case studies of implementations, and explorations of challenges, as well as many pedagogical models to deliver such education [8–10]; however, many models are either general and high-level, and thus not easily actionable (i.e., the implementing body has to first invest significant capacity to distil the model into specific, tangible actions and steps), or very specific (i.e., to a field, topic or region) and difficult to make applicable to a large number of schools. The uptake of innovative pedagogy is slow, with “schools remain[ing] largely seen as very resistant places for innovation” [5]. For example, most current education systems do not place affective learning outcomes—the demonstration of values, attitudes, and beliefs—as primary goals alongside cognitive outcomes. Yet, it is becoming increasingly well-established that sustainability education takes more than cognitive education and demands for all domains of learning—cognitive, psychomotor, and affective education—to be engaged [11,12]. Not only is the learning content important, but the way that the content is taught as well as the environment in which it is taught present crucial factors for successful sustainability education. It is thus critically important for the world’s education systems to commit to a pedagogical shift to embrace more affective education and sustainability education, so that future generations have the educational environment that drives societal and environmental well-being simultaneously with academic skills and knowledge.

This article aims to develop a working model for Values-based Education for Sustainable Development, a new framework to facilitate this pedagogical shift, and to gauge the level of foundational support and interest of the framework from the general public. The central question the article aims to investigate is: Can we, and how can we, use the principles within Values-based Education to structure an educational and pedagogical framework that embeds sustainability as an intrinsic value within the educational system and its students to drive Education for Sustainable Development?

UNESCO, the UN’s leading agency on Education for Sustainable Development (ESD), described ESD as a “key enabler of all other SDGs” [4]. Indeed, not only is ESD a crucial element of the fourth Sustainable Development Goal (SDG) of quality education, it is how all the other SDGs are brought to life—the foundation for the success of all other SDGs.

Currently, a large portion of the literature available for ESD and sustainability education is in higher education, usually at the post-secondary level [8,10]. Approaches for ESD and sustainability education that have been implemented most commonly fall within two types: ‘integration’ and ‘insertion’, where integration refers to a more holistic approach in which sustainability is fundamentally and transdisciplinary embedded, and insertion is a more surface-level incorporation of sustainability in often-disconnected subjects [9]. Currently, many educational settings introduce sustainability either in general or specific fields as well as in operational ways not related to education, with the educational and operational domains independent from each other. A plethora of literature reveals the importance of interdisciplinary and transdisciplinary action and collaboration, as well as the reinforcement of learning outcomes outside rigid academic structure [13].

Primary education provides an invaluable setting to start affective education, where learning is focused on developing values, beliefs, and attitudes that will greatly influence and benefit the student life-long [14]. Primary education is often considered the most

influential of all education levels, where teachings may not be explicitly recognized yet practiced and formed implicitly. Successful primary school intervention and development of values and beliefs related to sustainable development will considerably lessen the barrier for further development of sustainable behaviours in middle, secondary, and post-secondary education.

1.2. Fostering Sustainability as an Intrinsic Value: The Opportunity for VbESD

The role of values has been identified as crucial to creating transformative change towards sustainability and sustainable development [15–17]. Specifically, biospheric and altruistic values are associated with pro-environmental behaviours. Values are usually considered to form during childhood, influenced by the individual's needs, traits, experiences, culture, socialization, and temperament, and to remain relatively stable once formed [18]. Values drive intrinsic motivation, which in turn is associated with not only long-term success, including achievement, quality education, well-being, student achievement and student–teacher relationship quality, but also pro-environmental behaviour [19–22]. Affective education that successfully fosters intrinsic values and motivation—especially for sustainability—is therefore significantly relevant to sustainable development and especially to SDG 4: Quality education [23].

Values-based Education (VbE) was developed and founded by Dr. Neil Hawkes in 2006 and has now become a successfully-established educational model to deliver quality affective education to over 100 primary schools across the world and primarily in the United Kingdom (UK) [24]. A value is a principle that guides our thinking and behaviour, underpinning all behaviours, attitudes, personalities, mindsets, and choices, and is universal [24]. VbE underpins educational settings with universal positive human values such as respect, compassion, humility, trust, and integrity to create a transformational shift in the way that students learn [24]. Its students are immersed in the practice of such values, building the foundation to live with them on a daily basis, inside or outside the classroom. Indeed, VbE has been highly successful in facilitating affective learning. Other related concepts include values education, moral education, as well as character education and development. However, Values-based Education is unique in the depth of understanding and practice it fosters within its students to live the set of positive values embedded into their education setting.

VbE presents a significantly crucial shift for education and the future generation as a whole. Its methodology and theory build its impact for effective affective education. Its main audience consists of primary schools, allowing the shift for positive cultural transformation to start from a young age and create a ripple effect up the education system that will influence all other generations along the way [24].

The key outcome of VbE are the development of ethical intelligence and personal holistic competence (PHC)—which Hawkes describes as “the ability to deal with the complexity of life in an ethical and empathetic manner, whilst maintaining personal integrity and well-being” [25]. PHC is developed from a rich emotional intelligence—the knowledge, skill, ability, and courage to use self and interpersonal awareness in the right way—and both of them make up an individual's personal moral compass. Ethical intelligence is more than just having knowledge of what is ‘good’ or ‘bad’, as reality creates countless nuances that complicate the situation. Instead, it is knowing how to make decisions that honour the individual's whole suite of values, even when there are conflicting values at hand. The development of these invaluable competences requires a deep understanding and experiential learning of the values, self-leadership to practice and live the values, as well as a suite of holistic, positive values that are intrinsically embedded within the individual—all of which the Values-based Education model successfully nurtures in its schools.

Currently, the VbE movement has spread to around 20% of primary schools in the UK and over 40 countries and is continuously expanding [26]. Its impact is undeniable; there is statistical and anecdotal evidence that shows the difference having a values-based educational environment makes in a school. Since even before its official inception, Neil

Hawkes had found that teaching values in a meaningful, profound way improved the quality of the school's education significantly [25]. There were less behavioural issues, students performed better academically, and there were quantifiably more positive relationships built between students as well as students and staff in the school. After adopting a values-based educational approach, the school community becomes more harmonious, purposeful, and impactful [27]. A longitudinal study by Lovat et al. [28,29] found a positive correlation between VbE students' personal development and academic diligence.

In the understanding of a value as a principle that guides thinking and behaviour, sustainability fits profoundly as a value. Therefore, in order to empower the "values and attitudes" within the "knowledge, skills, values, and attitudes" of Education for Sustainable Development, sustainability needs to be nurtured as an intrinsic value within society and its members, where (1) it is understood not simply in a theoretical manner, but in a way that is embedded into an individual's intrinsic motivation; and (2) in situations where sustainability may be in conflict with other values, sustainability is understood well enough that each intrinsic value can be weighed accordingly and a decision made that will "best honour your whole suite of values of which sustainability is one of them" [26]. Values-based Education therefore presents an opportunity to be used to foster sustainability as an intrinsic value.

While VbE does not explicitly mention sustainability in terms of ESG components, the ultimate product of a generation built on VbE is exactly human sustainability. Therefore, there is a significant opportunity for the merging and synergy of VbE and ESD to create VbESD, which simply aims to bring sustainability from the periphery of VbE into its root in order to realize the outcomes of ESD in a primary education setting (with potential to extend its reach into secondary and higher education settings). The parallelism between different elements of VbE and ESD are presented in Table 1.

Table 1. Parallels between VbE and ESD.

Values-Based Education	Education for Sustainable Development
Leadership pillar encourages VbE students and teachers to lead their values and encourage others' integrity as well	Empowerment of people to take responsibility for present and future generations
Integrate values in a holistic manner into the school	Integrate sustainability issues in a holistic manner into the school
Values-based implies that all aspects of life, both personal and professional, is founded on the way that positive human values are used as principles to guide our thinking and subsequent behaviour	ESD is a crucial, key enabler for all other SDGs and is interconnected to all aspects of sustainable development as a foundational tool, to build capacity and empower sustainable development on all fronts
Societal transformation for a more ethically intelligent world and a transformation of an educational setting to be grounded by values and creating that shift in pedagogy within its educators	Societal transformation for a more sustainable world and a transformation of all aspects of the learning environment through a whole-institution approach, including transformation of what it means to be an educator
Values need to be imbedded within the educators and all staff in a school need to be committed and a part of the implementation	Competences for educators are outlined and need to be possessed in order for them to be relayed onto the students

It is well-established that sustainability as an intrinsic value cannot work on its own; it is not an isolated value. To reach full, deep-rooted sustainability, individuals and society as a whole need to develop other positive values and their ethical intelligence as well [30,31]. Thus, VbE acts as the perfect foundation to build ESD, not solely teaching sustainability as the one value but incorporating other values such as respect and kindness (i.e., for the planet, plants, animals, and people), responsibility (i.e., for our actions and environmental and social impact), trust (in each other's efforts and commitments), integrity (i.e., for our own values and commitments), peace and hope (i.e., for our societies and planet), collaboration and joy, amongst many others. Values-based Education has the crucial

methodology to add sustainability into its foundation, and by embedding sustainability as the root of the other values, it gives a concrete purpose for why such values are needed.

As crucial as affective education is to sustainability education, it has also been repeatedly observed as its main challenge. As Warburton [32] precisely points out, “the challenge for educational institutions is not simply to teach concrete facts about the environment but to create an active, transformative process of learning that allows values to be lived out and debated, and permits a unification of theory and practice.” This presents a perfect opportunity to utilize the VbE groundwork to tackle this challenge and imbed the values from theory into practice. Just like López-Alcarria [33] used the Agile methodology in education to foster ESD competencies, this paper demonstrates the use of VbE methodology within ESD to foster its competencies.

In the following sections, the best practices and barriers to sustainability education are identified before presenting a thorough description of the proposed VbESD framework. The methodology to create and validate the framework is then outlined, and the survey results shared. Finally, the findings are discussed and further interpreted to provide guidance for the VbESD framework’s next steps.

2. Literature Review

To develop the VbESD framework, a literature review was conducted to understand effective pedagogical principles of sustainability education as well as the limitations of current pedagogical frameworks for ESD. Five enabling pedagogical principles and four common barriers are identified and presented below.

2.1. The Importance of Childhood Development to Sustainable Development

Much of historical unsustainable development has been rooted in unhealthy relationships to nature, the land, and the Earth; to other human societies and communities; and to oneself. Therefore, each of these relationships must be healed in order to achieve true human and environmental sustainability. This sentiment is not new; Hill [34] expressed in 1999 that “What is happening socio-politically and environmentally in the world is the result of adult activity; and adult activity is the result of child development. Thus, to achieve social and environmental sustainability we must sooner or later examine the process of child development”. Mbebeb in 2020 [35] stated that “An important issue in sustainability debates, although often neglected, is the psychological argument that societal sustainability depends on mental and behavioural sustainability; thereby informing strategies in early childhood education. . . sustainable education must begin in early childhood, as the values, attitudes, behaviours, and skills acquired in this period may have a long-lasting impact in later life”. Samuelsson and Yoshie [36]’s UNESCO report “The contribution of early childhood education to a sustainable society” outlined diverse insights, perspectives, and experiences across 16 countries related to the importance of childhood education to foster values, attitudes and skills that support sustainable development. In it are case studies of educational centres fostering ‘sustainability ethic’ as well as ‘eco-literacy’ and ‘eco-intelligence’; philosophies around ‘harmony’ between humans and nature, people, and society, and individual harmonious development; and suggestions to incorporate holistic development of children including physical, conceptual, social, spiritual, and emotional to build a sustainable society.

2.2. Innovations in Affective Pedagogies for ESD

Many pedagogies for sustainability education exist, both within and outside of ESD. These include Education for Sustainability (EfS), environmental education (EE), sustainability education (SE), climate change education, and the multidisciplinary umbrella for all these approaches and more called Environmental and Sustainability Education (ESE) [37]. In 2020, Hadjichambis and Reis [38] introduced the concept of Education for Environmental Citizenship (EEC) and its corresponding pedagogical approach, on which Monte and Reis [39] built specifically for primary education. The EEC for primary education

integrates eight educational methodologies, including socio-emotional learning, critical inquiry learning, outdoor learning, collaborative learning, nature-based solutions learning, and more [39]. Each of these pedagogical approaches contribute to the goal of social and/or environmental sustainability with varying emphases on different aspects, principles, or learning outcomes as well as varying degrees of affective learning.

Dunlop and Rushton [40] found that education has the potential to transform environmental emotions and rewrite existing negative emotions associated with environmental sustainability (i.e., powerlessness, anxiety, hopelessness, fear, etc.) and the need for emotionally responsive pedagogies that can “identify responsibilities, improve coping potential, and improve future outlook” as a way to take intergenerational responsibility. This aligns with the meta-analysis by Bamberg and Möser [19,40,41] that found behavioural intentions having the highest predictive power for pro-environmental behaviour. Grund and Brock [42] urges educational interventions to therefore invest in emotional and sentimental environmental concepts rather than focusing on environmental knowledge. Mindfulness-based, contemplative teaching approaches have recently begun to be researched as a new way to combat socio-ecological challenges and promote social action on sustainable development [23].

2.3. Key Effective and Enabling Pedagogical Principles for Sustainability-Related Education

A wide range of literature exists for different pedagogical concepts, practices, principles, and frameworks that have been shown effective for sustainability-related education. A few common themes have been identified below as key enablers for sustainability education, with the aim to integrate each of them within the VbESD framework.

(E1) Active engagement and social learning: There is a focus on increasing student engagement and participation in the classroom, in order to develop, practice, and solidify the affective, social, and cognitive knowledge and skills attained [9]. Sustainability education has been recognized to need student engagement beyond academic facts to be successful. Indeed, active engagement and social learning activities are significantly more impactful than memorization and rote learning. Only with active engagement can intrinsic interest be fostered, skills be practiced and applied, concepts experienced, and relationships built [32]. Social learning is a model where there is a more equitable transfer and sharing of knowledge, where knowledge from all members of the community (and in this case, classroom), is valued and shared in formal, informal, and non-formal ways [43]. Creating meaningful engagements with either concepts, places, or people is integral to increase the understanding of what is taught in the classroom, as well as in extracurricular activities [44]. In that way, it is therefore crucial to sustainability education, where knowledge of sustainability is meaningless unless understood and taken up as a personal value.

(E2) Democracy, student involvement and student-centred learning: Wade [43] found that democratic approaches to learning and leadership build more capacity for sustainable development than authoritarian, top-down hierarchical models, and that leadership for sustainability precisely required democratic cohesion and a sharing of commitment, action, and leadership itself. In addition to active engagement is the necessity of including student perspectives and desires into their own learning. For example, Nwagbo [45] found that the guided inquiry teaching method, a “student-centred, activity-oriented teaching strategy...to enable students [to] discover answers to the problems at hand” greatly outweighed expository teaching methods, a teacher-centred approach where “the teacher delivers pre-planned lesson to the students with little or no instructional aids...which places the teacher as the sole possessor of knowledge, and the students as passive recipients of knowledge”. Co-design is another valuable participatory approach that can facilitate student involvement and taking ownership of their learning [46]. It is precisely the creation of meaningful interactions between the teacher and student alongside student involvement and engagement that solidifies the teachings within sustainability education, and successful sustainability education requires the shift from a teacher-centred to a student-centred approach, where the focus is less on pushing specific content and more on developing

the students' capacities to understand and adopt the values, skills, and leadership for sustainable development.

(E3) Purposeful, deep learning: Deep learning refers to the “key strategy by which students extract [underlying] meaning and understanding from course materials and experiences” [32]. It is a contrast to rote-learning and involves a high level of engagement and understanding of the topic at hand; learning for comprehension instead of description. For deep learning to occur, there needs to be an inherent motivation to understand and engage with the topic, which is why student interest is crucial and a factor that makes its pedagogy challenging [32]. Warburton [32] also argues that many traditional pedagogies offer superficial levels of engagement with material, regardless of whether it has deeper-teaching intentions, and that the sciences are more prone to adopting excessively serialist styles of teaching that focus on detail and specificity instead of a bigger, underlying purpose. Combating such shortcomings thus needs more attention. Deep learning is highly important for sustainability education, because sustainability is fundamentally a big-picture topic and requires an understanding of the bigger-scale impacts in order to be attained; it is inherently the ultimate underlying principle, cause, and purpose of sustainability education.

(E4) Interdisciplinarity and transdisciplinarity; holistic and integrative approach: Not only Wu [8] who stated that ESD “include more social and economic factors, not just environmental ones” but all articles examined in the literature review, whether directly or indirectly, identified interdisciplinarity and transdisciplinarity to be a crucial element within successful sustainability education. Interdisciplinarity connects the importance and the applications of sustainability across multiple fields, courses, topics, and subjects and creates space for collaborative work to advance sustainable development. Transdisciplinarity fosters co-creation across multiple stakeholders and practices. For a topic with such wide impacts across all fields, only such holistic approaches can paint its full picture for the learner [13]. The ‘integration’ approach and interdisciplinarity has been echoed by many researchers as being absolutely crucial to sustainability education.

(E5) Affective education: As Lovat et al. [28] noted over a decade ago, “the taxonomic notion that cognitive learning outcomes are separable from affective or social ones comes to be seen as inadequate. . . [there is a] need for new pedagogy that engages the whole person rather than just the cognitive person”. Research on pedagogy and quality education consistently points out that learning needs to be a holistic process; affective learning is just as important as cognitive learning, and although the challenges faced today need cognitive intelligence to mitigate, the roots of the challenges can only be tackled through affective, social competency [47]. Affective learning is especially important for sustainability education, where values, beliefs, and emotional connections to the topic act as the intrinsic motivators for further learning on, creating solutions for, and the leading of social and environmental change [48]. It is only with the combination of both cognitive and affective alignment to sustainable development that knowledge can turn into action, plans turn into practice, and possibilities be made reality [47]. Many curricula well-developed in cognitive learning outcomes lack affective outcomes, and this is one shift that is imperative to successful sustainability education.

2.4. Key Barriers and Limitations of Current Pedagogical Frameworks for ESD

Existing literature also includes various barriers and limitations to current frameworks and practices to facilitate ESD. Common themes have been identified below as key barriers for sustainability education. The VbESD framework will work to address and reduce each of these barriers.

(B1) Vague and varied definition of sustainability: Due to the complexity and inter-sectionalities of sustainability, it is difficult to provide a standardized definition across an entire field or sector. Even the definition of sustainability enacted in 1987 by the Brundtland Commission [49] of “meeting our own needs without compromising the ability of future generations to meet their own needs” is, reasonably, inherently non-specific and broadly-

applicable. The overarching quality of this definition is beneficial for its applicability, but poses challenges when implementing sustainability policies and standards in specific fields. The lack of consistent semantics and clarity creates confusion and hinders its introduction into the curriculum, especially within higher education [9]. It also creates heterogeneity within the knowledge, attitudes, and practices related to sustainability and an ignorance of non-environmental aspects of sustainability [50].

This barrier is also present on another level, where differing fields and disciplines have different understandings of the term sustainability [51]. Technical fields are often found to reduce the definition of sustainability to a single aspect and are inconsiderate towards the social, ethical, cultural, and global dimensions of sustainability. This creates a tension between more interdisciplinary and holistic definitions and more narrow, instrumental definitions of sustainability that are easier to insert into the curriculum, but less impactful [9]. These varieties of meaning of sustainability within different fields is precisely why transdisciplinarity and interdisciplinarity are crucial for sustainability education, because sustainability and sustainable development is inherently not a disciplinary concept. Overcoming this barrier needs both a shared, overarching definition as well as standardized definitions of related, specific concepts that address or eliminate the confusion of interchangeable terms.

(B2) Lack of educator and organizational capacity to change curriculum and pedagogy: Change to any structure or system requires capacity. Figueiró and Raufflet [9] identified that integrating sustainability into an educational environment needs the environment's staff to have the capacity to properly do so. Staff and capacity development therefore is a significant enabler for sustainability education, where staff have the time, energy, motivation, and resources to model and teach sustainable behaviours and skills in the classroom [9]. Staff-specific barriers include the lack of educator knowledge, motivation, and commitment. Teachers and administrators, especially if they did not grow up with education on climate change and sustainability, lack the formal knowledge and appreciation for sustainability education to competently deliver such education [9]. Without the basic knowledge and thus confidence and preparedness, educators would need to take their own time to learn, which is highly unlikely in the already-overcrowded curriculum [52,53]. To expedite this, innovative pedagogical techniques are often studied and recommended. Techniques such as action-learning, experiential learning, case study methods, project-based learning, problem-based learning, reflective learning, service learning, and adaptive learning are amongst some pedagogical approaches used that restructure the traditional teacher-centred and passive learning methods [9,31,54,55]. All of these approaches demonstrate the bigger picture of a “shift from a classical teaching model towards a more interactive one in which students participate in the co-construction of knowledge and understanding” [9]. However, this shift is easier said than done, as underdeveloped mandates for sustainability education in pedagogy and curricula design as well as the pressure to maintain academic foci remain barriers to the resources and attention needed for such capacity development and subject integration [52,54].

(B3) Excessive science focus: Aikens et al. [52] noticed upon a systematic review that there is a heavy association of sustainability education with science, particularly environmental science. This association does not reflect the intersectionality of sustainable development, and instead limits it while creating the silo effect that is highly prevalent within the attempts of integrating sustainability education [52]. Currently, most sustainability education is inserted into sciences courses, and this is the case in Ontario where a standalone Environmental Science course in secondary education was removed after a “failure of the infusion model of sustainability education”, and where “after this switch. . .very little ecological education was being taught” [52]. Instead, it was observed that sustainability was often taught as “decontextualized scientific knowledge versus sociocultural considerations across the syllabi”, which leads to disciplinary bias towards the sciences [52]. This excessive focus and association of sustainability education in the sciences presents a barrier towards its integration into all subjects [52].

(B4) Lack of policy and higher-level commitment: In order to create bigger-level change, leaders need to be involved. While there is a plethora of grassroots-level initiatives, ideas, plans, and innovations that are all impactful to the classrooms they are implemented in, the current climate crisis cannot be curbed with solely bottom-up initiatives. In the literature surrounding environmental and sustainability education, various policy-related barriers emerge. A systematic review of environmental and sustainability education policy trends by Aikens et al. [52] observed a lack of balance between the pedagogical dimension and the dimensions of policy development and enactment, which hinders a full-picture understanding of the role of policy within sustainability education. There is also the inherent lack of research surrounding the implementation and degrees of success of sustainability education policies [52]. Aikens et al. [52] described that a majority of the existing documentation on sustainability education policies largely “self-reports from government or sustainability organizations that function as ‘uncritical catalogues that focus on successes, and are silent about problems and failures’”.

From this literature review, it is clear that there is significant value in developing a comprehensive, holistic pedagogical framework that combines sustainability education and affective education for direct primary education application. In order to ensure the effectiveness of such a pedagogical framework, the above key enablers and barriers must be addressed in full. The next section outlines the VbESD framework to fill this need, and how it actively does that by applying the principles of Values-based Education to ESD.

3. Theoretical Framework

Despite ESD implementation in educational institutions and systems around the world, there is limited large-scale empirical evidence for the extent of ESD implementation in classrooms and the effectiveness of the existing approaches [56]. The VbESD framework aims to build upon existing approaches, integrating best practices as well as expanding the goals of existing pedagogies to include both human and environmental flourishing. This goal of social and environmental sustainability grounds the VbESD framework and is the manifestation of sustainability as an intrinsic value and its subsequent evolutions into an individual’s beliefs, attitudes, mindset, behaviours, and decisions.

Hill’s [34] observation reinforces the importance of child development to sustainable development, supported by recent researchers as well. Indeed, an individual’s educational system and environment has an immense potential and ability to influence not only their academic success, but to cultivate resilience towards their personal fulfilment and well-being, the skillsets to develop meaningful relationships with others, and their intrinsic motivation and purpose to build a better world—all of which are outcomes integrated within VbESD. This section introduces the VbESD concept and framework, including each of the VbESD pillars and how they individually and connectedly foster sustainability as an intrinsic value school-wide.

3.1. The Foundational Concept of VbESD

Values-based Education for Sustainable Development (VbESD) aims to apply the principles and methodology within the Values-based Education model into a model more explicitly focused on sustainability and sustainable development [57]. There are seven pillars of VbE, which spell out MIRACLE: Modelling; the Inner Curriculum; Reflection; Atmosphere and ethos; Curriculum; Leadership; and Ethical vocabulary. These seven pillars sit at the centre of VbE’s methodology for how they are able to foster values intrinsically. Seeing the VbE model as holistic, each one of its seven pillars are needed for its success and work together to create the beneficial results observed in VbE schools. In that respect, the VbESD framework builds on top of every one of VbE’s existing pillars, in order to apply a more focused lens on sustainable development. In addition, VbESD adds a pillar for institutional sustainability, on the operations level. Together, the pillars of VbESD bring sustainability into a school in a holistic and integrative manner, from the roots and embedded within the school’s core values. Table 2 shows how the seven VbE pillars can

easily be incorporated into an ESD context to build the VbESD framework, as well as maps this foundational concept to each enabler and barrier identified in Sections 2.3 and 2.4.

Table 2. Extending VbE Pillars with ESD to create the VbESD framework.

Pillar of VbE	Within VbE	How it Can Apply into ESD within the VbESD Framework	Tangible Examples in VbESD	Relationship to Key Enablers and Barriers to Sustainability Education
Modelling	All staff in a VbE school model the values in their day-to-day behaviour and language	All staff in a VbESD school model sustainable behaviour and include sustainability in their language on a daily basis	Staff recycle, are energy-conscious and water-conscious, use reusable bottles, containers, bags, utensils, and/or other items	B2, E5: Builds capacity and decreases barriers for educators to incorporate sustainability education and an attitude for sustainable living into the classroom without formal lesson plans and being a subject matter expert
Inner Curriculum	A structure to foster self-awareness, self-understanding, and self-regulation; intentional activities and interactions to attune both the student as well as the teacher to the student's authentic self, bypassing external walls put up from negative experiences	A structure to foster self-awareness, self-understanding and self-regulation for sustainability in addition to and in connection to the other values for students to relate their actions to the bigger picture and impact	Staff embed intentional activities and interactions that hone students' self-regulation and leadership to bypass the main barriers of sustainability such as instant gratification, convenience and materialism	E1, E2, E3, E5: Empowers learners to cultivate mindfulness and resilience, which directly fosters and strengthens social learning, democracy and student-centred learning, deep learning and affective learning
Reflection	Dedicated time to think about one's feelings and thoughts, and be present with peace and calm as well as visualize the values	Dedicated time to think about one's feelings and thoughts, and how each value connects to a sustainable world and to visualize that impact	During reflection time, staff intentionally and explicitly relate how each value connects to a better world, and create visualizations of that with their students	B3, E4: Connecting values with sustainability expands the application of values and sustainability to more than just science but to the world, and reinforces the holistic, inter- and transdisciplinarity of sustainable development
Atmosphere and ethos	A positive, friendly, encouraging atmosphere where positive values are foundational to the operation of the school	An atmosphere that demonstrates a high commitment and value for sustainability provides an important constant reminder for students that everything can be related back to sustainability, where sustainability is an added foundation to the operation of the school	School-level processes are also sustainable: Cafeteria uses reusable plates/cutlery and procures local, sustainable ingredients, staff are paid a living wage, school uses recycled paper and supports local and sustainable businesses, has sustainability initiatives and explicit commitment to social and environmental sustainability *	B4: Makes higher-level commitment from the institution visible and explicit to empower subsequent commitment from educators, staff, and students

Table 2. Cont.

Pillar of VbE	Within VbE	How it Can Apply into ESD within the VbESD Framework	Tangible Examples in VbESD	Relationship to Key Enablers and Barriers to Sustainability Education
Curriculum	How values are incorporated within their existing curriculum, through formal, informal and non-formal lessons	How sustainability is incorporated within their existing curriculum, through formal, informal, and non-formal lessons	Each subject is related back to sustainability and sustainable development, and discussions, assignments, projects and activities as well as values are connected back to sustainability	E3, B2: Facilitates deep learning of sustainability and the understanding of its importance to cultivate intrinsic motivation for sustainable behaviours. Having the curriculum also builds capacity for educators as they do not need to develop or curate their own resources and lesson plans outside the institution's curriculum.
Leadership	Leadership is not only demonstrated by the teacher to their students; VbE also fosters self-leadership and leadership from the student outwards to live the values taught	Sustainability as an intrinsic value needs to come from within the student as well	Sustainable choices are made very explicit, clear, and easy to make in the classroom and around the school. Reward systems or friendly competitions may be used to encourage leadership	E1, E2: Facilitates active student engagement to practice the knowledge and skills learned in the classroom. Offers a channel for student-centred learning.
Ethical vocabulary	Students are taught what values are, and every opportunity is taken to explicitly talk about values (i.e., displays, activities, etc.)	Students are taught what sustainability means, the science of climate change, the impacts of unsustainable behaviour, etc.	Educators explain how different values contribute to sustainable development, and take every opportunity to discuss and mention sustainability-related topics in the classroom and relate sustainability across all subjects, lessons, projects and assignments	B1, B3, E1, E3, E4, E5: Fosters specific, deep and intersectional understandings of sustainability that traverses all subjects, while actively engaging students into a common language of values and sustainability.

* The atmosphere and ethos section is expanded in the VbESD framework to include a more separate operational context, for an eighth pillar of sustainable school operations.

The 'iceberg model' developed by Hall [58] illustrates the impact that VbE makes and that VbESD has the potential to make in a society. The iceberg model explains that at the surface, or visible, level of a society is its culture, shaped by the group's routines and structures. These routines and structures are formed based on mindsets, and the mindsets created from values. Figure 1 outlines the way in which VbESD facilitates the transformation of values into mindset and skills, behaviours and actions, and finally to a sustainable culture.

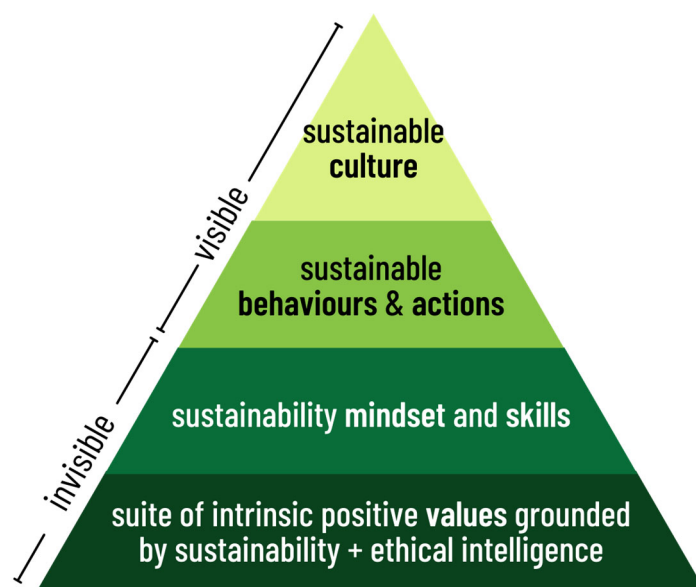


Figure 1. The VbESD ‘iceberg model’ showing its levels of impact.

Values-based education, whether VbE or VbESD, transforms the school and community’s culture from the very base: its values. By nurturing positive values alongside sustainability as a value in children, VbESD will in turn sprout ethical mindsets, empowering routines and structures and ultimately, a culture of social transformation where people, animals, and nature can all flourish together [23,36,39,56]. On a more tangible scale, Values-based Education for Sustainable Development directly develops an individual’s ethical intelligence and intertwines it with the value of sustainability. This combination is extremely powerful and lays the crucial foundation for sustainable development that is urgently needed.

3.2. The VbESD Blueprint

The first steps to implement VbE is outlined through the ‘VbE blueprint’ [59], a guide for schools to start the conversation and process of introducing Values-based Education into their school setting (see Figure 2). It outlines the process of implementing the VbE structure and development, which is summarized in a chart below:

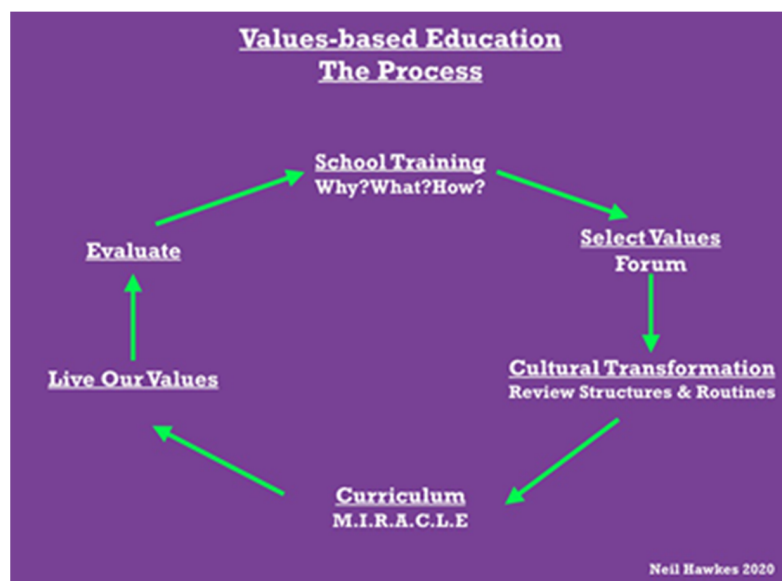


Figure 2. VbE’s process of developing a values-based school [59].

The blueprint establishes the commitment and purpose of a VbE school, affirming that while it brings significant positive effects to all aspects of the school community, it is not a light or easy commitment. All staff in a VbE school need to be actively committed as well as willing and eager to learn and practice values-based living and teaching, as the success of VbE is directly connected to the integrity within the leadership of the school.

In this way, the VbE blueprint is highly applicable to VbESD as well. A main distinction between the VbESD blueprint and the VbE blueprint will be that in addition to asking each school and its stakeholders which values are most important and to focus on, there will be an additional step that asks how each value relates back to sustainability, and how that connection can be made explicit within their curriculum. It is only once all stakeholders and staff within a school are made clear on where sustainability connects their values and curriculum, can the school operate in a holistic, cohesive manner. This process is further described below. More details on how each value can be connected to sustainability is elaborated on within Section 3.3.7. on the 'ethical vocabulary' pillar.

Defining sustainability

Before anything else, a school that decides to practice VbESD must decide how they would like to define sustainability. This is encouraged as a co-creation exercise, where the school's staff, students, and other stakeholders such as parents come together. Seeing as the vagueness of what sustainability means and inconsistent definitions are common barriers to incorporating sustainability within the education system, it is important that the VbESD framework has a clear definition of sustainability. Therefore, to not compromise on either consistency nor each school's creative freedom, the VbESD framework encourages participating schools to have two definitions of sustainability: one as the formal, official definition, and one as to what that looks like within their school. The official definition may remain "meeting our own needs without compromising the ability of future generations to meet their own needs" from the Brundtland Commission in 1987 [49]. The school-specific definition can be established at the same time as the other definitions and values that are decided for the school, further explained below.

Underpinning sustainability within the school's chosen values

Once a school decides and commits to adopting the VbE model, they undergo a process of consultation with their stakeholders, including all their staff, parents, governors, and pupils, to decide each of their school's values. The most important values are shared and decided upon collectively, as well as how they are organized (i.e., one value per month, term, week, etc.). For example, one common approach is selecting 22 values, cycled through fully every two academic years with 1 value per month [59].

After choosing the school's values, the VbESD framework furthers the process by adding the step of relating each value back to sustainability. In the VbESD framework, all of the values selected are rooted in sustainability regardless of which ones they are and how many. The value of sustainability is then present within all the values, and it allows the school the freedom to choose whichever values are important to them, while maintaining the explicit goal and overall foundation of sustainability.

For example, a school chooses the value of respect as one of their values and defines it as showing courtesy and treating everyone with care and dignity. This value's understanding would then be explicitly expanded to relate to sustainability as well, in a way easily understood for children. For instance, they can decide that respect is important to sustainability because in order to care for and value the planet and its people, we must first have respect for all the plants, animals, and people that live here. Below are other examples of how other values can be related back to sustainability:

- *Love* is important for sustainability because it is from love that we care about each other and the planet;
- *Teamwork* is important for sustainability because by working together, we can solve the world's issues much faster and build stronger communities;

- *Happiness* is important for sustainability because happy people do good work, spread happiness and inspire others to pursue their well-being as well;
- *Honesty* is important for sustainability because in order to improve, we need to be honest about our actions, goals, and progress and willing to share ourselves;
- *Trust* is important for sustainability because we need to trust each other, trust businesses, trust leaders, to make decisions that will lead to a better world;
- *Kindness* is important for sustainability because kindness allows us to understand others, provide others with what they need, and to not harm others, including the environment;
- *Resilience* is important for sustainability because resilience is needed to overcome challenges and bounce back from societal issues such as poverty and hunger and natural disasters;
- *Hope* is important for sustainability because hope creates and keeps the vision for a better world alive.

With this added step when establishing the school's values, there can be a clear and explicit connection and reason for how each value connects and leads to sustainability. This provides a common language across educators, staff and students, greatly reducing barriers related to communication and setting the foundation for the ethical vocabulary pillar further described in Section 3.3.7.

3.3. VbESD Pillars

The pillars of VbESD are adopted from the seven pillars of VbE—modelling, Inner Curriculum, reflection, atmosphere and ethos, curriculum, leadership and ethical vocabulary—with an additional pillar of sustainable school operations, spelling out 'MIRACLES' instead of 'MIRACLE'. The eighth VbESD pillar fills a gap found in the original VbE pillars by distinguishing the more operational aspects of institutional sustainability from the more student-facing aspects (i.e., displays, bulletin boards, attitudes of staff, etc.) captured in the atmosphere and ethos pillar, such as the institution's infrastructure, procurement, internal policies and other elements that are not as conspicuous.

Together, the eight pillars of VbESD work in an integrative manner to foster intrinsic values amongst its students. It carries a holistic approach that stems from the roots of the school's operations, to influence all aspects of the educational environment. Just like the VbE framework, the VbESD framework calls for a high level of commitment from the school's leadership to transform the school's culture. Implementing VbESD is, challengingly, not a short-term or low-engagement endeavour; it takes all the staff at the school to commit to the cultural transformation and to sustain it long-term and consistently. However, with intrinsic motivation, a clear structure, as well as quality resources, support, and training, implementing VbESD will be a highly rewarding challenge where its deep benefits and increase in the school's performance, social well-being, and harmony will prove a significantly positive return on investment in all aspects, and the process unwaveringly worthwhile.

Figure 3 illustrates the concept of VbE as well as its 8 pillars. Below are descriptions of how each pillar can look like for a primary school practicing VbESD, relating VbE to ESD for a sustainable world.

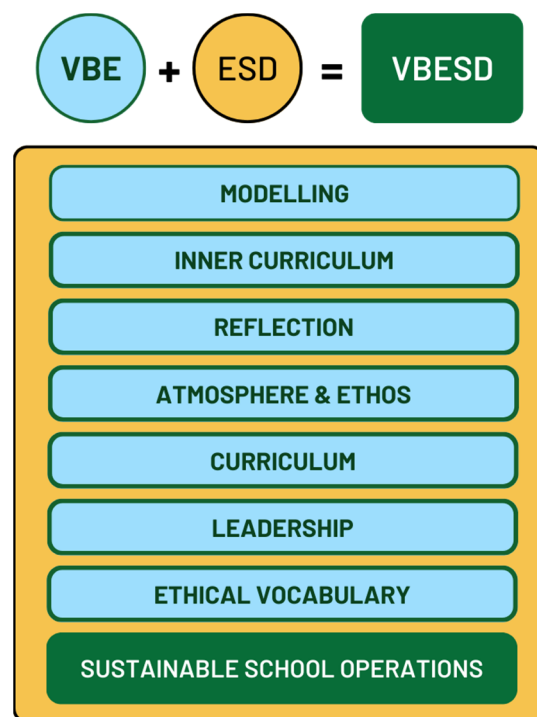


Figure 3. The concept and eight pillars of the VbESD framework.

3.3.1. Pillar 1: Modelling

Modelling refers to the modelling of behaviours that the staff and students display, which leads each value by example [60]. Schools practicing VbESD will not only model the values they choose within a VbE framework, but will all have the additional value of sustainability that grounds all of the other values. This means that all staff within a VbESD school model sustainable behaviours and relate their actions back to sustainability, thus also including sustainability-related language in their day-to-day conversations.

Examples of modelling sustainable behaviour:

- Properly sorting waste, such as recycling any recyclable materials;
- Reducing waste when possible, such as modelling the reuse of good-on-one-side paper, bringing litterless lunches, and using reusable bags, bottles, containers, utensils, etc., instead of disposable items;
- Using resources efficiently, such as turning lights and monitors off, as well as responsibly using the classroom sink and other classroom materials;
- Treating nature with respect when outdoors, such as not breaking tree branches, picking flowers and/or leaves, or disrupting wildlife, and using dedicated walking paths;
- Treating nature with respect when indoors, such as repositioning spiders and insects instead of killing them, and taking care of indoor plants;
- Conscious choice of classroom materials, such as eco-friendly stationery items (i.e., 100% recycled post-it notes, post-consumer recycled paper, etc.).

It is important to note that the added modelling of sustainability in this pillar within VbESD does not mean that staff are expected to lead a perfect example of sustainable behaviours; it is simply bringing more explicit attention to achievable and feasible behaviours when possible.

This pillar works very much hand-in-hand with other pillars, such as ethical vocabulary and sustainable school operations, which will be described in more detail below.

3.3.2. Pillar 2: Inner Curriculum

The Inner Curriculum pillar focuses on honing self-awareness, self-understanding, and self-regulation, and is entirely unique to the VbE model. The VbE philosophy states that when individuals can control our inner world, they learn how to better navigate the outer world, as internal peace radiates outward. Values-based Education operates with the belief that at the core of every individual is an authentic, inner essence, which is not bogged down or locked by negative and limiting experiences. Values-based educators use activities to attune their students to their internal world and the opportunity to explore within and give that attention to themselves instead of their outside environment. When values-based educators connect with and relate to their pupils, they relate from heart to heart, instead of what's on the external front. As explained by Values-based Education, the Inner Curriculum integrates the profound insights found in education, interpersonal neuroscience, psychotherapy, and the wisdom of humanity to develop students' control over their thoughts, feelings, and emotions and ultimately, their self-leadership [61,62].

In a similar way, the VbESD framework draws on this Inner Curriculum to cut through the main barriers of sustainability such as convenience, instant gratification, materialism, and excessive consumption by relating straight to the deeper levels of an individual and attuning to their core desires. Students are able to effectively regulate their impulses towards convenience and instant gratification, as they understand the impacts of their behaviour and how their actions' ripple effects are bigger than themselves. Indeed, just as the VbE Inner Curriculum leads to the flourishing of humanity, the VbESD Inner Curriculum leads to the flourishing of both humanity and the environment.

Examples of the Inner Curriculum in practice within a classroom:

- Educators know how to respond to students' behaviours, including challenging ones, with compassion and in an emotionally-regulated manner;
- Educators can uncover the deeper meanings behind students' behaviours and respond to their deeper needs (i.e., to belong) instead of reacting to the surface behaviour (i.e., fighting);
- Educators relate to students from a place of authenticity, fostering attunement through deep listening and empathy instead of from a place of superiority to create harmonious relationships;
- Educators take time to conduct activities with students to foster self-regulation strategies, such as practicing breathing exercises;
- Students learn and practice how to understand and attune to their true selves, including how to regulate their emotions when overwhelmed through strategies such as pausing.

3.3.3. Pillar 3: Reflection

This pillar of the VbESD framework takes the existing pillar of reflection from the VbE model and imbeds the value of sustainability within it, by connecting the reflections and visualizations to sustainability. This is achieved by adding in prompts and visualizations for how each value relates back to a more sustainable, peaceful, better world. During reflection time, students have the opportunity to not simply be guided through visualizing the value at hand and being present to their thoughts, but also guided through how that value shows itself as a crucial element to a better world. The students are then invited to imagine a world where that value is abundant, and where they and the people and community around them are all practicing that value. They can be led to imagine such a world, and with that, foster their self-motivation as well as the optimistic thinking and action that lies at the core of the reflection pillar.

An example of incorporating sustainability into reflection time

Within the online videos that are presented on the Values-based Education website, the third online training video is on 'reflection', where VbE's CEO Bridget Knight explains her "painting with words" methodology for values-based visualizations. In her training, she

walks through a script for a guided reflection on the value of courage [63,64]. Sustainability can easily be incorporated within that reflection by relating how courage is needed for a sustainable world and sustainable behaviours. There are infinite possibilities for how this can look like, but some questions that educators can ask themselves to develop a script can include the following: How does living this value make the world a better place? How can living this value promote environmental, social, or economic sustainability? How can living this value advance the Sustainable Development Goals? Why does our society need this value to flourish and thrive? How can this value benefit the student, as well as on a bigger scale—to their family, the classroom, their community, the world? How would they have shown this value recently?

Once these questions are explored, their answers can help develop a few phrases to add into the guided reflection and visualization. Below is an example of phrases that can be included:

“Reflect back to when you felt courageous. It could have been when you shared what you were grateful for this morning. It could have been you raising your hand in class, and sharing your thoughts. Now, grasping the light of courage in your hands, feel it rush into your heart, your soul, all within you. And imagine everything you can do with all that courage. The world needs courage to thrive and flourish. It is with courage that people follow their dreams and put in the effort to turn their ideas into reality. It is with courage that new technologies are invented and with courage that people speak up about issues in the world. It is with courage that people stand up for nature, for the environment, and ask the world to pay attention to protecting our Earth. It is with courage that people stand up for what’s right, and for their friends in trouble, and for telling the truth when situations are hard. Imagine how the world would look if people had more courage.”

The VbESD framework will also outline a ‘series of gratitude’ each day, for example each morning. This set of activities may take around 5 min, and has three components within it that work in synergy.

(1) Gratitude Circle: The first component is the ‘gratitude circle’ where the students gather in a circle to start (or end, or take a break within) the day, and the teacher takes a minute to go around to the students asking what they are grateful for that day. The students will be invited to provide two things they are grateful for, with one of them being an element from nature (i.e., grateful for the sunshine today; for the clear skies; for the warm breeze, etc.). The teacher is expected to create a safe, inviting space for the students to share, and appreciate each answer. This sharing is structured to be a few minutes long. At first, students may take a while to think about what they are grateful for. However, once this becomes a regular, daily practice, students will more actively and purposefully think about things they are grateful for in the morning, or on their way to school, and come prepared for the circle. After honing this practice, this sharing would take 2–3 min.

(2) Daily Reminder: After the sharing comes the second component, the reading of a ‘daily reminder’. At the start of each month (or with each change in the value), the teacher works with their students to come up with a paragraph together that relates gratitude, the value at hand, and sustainability together. The structure of this reminder can look like this:

“Today, we are grateful. We are grateful for (noun), for (noun), and for (noun), which nature provides us so generously with. We are grateful to be living on this beautiful home, our Earth, and we thank the (name(s) of the first nations or indigenous people if applicable/our ancestors) for taking care of this land for us. We know the importance of the responsibility we have in keeping this home beautiful and abundant in (noun), (noun), and (noun) for all the future children in this world. Our Value of the Month (value) means (phrase) and living with this value will bring sustainability to the world because/by (phrase).”

The brackets are words and phrases that the teacher and students come up with together. This paragraph will then become a script that will be put up in the classroom, as well as expressed at the start of each day. There could be various ways that this script can be expressed, and a few examples include where the teacher reads to the students, where the teacher invites any willing students to read together with them, where the students read collectively without the teacher, or as a 'prize' where a student is awarded the honour of reading it to the class. Creativity can be applied to this component with ease and is greatly welcomed. This component explicitly links sustainability with the value, and gratitude for nature which is key for fostering sustainability as a value. Expressing this daily reminder would take about a minute.

(3) Moment of Gratitude: The two previous components lead up to this final component, where the students are invited to take one minute to be grateful and think about what they are grateful for. This component is best at the end, because the students would have received prompts from their peers as well as the daily reminder, and have the connection between the value and sustainability fresh in their minds. At the end of the minute, the students can be given another minute if the teacher wishes, to write their gratitudes or thoughts down in their reflection journal. With this component taking about 2 min, the entire series of gratitude would take about 5 min structured at the beginning of each day.

3.3.4. Pillar 4: Atmosphere and Ethos

A school's atmosphere is what surrounds each learner both inside and outside the classroom [60]. It permeates the entire school, and any and all visitors can feel it as soon as they step inside. With globalization and rapid modernization, many educational settings nowadays have an atmosphere that is focused on achieving high grades and results, reflecting an increasing demand and culture for the value of academic success. However, values-based schools focus on bringing a deep positive difference to the student's worldview that underpins their thoughts and decisions. A school's atmosphere is determined by any structures and systems put in place, for example, reward systems, friendly competitions, community projects and activities, and school-wide campaigns. A VbESD school atmosphere would have the same welcoming, friendly, and positive environment as a VbE school, but also one where there is a focus on learning from and living in harmony with nature. Clear nature elements and displays with an explicit focus on sustainability would be present, such as signage, stickers, boards, plants, and green spaces.

The atmosphere and ethos pillar also works in cohesion with Pillar 8 of 'sustainable school operations' (see Section 3.3.8), and there are overlapping features. It should be recognized that it is the more visible elements of Pillar 8 that encompass the atmosphere within a school, and that the goal with this pillar is to explicitly inspire passers-by and anyone within the school environment with the school's active action on sustainability.

Examples of elements in schools creating an atmosphere and ethos rooted in sustainability:

- Living walls and classroom plants;
- School gardens (i.e., a values garden would perfectly connect VbESD elements to VbE); outdoor time and outdoor education;
- Boards and displays that explicitly mention sustainability-related topics; stickers on resource-using locations (i.e., electrical outlets, light switches, taps, toilet flushers, computer monitors, etc.);
- Signage related to sustainability (i.e., waste sorting signage); green space and natural architecture (i.e., nature playgrounds);
- Books about sustainability concepts within classrooms and the school library.

Displays also play a key role in reinforcing students' ethical vocabulary (see Section 3.3.7), where sustainability is not only embedded within the language used in class, but also within visual displays all around the classroom and school. In most VbE schools, there are displays of values in the halls and in each classroom, ranging from bulletin boards, murals, values baskets, values boxes, values-based characters, posters, and

signs. In schools practicing VbESD, displays can showcase the foundational or overarching nature of sustainability connecting all the other values. For example, if there was a display of a values tree with leaves symbolizing the values, sustainability could be added at the root or trunk of the tree. Displays offer a safe and regular space for creativity to be brought into the narrative, another important element to foster for sustainable development and innovation.

3.3.5. Pillar 5: Curriculum

Seeing as each school already has this component, this pillar within VbESD is not designed to replace but rather add onto and ground any school's existing curriculum. In the VbE framework, though, the curriculum is not only focused on numeracy and literacy, and memorizing facts and figures—values sit at the core of it, and transcend the formal, informal, and hidden or implicit layers of the curriculum where they are taught not only implicitly but explicitly [60,65]. The VbESD curriculum includes everything that the VbE curriculum comprises, but it also adds on explicit lesson planning for raising awareness, knowledge, and skills about sustainable development. In a VbESD curriculum, anything that can be related to sustainability without compromising other teachings is carried out. This pillar is also where the 'knowledge and skills' within Education for Sustainable Development are fostered—the knowledge and skills required to become a responsible, engaged, global citizen and leader. The VbESD framework outlines a curriculum that will explain the science and definition of sustainability while addressing the issues, solutions, root causes, and intersectionality of climate change and unsustainable development, in order to foster the core competencies within Education for Sustainable Development. It will incorporate elements to engage student-led learning, project-based learning, experiential learning, partnerships with local and global organizations and stakeholders, and imbed the understanding that sustainable development and climate action have a highly interdisciplinary nature.

For this pillar, learning outcomes will be guided by the UNESCO "Learning for the future: Competencies in Education for Sustainable Development" [3], as well as curriculum guidelines from ESE approaches, including EE, EfS, and outdoor education [37].

Examples of topics covered within VbESD:

- Definition(s) and types of sustainability;
- Importance of sustainability;
- Science behind climate change;
- Effects and impacts of climate change;
- Solutions to climate change;
- Intersectionalities of the above.

Examples of integrating the value of sustainability in curriculum across different subjects:

- In Language class, choosing reading materials that relate to sustainability and sustainable development instead of arbitrary ones, to illustrate the same concepts (i.e., poetry, literary devices, storytelling, character development, character tropes, etc.);
- In History class, incorporating learning of historical sustainability events (i.e., the Kyoto Protocol, Paris Agreement, creation of the Millennium Development Goals (MDGs) and SDGs, etc.), including ones local to the school and/or community;
- In Science class, including teachings about climate change (i.e., greenhouse gases, pollution, and sustainable innovations (i.e., circular economy, carbon capture, social enterprises, etc.);
- In Drama class, incorporating sustainability as a theme during class activities or projects (i.e., instead of entire free rein, encourage students to create pieces around a sustainability topic or narrative);
- In Physical Education class, increasing elements of outdoor learning (i.e., nature walks and/or hikes, etc.);

- In Social Studies class, incorporating field trips to local environmental/social justice organizations and/or social enterprises where students can learn about their work, be exposed to sustainability work in real-life, and get inspired;
- In Art class, using nature and landscapes as examples (i.e., to paint/sketch/etc.) instead of inanimate objects;
- In Math class, incorporating sustainability elements in example and practice questions/problems (i.e., using '3 bees' instead of '3 pencils' as a simple example).

3.3.6. Pillar 6: Leadership

Leadership within VbESD is crucial and refers to leadership of all kinds. First and foremost is the leadership of the school staff, all the way from the top administration and management of the school to its office administrators, teachers, support staff, and even janitorial staff [60]. Only with full staff onboarding of the VbESD model can a school realize its full transformational potential and offer a holistic leadership for values-based living.

However, leadership does not only encompass teacher leadership that influences their students in values-based educational settings: leadership starts from the student themselves and extends to multiple levels beyond their individual actions. Firstly, values-based education fosters self-leadership to live the values they learn, supported by all the other pillars. Next, students display leadership to encourage and keep their classmates and peers accountable within the values-based school environment. From there, students bring their leadership to their family when they share about the values and learnings at home. Even greater than that leadership is when students become leaders within their community by modelling their values in their extracurricular lives. As they grow older, a global leadership emerges once they become engaged global citizens. Everyone who is within the student's environment is part of a ripple effect that is deeply transformative. Leadership within VbESD encompasses everything within VbE, with an added leadership pertaining to sustainable behaviours and lifestyles. Indeed, VbESD cultivates leadership that is much needed in the rapidly-developing world that we are living in, one that is compassionate, courageous, gentle, resilient, and insightful.

On an even bigger level, VbESD schools themselves act as leaders to demonstrate to other schools and education systems that such education is possible and provide replicable methodology for other interested schools to follow.

Examples of sustainability leadership cultivated within students through VbESD:

- Integrating sustainable practices in their own life (i.e., turning the light off when the last to leave the classroom, turning the monitor off when finished with the computer, putting their juice box into the recycling bin while putting the straw in the garbage, etc.);
- Encouraging their classmates and peers to practice sustainable behaviours (i.e., reminding their friends to stay on the dedicated walking path, showing their friends their new reusable water bottle, etc.);
- Starting conversations at the dinner table at home to engage family members in what they learned (i.e., sharing about circular economy examples, sharing stories from a nature walk, asking them to pack a litterless lunch the next day, etc.);
- Starting and/or supporting school initiatives and/or community projects (i.e., tree planting, donation drives, clothing swaps, etc.) that contribute to sustainability and sustainable development;
- Joining school environmental clubs and/or campaigns by environmental organizations.

3.3.7. Pillar 7: Ethical Vocabulary

The ethical vocabulary grounds Values-based Education by providing its students with a common language that expresses their understanding of the values, and the tool to communicate their thoughts and reasonings from that shared understanding [60,66].

In a VbESD school, this ethical vocabulary is expanded from the values in VbE, to incorporate language that relates to sustainability as well. In addition to understanding what values such as courage, hope, love, joy, respect, and kindness mean, students are also raised in the environment to understand what sustainability means, in all its aspects. They will understand not only the terms of sustainability and sustainable development—including its pillars of environmental, economic, and social sustainability and concepts such as climate change, global warming, recycling, clean energy, environmental degradation, biodiversity, ecosystem, social well-being, eco-friendly, overconsumption, waste, resource usage, stewardship, pollution, conservation, and preservation—but also how values are connected with sustainable development.

However, the essence of the ethical vocabulary pillar is that students not only know the vocabulary, they fully understand and experience the vocabulary as well. In order to understand and experience the values taught in a values-based school, there needs to be a significant amount of intention behind selecting and planning for each value. This values-selection activity was outlined in Section 3.2, followed by the school-specific discussion to create their own definition of sustainability (which can exist alongside the official one). It is important to keep in mind that the school-specific definition should be easy to understand, even for children. An example of this could be the following:

“To behave sustainably means to behave in ways that meet our own needs without compromising the ability of future generations to meet their own needs either. At (name of school), this means to make sure that we take care of our home, including the people, animals and nature, so that they all thrive even when we’re old.”

Application example of a school-specific definition of sustainability

The ethical vocabulary, including the school-specific definition of sustainability, is something that VbESD schools would make very visible and part of staff and students’ everyday communications. For example, they can be integrated into the daily morning announcements (i.e., at the end), which could sound like this:

“Remember everyone: at (name of school), we are change-makers and change-leaders and do our best to build a better world. For us, this means to make sure that we take care of our home, including the people, animals and nature, so that they all thrive even when we’re old. This month’s value is Teamwork. Teamwork is important to build a better world because by working together, we can solve the world’s issues much faster and become stronger communities.”

Explicit connection to sustainability in everyday language

As outlined in Section 3.2 with examples, each of the school’s chosen values are clearly and explicitly connected back to sustainability. Just like how in VbE schools every opportunity is taken to explicitly talk about each value, teachers in VbESD schools would take every opportunity to not only talk about each value but relate it back to why it is important for sustainability as well. Some examples are provided in Table 3, but there are unlimited opportunities to bring sustainability and values into the discussion.

With regular, consistent mentions of values in addition to the intentional act of relating them back to their importance and sustainability, teachers are able to create an environment where the students are surrounded by the values and where sustainable development is embedded within the core of their learning and common vocabulary.

Table 3. Examples of incorporating sustainability explicitly into an educator’s daily language.

Non-VbE Educator	VbE Educator	VbESD Educator
“Please recycle, class!”	“Please recycle, class!”	“Recycling these papers shows responsibility and is important because it lets us use the same paper to make new pieces of paper, instead of cutting down more trees and causing harm to the environment”
“And what did Snow White do?”	“What values did Snow White display here?”	“What values did Snow White display here? How did that help her? What might you be able to do better if you had [insert value]?”
“Let’s have a short break, class.”	“Let’s have a short break, class. Use this time to regain some peace and calm.”	“Let’s have a short break, class. Use this time to regain some peace and calm. Let’s also take this break to refill your water bottles! Using reusable bottles is great because we can use them again and again, without needing to create plastic waste.”
“Don’t step on the grass!”	“Thank you for showing care around the grass.”	“Thank you for showing kindness to the earth by being careful around the grass. Kindness is such an important value to have because that is how we will make sure that we treat both other people and our planet well, and leave it in good condition for our future generations.”
“You did so well today!”	“You showed a lot of courage today!”	“You showed a lot of courage today! That courage is so valuable because when you grow up and need to make harder decisions, you will be drawing on that courage. If you have a great idea for the world, you will need a lot of courage to make it come true.”
“I loved the story that you wrote! You have a great imagination.”	“I loved the story that you wrote! There is so much hope filled inside.”	“I see a lot of hope in this story you wrote. This hope is what will create our brighter future, and let us see the potential for the world, where people are happy and the planet is healthy.”

3.3.8. Pillar 8: Sustainable School Operations

This last pillar is a new pillar that provides the final distinction between a VbESD school and a VbE school. Sustainable school operations consist of everything that happens at an institutional level, primarily operational infrastructural elements that are less student-facing. It entails the ‘behind-the-scenes’ activities that create the deeper foundation for the atmosphere and ethos pillar and the underlying culture of sustainability. While these items are often in the periphery of a school’s visible elements, such school operations do not need to be inherently invisible. Precisely, the key to generate impact from this pillar is explicit and effective communication for these otherwise-less-visible elements.

Examples of sustainable school operations:

- Having sustainable choices within the school’s foodservice, such as plant-based meals, nutritious breakfast and snack programs, and sustainable cafeteria practices (i.e., practices to reduce food waste, procurement of local and/or organic food);
- Having infrastructure that supports the efficient use of resources (i.e., low-flow toilets and faucets, LED lighting, ENERGY STAR appliances, computers on energy saver mode, etc.);
- Installing intentional green space (i.e., living walls, rooftop or school/community gardens, etc.) and building/interior design that maximizes natural light;
- Using products that are environmentally-friendly (i.e., non-toxic cleaning chemicals, soaps without microbeads, post-consumer recycled paper napkins and toilet paper, etc.);
- Choosing local procurement when possible to support local and/or small businesses (i.e., catering options, contracts for services, etc.);

- Designing hiring and recruitment practices that consider applicants' values, attitudes, knowledge, and skills on sustainability;
- Investing in professional development and training about sustainability and ESD;
- Setting school-wide structures to recognize sustainability leadership (i.e., awards, rewards system, etc.);
- Establishing a sustainability committee and/or working group(s);
- Incorporating sustainability topics into discussion items and agendas at school and/or parent council meetings;
- Creating official communication channels any/all of the above (i.e., educational signage about low-flow toilets and recycled paper napkins, showcasing a paragraph or page about institutional sustainability on the school website, sharing sustainable initiatives on the school's social media, etc.).

While in a sense, these structures can be considered 'modelling' on a school level, a separate category for them is more reasonable because they are usually not decisions that teachers can make themselves, unlike modelling and the curriculum. Of course, developing this pillar also takes more than simply staff behaviour—it also needs financial resources and time as well. Guidelines will be provided for these sustainable school operations to serve as ideal goals, and VbESD schools would simply try their best and implement whatever is feasible and possible alongside a reasonable time frame. The ultimate goal in this pillar is to have such embedded institutional sustainability that it will be the clear and easy choice all around.

3.4. Differentiation of VbESD from Other Sustainability Education Approaches

VbESD presents a unique approach to sustainability education that not only involves students and teachers, but the entire school—from its principal to its janitors—and beyond. It encompasses student–teacher relationships, psychological development, the school's visual environment and infrastructure, operations and policies, and a concerted, intentional effort across the school to deliver transformational education that fosters resilient, ethically intelligent leaders of tomorrow.

VbESD integrates sustainability into each and every subject and activity, and daily conversations, instead of specific courses and discussions. The framework has a holistic affective approach combining teachings from neuroscience and psychotherapy, rather than a cognitive approach focused on teaching knowledge. VbESD expands the learning scope and opportunities to not only those obtained through diverse human and non-human relationships (i.e., teacher–student, student–student, student–self, student–community, student–nature, etc.) but also through infrastructure and atmosphere (i.e., displays, signage, posters, murals, etc.), as well as operations and processes (i.e., foodservice operations, procurement policies, etc.).

4. Methodology

As presented in the introduction, the central research aim is to investigate whether and how a pedagogical framework could be created to foster sustainability as an intrinsic value to advance Education for Sustainable Development. This research goal is explored through a deductive–inductive approach, where existing evidence, theory, research, and practice is combined with new theory and investigation into a possible new framework. In the deductive phase, current practices and limitations of sustainability education and ESD, as well as their pedagogical approaches, are critically analysed to understand the context thoroughly. Identified best-practices as well as insights gathered from discussions with VbE staff and two in-depth surveys are then used in the mixed-methods inductive phase to develop and build the Values-based Education for Sustainable Development (VbESD) framework and thus demonstrate the opportunity to use the principles within VbE in ESD.

4.1. Building the VbESD Concept and Framework

To lay the groundwork for the VbESD concept, parallels between VbE and ESD were mapped out. Subsequently, each of the seven VbE pillars were analysed and extended into an ESD context to build the foundations of the VbESD framework, focusing on providing concrete examples with the goal of being easily implementable, tangible, and impactful.

To ensure the alignment of VbE during the development of the VbESD framework, multiple conversations were also had with Nigel Cohen, Strategic Director at Values-based Education and International Values-based Education Trust trustee, over email correspondences and a live virtual discussion. The correspondences were aimed to introduce an awareness of VbESD at VbE for the potential of mutual collaboration, as well as to ensure an accurate understanding of VbE while developing VbESD. During the conversations, key distinctions were made in terms of what the primary principles of VbE are, how VbE and sustainability relate, and the difference between values education and values-based education for sustainability [26]. These conversations have helped to bring insight and groundwork to this framework and serve as the basis for further consultation.

4.2. Development of the Survey to Establish Values-Based Education for Sustainable Development (SEVbESD) and the Survey to Implement Values-Based Education for Sustainable Development (SIVbESD)

4.2.1. Objectives of the SEVbESD and SIVbESD

Two surveys were developed to support the conception of VbESD: the survey to establish Values-based Education for Sustainable Development (SEVbESD) and the survey to implement Values-based Education for Sustainable Development (SIVbESD).

The SEVbESD aims to consult the general public as well as various stakeholders (i.e., educators and curriculum designers, VbE staff, and affiliates) in order to establish a baseline understanding of how much interest, support, and willingness there would be in establishing a framework for sustainability education such as VbESD, what perceived barriers are present, and obtain feedback for important elements to include in the framework. The primary questions of the SEVbESD are as follows:

- Is there interest in a framework fostering sustainability as an intrinsic value within the education system?
- Is there support for introducing VbESD on the global, country, and local levels?
- Is there willingness from educators to implement VbESD within their own teaching and within their own school?
- Do VbE practitioners believe that VbESD is feasible on a conceptual level?
- Is there a perceived sense of importance in sustainability education?
- What are the most commonly-perceived barriers to implement the VbESD framework, and what are some possible solutions?
- Has values education for sustainability education been historically impactful, and if not, why not?
- What level(s) of education is most perceived as the critical window to implement sustainability education/the VbESD framework?
- What are the primary elements to focus on in the case of them needing prioritization?

The SIVbESD is a follow-on survey to the SEVbESD. It aims to understand the feasibility of implementing and the willingness to implement VbESD into existing educational systems, as well as any additional feedback for improving the working model. Additional investigations that the SIVbESD would explore are whether there is any increase or decrease in the support for VbESD after having seen the framework itself, the main barriers for implementation from educators having seen the framework, and whether there are any trends between an individual's willingness to adopt the framework and their past experiences.

4.2.2. Survey Target Audiences and Dissemination

The SEVbESD and SIVbESD were online questionnaires consisting of 57 questions across 7 sections and 49 questions across 6 sections, respectively, and shared to the general public with an emphasis on educators, curriculum designers, and individuals in the VbE community through word of mouth and various online and social platforms. They consisted of various types of questions, including multiple choice, checklists, 11-point Likert scales, and short-answer and long-answer questions. Unique to the SIVbESD is its request for an additional level of engagement and commitment from its participants to obtain an understanding of the VbESD framework first. Three options are provided to generate this understanding: a set of presentation slides for participants to read through, a written document of the framework, as well as an invitation to attend a live 30-min presentation of the framework with a questions period following the presentation. After the participant has received a general understanding of the framework, they are asked a series of questions pertaining to its feasibility.

Both surveys were delivered publicly, with a special focus on core communities highly relevant to the research: the VbE and International Values-based Education Trust (IVET) Foundation community (including VbE board members, VbE practitioners and educators, any staff at VbE schools, VbE Affiliates, IVET Affiliates), as well as primary school educators and staff. Nonetheless, data from any educator or staff in a learning institution would also be valuable, as well as the general public, in order to have a diversity of audiences and identify any differences in perception between them. The surveys were estimated to take 20–30 min to complete, and because the sampled population is the general public, the sample size needed for a 95% confidence level and a 10% margin of error was 97 people, which was set as the minimum target.

$$n = N \times X / (X + N - 1), \quad (1)$$

where $X = (Z\alpha/2)^2 \times p \times (1 - p) / \text{MOE}^2$, and $Z\alpha/2$ is the Z-score of the normal distribution at $\alpha/2$, MOE is the margin of error, p is the sample proportion, and N is the population size. For a confidence level of 95%, α is 0.05 and the Z-score is 1.96.

4.2.3. Survey Target Audiences and Dissemination

Exploratory data analysis of both ordinal data and natural language data was performed. Proportions and percentages of different responses to each question were analysed and if relevant, related back to demographics or previous experience and/or education. Themes related to primary questions were investigated in a more detailed manner, with responses from subpopulations analysed in relation to other subpopulations. For short- and long-answer responses, key words were identified and analysed thematically. Common themes and phrases were observed for their degree of support as well. Each suggestion not already taken into account in the VbESD framework was considered and noted for the next steps of VbESD's development, either immediate or longer term.

4.2.4. Survey Design and Outlines

Outline of the SEVbESD: The SEVbESD first starts off with a section on establishing the demographic of the surveyee. Questions are used to establish age, gender, and ethnic background as the basic demographics surveyed. Demographics related to their educational background are also gathered. Next, there are questions to gather a general idea of their knowledge on sustainability and how much the participant values it (i.e., in their lifestyle, behaviours, or as a value), as well as how they would rate its importance within the education system on different levels. The survey asks what the surveyee believes are the best ways to incorporate sustainability within the education system and provides choices of mandatory or elective courses, course-specific or integrated within different courses, as well as the choice for a full integration at the foundation, across all courses and operations. Section 3 focuses on establishing the connection between values-based education and

sustainable development, with questions similar yet distinct depending on whether the surveyee is involved within VbE. Both audiences receive questions around whether the surveyee believes sustainability can be fostered as an intrinsic value and in the education system, and if that would be valuable. The wording, however, is more general for non-VbE practitioners. The next section starts with questions about the respondent's previous experience with both values education and sustainability education, exploring at which education level they received it, how they received it, and the impact it had on their life. The survey then explains the concept of VbESD and asks the surveyee to rate their support for and willingness to adopt the framework. The last question in this Section 4 asks whether or not the surveyee is an educator of any kind, and leads to the next section on support for and perceived barriers to VbESD. For educators, Section 5 asks whether they already incorporate sustainability into their teachings, and whether they support introducing the VbESD framework on a general and individual scale, followed by a checkbox question on what barriers they perceive for VbESD implementation on both levels, as well as space to elaborate regarding their solutions. Non-educators are only asked one set of these questions, for the general education system. Section 6 relates to identifying important elements and aspects to VbESD, where different pedagogical approaches, curriculum elements, and other aspects (i.e., student-led learning, experiential learning, the science of climate change, staff being positive role models, the impacts and solutions and root causes of unsustainable behaviours, support from higher-ups, etc.) are presented for the surveyee to rate for their importance to the VbESD framework. Surveyees are also prompted to provide additional feedback for barriers not mentioned. Then, the surveyee is asked whether they would have liked their primary education to have implemented VbESD, and what level of education they believe that VbESD would be most important to be implemented. The last section (Section 7) of the SEVbESD focuses on the next steps, asking the surveyee how they would like to continue this discussion, any additional comments, and to leave a space for them to provide any connections to the VbESD and feedback for the survey. The full SEVbESD preamble and questions can be found in the Supplementary Materials.

Outline of the SIVbESD: Similar to the SEVbESD, the SIVbESD first starts off with a section on establishing the demographic of the surveyee. Questions are used to establish age, gender, and ethnic background as the basic demographics surveyed. Then, demographics related to their educational background are also gathered. The participant is then asked to provide feedback on the VbESD presentation if they attended. Before the next section, the participant is asked to read through the VbESD framework provided if they had not attended the presentation, so that they are familiar with the framework first. They are then asked to rate their support for the VbESD framework, its importance, urgency, and feasibility on different scales (i.e., global, country-level, local), and their willingness to adopt the framework (hypothetical if they are not an educator) now that they have actually seen it. They are also asked to rate its effectiveness and impact for the students and whether they would have wished their primary school had such a framework. The next section is presented to educators and concerns the barriers to implementing VbESD; the same barriers are presented as in the SEVbESD, but this time in the context of after the participant understands the framework. Educators are prompted about potential solutions of the barriers as well. Participants are then asked questions pertaining to their perception of the VbESD framework and how much they believe VbESD can foster sustainability as an intrinsic value. Penultimately, participants are asked to rate the importance and impact of each pillar as well as provide any other elements that were not covered. They are then asked to rank the importance of VbESD to each education level, the same as asked in the SEVbESD. Lastly, participants are asked about follow-up conversations and products regarding VbESD. The full SIVbESD preamble and questions can be found in the Supplementary Materials.

5. Results from the Surveys to Establish and Implement VbESD

5.1. Results from the SEVbESD

The following section describes the results from the survey to establish Values-based Education for Sustainable Development. A total of 129 individuals participated with results from 128 participants described below, as one of them did not consent for their answers to be used.

5.1.1. Section 1: Demographics

The demographics of the SEVbESD participants cover a wide range of age, ethnicity, educational background, and career field. Out of 128 participants, the majority (69 people; 53.9%) were between 18 and 25 years old; there were 42 participants (32.8%) aged 25–40; 11 (8.59%) that were 40–65 years old, 4 (3.13%) above 65 years old, and 2 participants (1.56%) between 13 and 18 years old. No participants were 1–12 years old.

Most participants (96 of them; 75.0%) identified as female, and 28 (21.8%) as male. Other populations represented included transgender, queer, non-binary, and gender-fluid, totalling 4 participants (3.13%). The majority, 68 participants (53.1%), were white or Caucasian followed by East Asian and South Asian individuals, together comprising 37 participants (28.9%). In total, 11 of the 128 respondents (8.6%) grew up in Italy. Other communities represented included Southeast Asian, MENA, Indigenous, Black, West Indian, Hispanic, and Southeastern European.

Most participants grew up and obtained their most relevant education in Canada (70.9% and 75.0%, respectively), although participants also came from all other continents (Asia, North and South America, Australia and Oceania, Europe) as well. The school boards represented included ones across Canada and internationally, with the most represented (34 participants; 33.7%) being the Toronto District School Board.

The two majority populations surveyed were students (58 participants; 45.3%) and general community members (46 participants; 35.9%), although careers fields varied from logistics, community development, administration, e-commerce, social work, non-profit, programming, technology, law, real estate, agriculture, healthcare, advertising, and many more. Educators comprised 41 participants (32.5%) and ranged between primary, middle, secondary, and post-secondary educators, as well as outdoor educator, community educator, and educators within educational non-profit organizations. Fields of study ranged from environmental sciences to business, architecture to law, and various others.

5.1.2. Section 2: Sustainability as a Value

As seen in Figure 4, 100% of the participants valued sustainability at a 6 or more in the 11-point Likert scale, with 39.8% responding with a 10. In terms of knowledge and behaviour around sustainability, the distribution was similar to a normal distribution between 3 and 10 scores with 7 as the mode, with 29.7% and 28.9% of respondents answering 7, respectively. In terms of the importance of sustainability as an intrinsic value (i.e., guide their thinking and behaviour), 100% of the respondents answered between 5 and 10, with a 40.6% majority at 10.

A similar and more extreme observation was found in the importance of incorporating sustainability into the education system, with 64.1% and 67.5% of respondents scoring 10 (extremely important) for globally and locally, respectively. As for incorporating education for sustainability into the participants' fields of work and the education system, all participants still responded with a 5 or more, and 'extremely interested' was selected by 55.4% and 56.3% of participants for their field of study/work and into the education system, respectively (Figure 5).

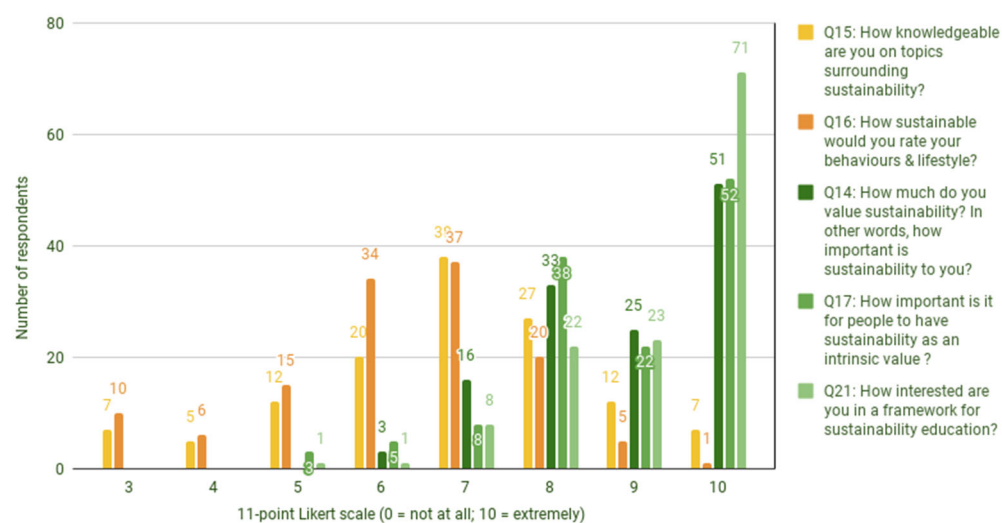


Figure 4. Participants' knowledge, lifestyle, value, and interest for sustainability (results from SEVBESD Section 2: Questions 14–17, 21).

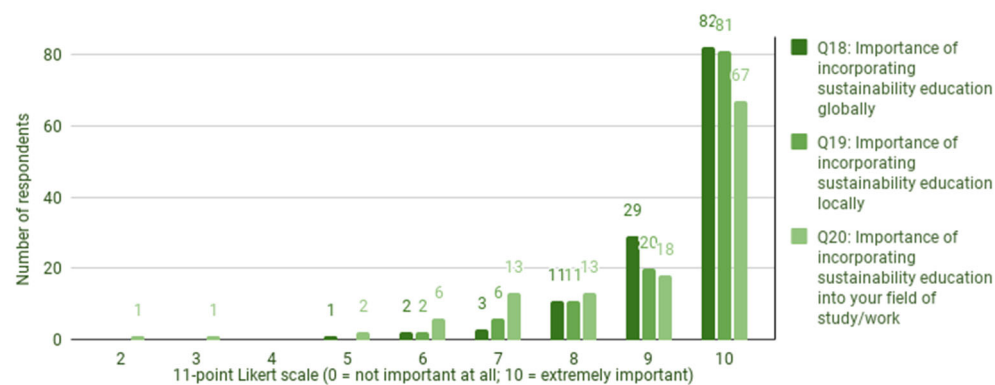


Figure 5. Participants' rating of the importance of incorporating education for sustainability education on multiple levels (results from SEVBESD Section 2: Questions 18–20).

The majority (91 respondents; 71.1%) of respondents felt that the best way to incorporate sustainability into the education system was through an integrated, foundational manner into the school and curriculum, and “brought up in any subject possible and tied into assignments, projects, discussions, extra- and co-curricular activities, and the operations and environment of the school and staff behaviours”. Secondly were “into core, mandatory subjects” with 56.3% of respondents and “into all existing subjects” at 51.6% respondents. A total of 39.1% of participants believe that sustainability should be its own core mandatory subject, and 24.2% believe the same but as an elective course. Other suggestions were to include at least one lesson per subject that relates to sustainability as a minimum; to embed sustainability within the building structure and construction as well; to honour the importance of agricultural and horticultural education and outdoor education in school gardens; and to foster it as a value similar to responsibility and kindness, “ingrained in the mindset rather than taught explicitly”.

5.1.3. Section 3: Values-Based Education and Sustainable Development

The questions from this section were branched off depending on whether or not the participant is involved with the VbE movement. There were 8 participants (6.25%) who identified as involved with the VbE movement, and 120 (93.75%) as not involved. Those involved represented VbE advisors, affiliates, educators, and former students.

Within the 8 participants involved with VbE, all 8 agreed that VbE provides the framework to foster the values and attitudes for sustainable development, and empower its students for a more sustainable world (responses ranged between 6 and 10) and all of them

agreed that VbE could be used even more powerfully for the same goal (responses ranged between 7 and 10). All participants from the VbE community agreed that sustainability could be fostered as an intrinsic value similarly to kindness and respect, and that a framework using VbE for sustainable development would be valuable to the education system (answers for both questions ranged from 7 to 10).

Of the 114 non-VbE practitioners, all participants but one agreed that having sustainability as an intrinsic value would foster the attitudes and behaviours needed for sustainable development, and empower individuals for a more sustainable world, and that our education can be used more powerfully for that goal, with 51.7% and 55.8% participants scoring it as 10 for ‘strongly agree’, respectively. In terms of fostering sustainability explicitly as an intrinsic value through deliberate teaching and modelling, 52.5% of participants strongly agreed, with everyone except two participants scoring higher than 5 (one participant scored 4 and 5 each). In total, 61.7% of respondents strongly agreed that a framework that can foster sustainability as an intrinsic value would be valuable to the education system, with responses for that question ranging from 7 to 10, and one participant scoring 5. This distribution is visually shown in Figure 6.

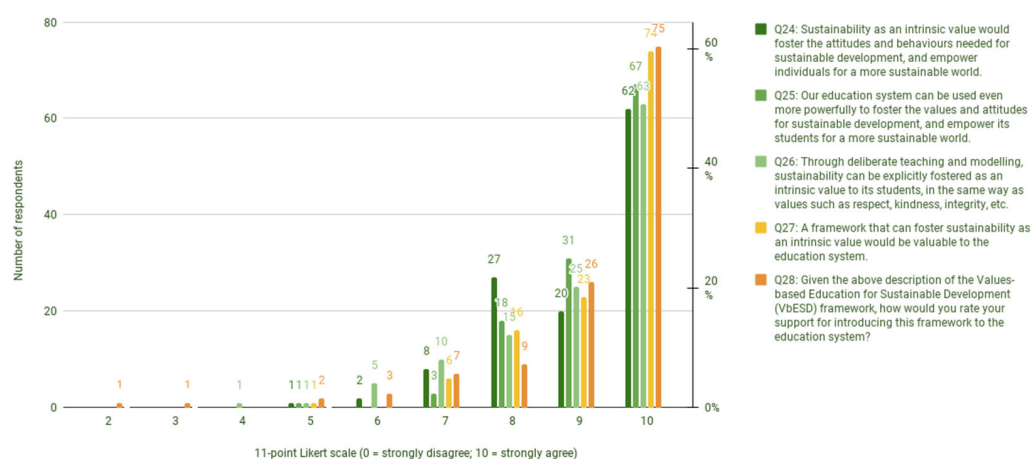


Figure 6. Perspectives of VbE and sustainable development from non-VbE practitioners (results from SEVbESD Section 3B: Questions 24–28).

Additional comments in this section included that non-traditional styles of teaching can be useful too (i.e., games and shows); that older individuals can change as well and that education programs for sustainability should also look at implementation within community centres; that policies are integral to the process and that governments uphold various unsustainable values that need to be fundamentally changed; that sustainable development can be made into its own important subject; that most of what select participants have learned about sustainability was learned outside of their school (friends, family, social media, self-learning); that values need to not only be practiced at school but in the home environment too; that with VbESD children can grow up with values that their parents and home environment may not have or teach; that the ability to make certain sustainability choices come with privilege; that knowledge of sustainability does not necessarily mean change, and that other players such as businesses have a greater influence on standard practices; that extracurricular programming, experiential learning, and outdoor education can be other highly valuable sources of learning for sustainability; and that the economic model needs to be aligned with these values otherwise it might make it frustrating when faced with real-life choices in a bigger model without sustainability as a value.

5.1.4. Section 4: The Call for Values-Based Education for Sustainable Development

Out of 128 responses, 86.7% of participants responded that they have been taught values in a school setting before, most of them in a primary setting and most of them being explicit in mentions of the value as well as the staff leading them by example. In total,

33.3% of participants reported a significant impact on their life from the values education, while 64.9% of them reported 'yes, somewhat' to the impact with a variety of reasons why.

In contrast, 82.0% of participants had received education on climate change before, most of them in a post-secondary school setting (63.8%) with secondary education and extracurricular training/education following, respectively. A 90.7% majority of respondents learned about the effects of climate change, and the solutions, definition, importance, and science behind climate change were all taught to about 70–80% of respondents. The responses on the impact of sustainability education on the participants were almost split equally between significant and somewhat of an impact (50.5% and 46.8%, respectively). Many examples of impacts were given, including changes to daily choices and behaviours as well as pursuing further sustainability-related education or careers.

After reading the statement of VbESD being a framework that can foster sustainability as an intrinsic value, 60.5% of respondents scored their support as 10 out of 10, and 57.2% were willing to adopt the framework within their own teaching if they were a primary school teacher. All responses in these two questions were scored with a 5 or more, with the exception of a '2' on the support due to the respondent living in an area that would not have perceived parent support, and a '3' for unknown reasons. Comments in this section included how children are highly impressionable at this age and being in this environment can be inspirational for their lifetime; how VbESD can combat the passive outlook currently on the environment and the waste we produce; how children are the future; how sustainability might be a value that obtains pushback; that corporations and other powerful financial agents have a bigger impact relatively and that children should be aware of them; that it is harder to influence individuals when they get older; that primary education is key although it would be challenging; that this should also be implemented on a corporate level; that there seems like there is nothing to lose from implementing this framework; that there is insufficient support for teachers to integrate this into their curriculum as their capacity is limited; that parents need to be a part of solidifying actions with the student as well; that sustainability needs to be taught in an integrated way with other topics such that connections can be made in day-to-day environments; and that other ways of introducing sustainability (i.e., children's books, games, stories) can also be used.

5.1.5. Section 5: Support and Barriers to VbESD

This section is also divided into specific questions for educators and non-educators.

Out of the 40 participants who identified themselves as educators, almost half (48.72%) already incorporate sustainability education into their teachings as much as they can. In total, 33.3% incorporate it a little bit, 5% incorporate only what is in the curriculum, and 12.8% do not incorporate it at all.

Bigger-Scale Support and Barriers within Educators

Over half (53.66%; 22 participants) of educators who participated in the survey "extremely support" the introduction of VbESD into the general teaching community (shown in Figure 7). On a bigger scale, the top perceived barriers for the adoption of VbESD within educators are a lack of approval and support from those in power (14 respondents) and a three-way tie between a lack of time to prepare; lack of knowledge around sustainability; and a lack of practice and behaviour modelling for sustainability (11 each). In terms of general barriers, the top three were a lack of readymade resources (28 respondents), lack of knowledge on the topic (27 respondents), and a lack of approval and support from those in power (27 respondents). Comments from this section include that support from superiors would be pivotal; that financial support would be a big barrier as many educators need to find that themselves; that a clearer definition would be helpful, as much of the curriculum in their local education system is up to the teachers' own interpretation and delivery; that current teacher knowledge is lacking in sustainable development and this needs to be established first; and that having readymade materials and resources would be helpful.

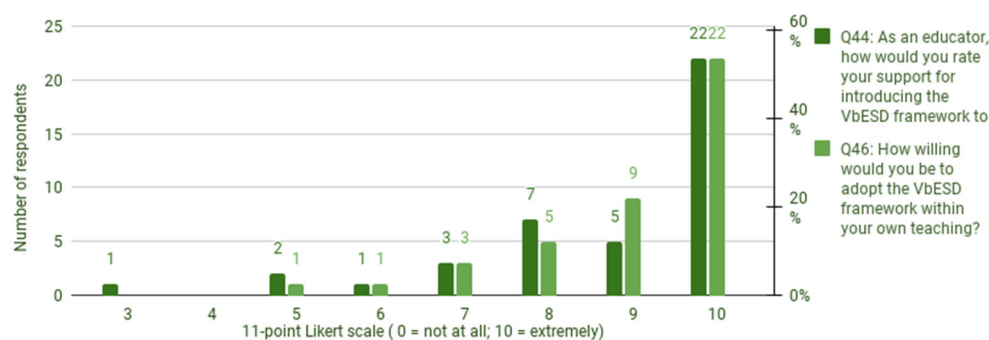


Figure 7. Educators' support for Values-based Education for Sustainable Development (results from SEVbESD Section 5A: Question 44 and 46).

Comments relating to how these barriers can be overcome include paid training and teacher education; fostering emotional proximity to those not directly affected by the matter; providing teachers with resources; support from the school board and those in charge; acknowledgement that educators do not need to live a perfectly sustainable life to teach its importance; consulting teachers who have had success with the practice to leverage their teaching styles and techniques; and integrating community-based decisions into pedagogy (i.e., asking students how they feel about it). The most common theme observed in this section is educator training, knowledge, awareness, and understanding.

Individual-scale support and barriers within educators

Individually, over half (53.7%) of educators were willing to adopt the VbESD framework into their own teaching, with all respondents scoring their willingness at a 5 or more (Figure 7). The biggest 'top-three barriers' on an individual scale for educators were the lack of approval/support from those in power (11 respondents), lack of financial resources (10 respondents), and lack of space in the curriculum (9 respondents). Overall, the barriers with the most selections were the lack of readymade resources (24 respondents), lack of approval/support from those in power (23 respondents), and a tie with 19 respondents each for the lack of financial resources and lack of space in the curriculum.

Comments from this section included that support from higher-ups and management would make a big difference, and it would provide motivation even if there was no inherent interest; that the teacher first needs to understand the importance of sustainable development in order to communicate that to their students; that outdoor time is vital to developing care in students; that external resources (i.e., speakers, field trips, videos) would be helpful for both the teacher and students' learning and participation; that training on effective ways to teach sustainability would be beneficial as for funding; that teaching environmental education is not mandatory and often relies on educators' own interests; that the whole structure of what it means to teach needs to shift; and that teachers' own knowledge needs to be grounded in order to teach it.

Comments relating to possible solutions to the presented barriers include the following: incorporating sustainability and values within the curriculum already; administrative support; having well-thought-out resources; training programs and funding for existing organizations who do this work; collecting data and evidence to show its success; having an educator-based conference or workshop at the beginning of each year to introduce this framework; and having a mandate or enforcement to align with VbESD.

Support and barriers within non-educators

Outside the educator community, the top five barriers to adopting a framework for sustainability education are as follows: lack of financial resources and support (72% respondents); lack of internet interest and intrinsic motivation (65.9%); lack of approval/support from those in power (64.6%); and a lack of space in the curriculum (62.2%). There is an interesting cap between the lack of approval/support from those in power and that from the community, with the latter only chosen by 41.5% respondents. Comments elaborat-

ing on barriers included resistance to change the current pedagogy; lack of political and community approval and funding especially in towns that are more reliant on extractive resources; educators who may be stubborn and unwilling to change; that sustainability as a value may be harder to visualize tangibly in its results, as they are not always directly visible; that there is a common view currently of academic subjects being separate from individuals' intrinsic values and practices; that the reality is that not everyone will be motivated; that classes not tied to grades and marks may be dismissed as unimportant and a waste of time; that schools with limited financial resources may not be able to deliver quality programming if it is different from classical programming; that politics play a big role in the shaping of curricula; and that educators have historically had a lack of support when implementing changes and it is an unfair burden for them. Common themes within these barriers are that political influence is important to curriculum or education system change, that support from those in power is necessary, and that change in general will see resistance and pushback.

In terms of solutions to overcome these barriers, comments included the following: more support from governments and higher-ups; increasing the budget for related educational programs; having resources and readymade lesson plans for teachers not already knowledgeable on sustainability; integrating it into existing courses if new ones cannot be made; having student voices heard and incorporated into advocating for the framework; teacher training; having an economic benefit as an incentive; having consistency in the framework's language and implementation; bringing these issues to media to influence politicians and public opinions; top-down policy-driven change; creating extracurricular opportunities for engagement; presenting solutions to higher-ups instead of issues; organizing voluntary internal committees within schools where teachers discuss how to incorporate sustainability or VbESD into their curriculum; consultation with relevant stakeholders but also the frontlines of the teaching; and having more scientific evidence. Major themes within these are the importance of political support, educator training, and provision of readymade resources and clear steps for curriculum integration.

5.1.6. Section 6: Important Aspects to VbESD

Participants were asked to rate 18 different elements on their importance to the VbESD framework (Figure 8). Out of 128 respondents, the elements that over half of them selected as 'extremely important' (those with over 64 respondents) are as follows: support and commitment from higher-ups (81 respondents); a well-structured framework with clear steps (70 respondents); collaborative and transdisciplinarity to infuse sustainability into all divisions of the school (68 respondents); a clear definition of sustainability (67 respondents); focusing on the solutions to climate change and unsustainable behaviour (66 respondents); education on the science of climate change (65 respondents); experiential learning (65 respondents); and clear learning objectives and measurable competencies (65 respondents).

Other elements brought up by respondents included involving external stakeholders and the community; influencing politicians and government action; encouraging extracurricular clubs to focus on sustainable development and possibly earning credits with such participation; having an international focus; empowering teacher-led initiatives; obtaining parental support; showcasing practices from other cultures on how to take care of the land; including dietary education and alternative medicines; and balancing the issue of educationalization.

In total, 96% of participants responded that if they had the option to, they would have liked their primary education to have implemented a VbESD framework, with 4% responding "I'm indifferent". Out of the different education levels, primary education was overall deemed the most important to implement a VbESD framework in (44 respondents (36.1%) scored it as such) followed by middle education, where 25 (21.2%) respondents scored it with a 1 (most important) and 31 (26.3%) scored it 2 out of 5. This ranking distribution is visually depicted in Figure 9.

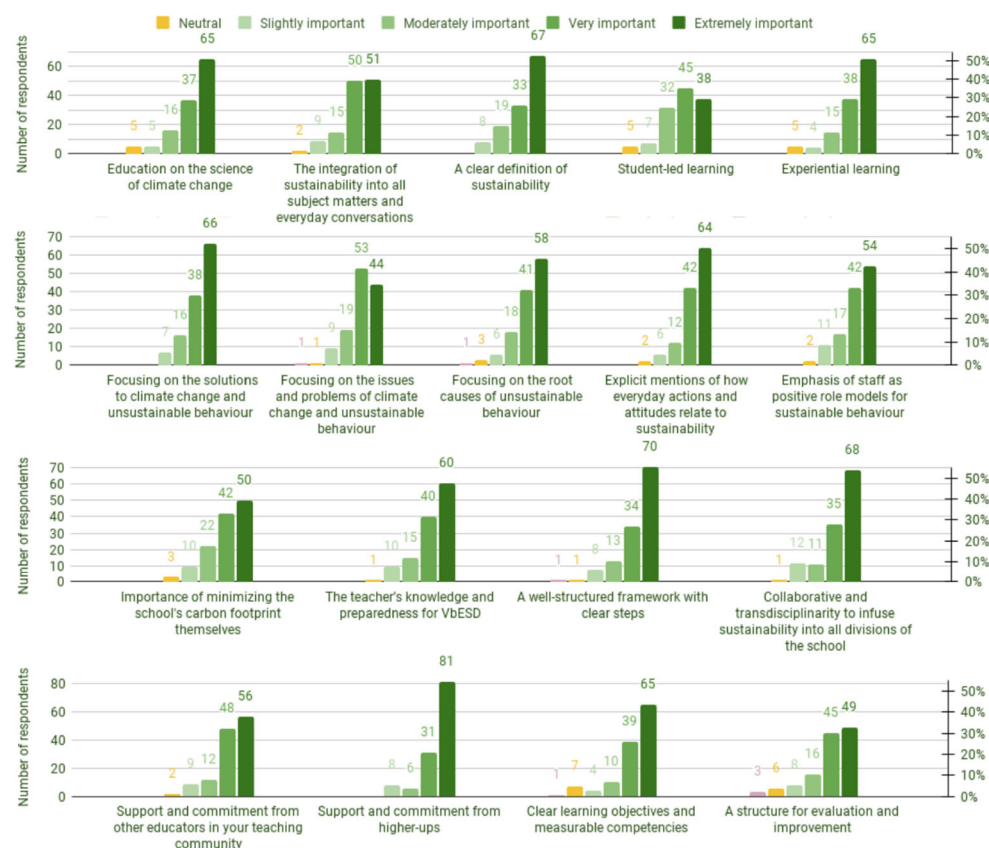


Figure 8. Important aspects for the VbESD framework (results from SEVbESD Section 6: Question 48, items i–xviii).

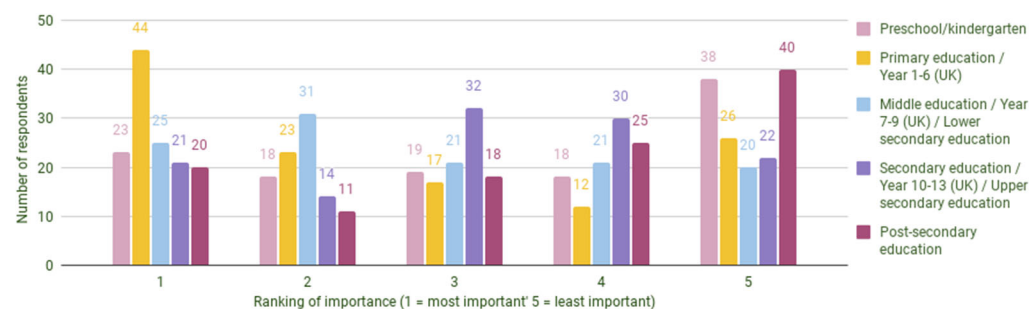


Figure 9. Rankings of importance for the implementation of VbESD into different education levels (results from SEVbESD Section 6: Question 52).

5.2. Results from the SIVbESD

The results from the Survey to Implement Values-based Education for Sustainable Development consisted of data collected from 29 individuals, obtaining results which at a confidence level of 95% would have a margin of error of 18%. In total, 19 participants (65.5%) were non-educators and 10 (34.5%) were educators. All 29 respondents had completed the SEVbESD prior to filling out the SIVbESD.

5.2.1. Feedback from the VbESD Introductory Presentation

Out of approximately 35 attendees to the VbESD presentation, a total of 6 formal responses were gathered about the presentation on the SIVbESD. All scores ranged between 8 and 10 in terms of the participants' understanding of VbESD after the presentation, the increase in learning about the framework from the presentation compared to them reading it through on their own, and how interesting and engaging the presentation is. Most participants would be interested in both synchronous and non-synchronous

e-learning modalities for further and more specific VbESD training, with a majority for non-synchronous. A total of 66.7% of participants would be interested in the design and implementation of a serious game relating to VbESD or sustainability [67].

5.2.2. Educators' Perceptions and Responses

After having understood the VbESD framework, all educators rated 5 or more in the 11-point Likert scale in terms of their support, the importance, and urgency of implementing the VbESD framework (see Figure 10). Compared to non-educators (Figure 11), educators seemed to rank the same metrics lower on average. Comments from educators aside from their support included that while urgent, it is important to also take the time to solidify details before implementing it, and that it may be a slow process to implement, however valuable. In terms of the feasibility of VbESD, scores for global implementation ranged from 4 to 9 with the mode being 7; scores for country-level implementation ranged from 5 to 10 with the mode being 6; local scale scores ranged from 3 to 10 with the mode being 9; and scores for VbESD feasibility into their own school ranged from 4 to 10, with 6, 7, 8, and 9 scores all selected by two educators. The common theme within comments was that global feasibility is much more uncertain and challenging due to different policies, societal values, contexts, and government, but that smaller (i.e., developed countries, regional areas, school boards) scales can lead and inspire change on bigger levels.

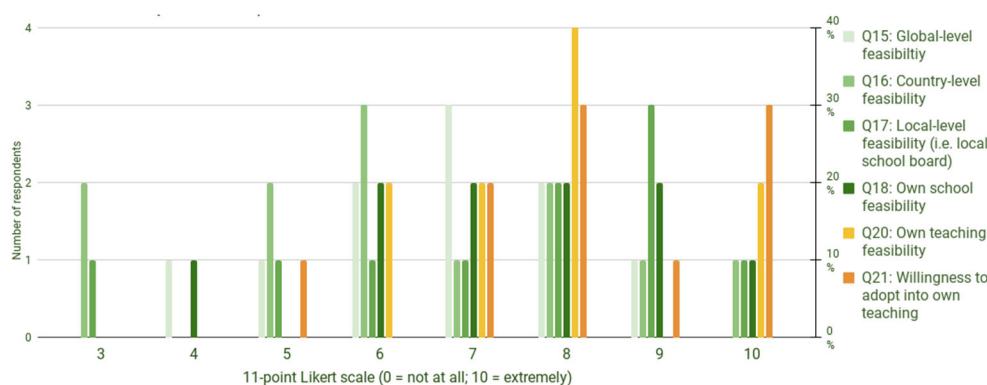


Figure 10. Educators' perspectives of VbESD's feasibility and willingness to adopt the framework after having seen the working model (results from SIVbESD Section 3A: Questions 15–18, 20–21).

Scores ranged from 6 to 10 with 8 being the mode for educators' rating of the feasibility of VbESD into their own teaching, and from 5 to 10 (modes of 8 and 10) for their willingness to adopt the framework within their own teaching (Figure 10). Comments included that the model was clear and easy to follow; that it was inspiring; that a top-down mandate may be more encouraging; and that primary level would be ideal so that they can build the values and have them developed when they are at post-secondary level, as opposed to only developing them then. Educators scored the effectiveness of VbESD to empower their students for ESD goals ranging from 7 to 10 (mode = 9) and the difference the framework will make ranging from 6 to 9 (mode = 8). The common theme in comments related to VbESD's impact is that a small-scale level (i.e., single class) may not have as much impact but that if implemented across subjects and at a whole-school level or even multiple classes throughout multiple years, it would undoubtedly impact its students. Other comments included that VbESD balances the possibility of overwhelming students with the global climate crisis and their role within it through a positive and local-hero viewpoint, as well as the interest in future research on the minimum amount of implementation to see a difference. A total of 90% of educators responded that they would have liked their primary education setting to have implemented a VbESD framework, with the 10% (1 respondent) responding "I'm indifferent" with the reasoning that they had other, extracurricular settings instil the values for them. If their primary schools had implemented a VbESD framework, scores for the difference it would have made to their lives ranged from 3 to 10 (mode = 9),

with comments of how it would have built knowledge and habits, been empowering, and inspired community engagement and contribution.

Support and barriers: On a bigger scale, the top ‘top-three’ barriers were the lack of interest from students (5 respondents) and lack of financial resources (4 respondents). Overall, the barriers that were selected by 8 of the 10 educators were the lack of compensation for the work, lack of training, lack of knowledge on the topic, lack of financial resources, and a lack of clarity and consistency on what ‘sustainability education’ is. Solutions provided included evidence, financial support, clear framework, policy mandates, change in education philosophy, and teacher patience, persistence, and passion. Individually, there were six ‘top-three’ barriers that were selected by 3 of the 10 teachers: lack of time to prepare, lack of space in the curriculum, lack of compensation for the work, lack of readymade resources, lack of enforcement or management system, and lack of approval/support from those in power. Interestingly, lack of interest from students received no votes as the ‘top-three’. Overall, teachers on an individual scale perceived a lack of readymade resources (8 respondents) as the biggest barrier, followed by a tie between a lack of time to prepare and a lack of approval/support from those in power (6 respondents each). Possible solutions offered included higher-up support, further simplification, practice, financial incentives, mandates, and bottom-up change alongside empowerment.

5.2.3. Non-Educators’ Perceptions and Responses

Out of 19 non-educator participants, the scores for their support to incorporate VbESD into the education system ranged from 7 to 10 (mode = 10). Bigger-scale feasibility scores ranged from 4 to 10 (mode = 8) and local-scale feasibility scores ranged from 4 to 10 as well, but with a mode of 7 and 8 and a higher mean. Comments stated various challenges, such as the amount of time it might take, political resistance, funding, and limited resources. Scores for VbESD’s effectiveness to empower ESD goals ranged between 5 and 10 (mode = 8), and between 5 and 10 (mode = 8) for its difference-making impact. Comments included that it could have significant impact; that family pressure and beliefs may be a hindrance; that it can inspire adults; and that the teacher’s ability and pedagogy makes a big impact. All 19 non-educators responded “yes” to having had VbESD if they could go back in time, although one comment stated that their elementary school had some of the elements already. The perceived difference it would make to the participants themselves if they had VbESD at their own primary school had scores between 5 and 10 (mode = 8) and comments supported the impact while also noting the impact of other factors that led to the participants’ sustainability values and behaviours today, as well as to consider the potential that some students may not internalize and integrate the learnings into their real life. All non-educators (see Figure 10) scored VbESD’s importance as 6 or more (mode = 10), its urgency as 7 or more (mode = 10), and their willingness to adopt the framework as a primary teacher as 5 or more (mode = 10). Figure 11 illustrates these results alongside responses of educators.

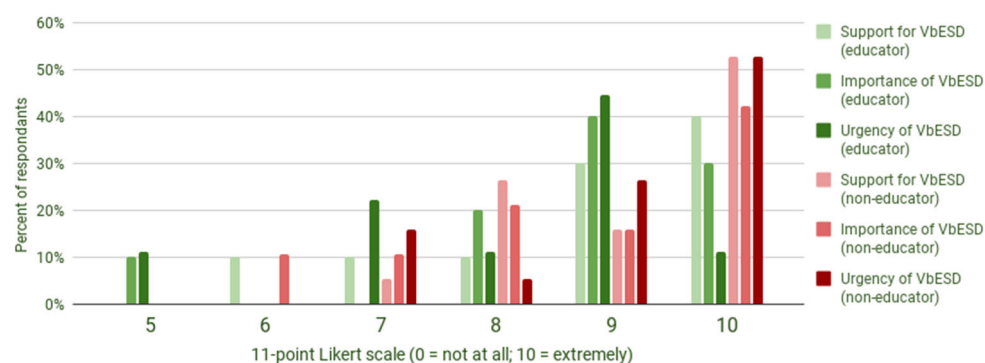


Figure 11. Perceived support, importance, and urgency of VbESD amongst educators and non-educators (results from SIVbESD Section 3A: Questions 11–14; Section 3B: Questions 11, 21, 22).

5.2.4. Perceptions of the VbESD Framework

Out of the 29 respondents, all of them believe that VbESD can foster the values and attitudes needed for sustainable development and empower individuals for a more sustainable world (all scores were 6 or higher, with the mode being 10), that sustainability can be fostered as an intrinsic value with VbESD, and that the VbESD framework would be valuable to the education system (scores ranged from 5 to 10; mode = 10 for the latter two). Comments supported that theoretical values-teaching is insufficient and there needs to be concrete actions as well.

5.2.5. Important Aspects to VbESD

Out of the eight pillars, the top pillars ranked for ‘extremely important’ to the VbESD framework are the leadership pillar (15 respondents), ethical vocabulary pillar (13 respondents), and a tie at 12 respondents for both the modelling and sustainable school operations pillar. The top pillars ranked for ‘extremely impactful’ for imbedding sustainability as an intrinsic value are the modelling pillar (14 respondents), a tie between the atmosphere and ethos and leadership pillars for second place (11 respondents each), and another tie between the reflection and ethical vocabulary pillars (10 respondents each). Across the pillars, at least 8 and 7 respondents thought each pillar was ‘extremely important’ or ‘extremely impactful’, respectively. In terms of level of education for VbESD implementation, 69% (20 respondents) ranked primary school to be the most important, followed by middle education (7 respondents), and preschool/kindergarten (6 respondents). Post-secondary education was ranked the least important, with 17 respondents rating it the least important compared to the other levels. The rated importance and impact of the VbESD pillars are displayed in comparison in Figure 12.

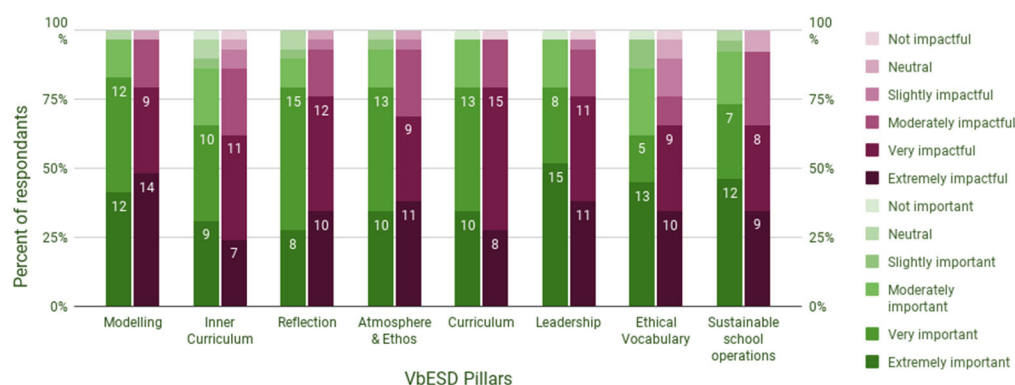


Figure 12. Perceived importance and impact of VbESD pillars (results from SIVbESD Section 5: Question 39–40).

6. Discussion of Insights, Limitations and Next Steps

6.1. Insight from the SEVbESD and SIVbESD Results

The SEVbESD and SIVbESD results provide a strong justification of the need for the VbESD framework, as well as preliminary support for its development. Undeniably, a strong interest in and support for developing and implementing the VbESD framework is observed, rooted in existing values of sustainability and recognition of its importance. All of the sampled population are at least neutral to or value sustainability, and believe that it is important as an intrinsic value as well as important to incorporate into the education system, both globally and locally. Most of the surveyed population believe that the best way to incorporate sustainability into the education system is through a holistic, comprehensive approach where sustainability is integrated into the school and curriculum as the foundation, and all/any topics and assignments possible, including school operations, extra/co-curricular activities, and staff behaviour. Most of the respondents had values education in primary school, with their teachers using language containing values as well as leading them by example. However, the impact for most of the surveyed population could

have been more significant, outlining a valuable opportunity for the VbESD to implement more impactful and powerful values education. In comparison, most respondents had education related to climate change or sustainability in their post-secondary education. Most reported that the sustainability education they received was impactful, although the level of impact was split equally between significant and limited. All participants regardless of age group and demographics were either neutral or in favour of implementing the VbESD framework. A summary of the key findings are presented in Figure 13.

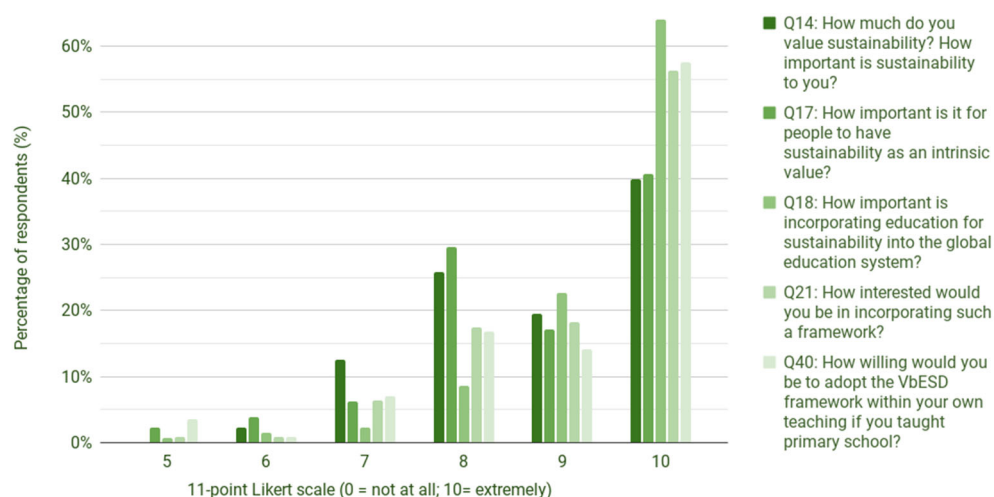


Figure 13. Select results from the survey to establish VbESD demonstrating its key findings.

Within the VbE community: Although there was very limited feedback obtained from the actual VbE community and individuals involved with the VbE movement, a preliminary scope was still able to be obtained from the surveys. All respondents from the VbE community believed that VbESD could be successful and valuable, although there is a critical lens regarding the feasibility of the framework at this early stage of VbESD's development. There are three differing views that have been observed through both conversations with the VbE community and their feedback from the surveys. The first is that VbE can be successfully applied to VbESD as their core models are very similar and sustainability is a value that can be fostered intrinsically using the VbE methodology. A second view is similar to the first, with the difference that VbESD may not be necessary as a full distinction to VbE, seeing that various VbE educators already implement sustainability education within their own teaching and VbE itself is sufficient to drive ESD. A third view is that VbESD could be highly valuable but there would need to be major considerations for the local stakeholders, not only the education system but also other institutions and corporations whose support will be needed. This view is supportive of VbESD but requires concrete and actionable steps on how it can manifest. Altogether, there is a general support for VbESD within the VbE community but more tangible methodology will need to be provided to better assess the feasibility of the framework in specific cases.

Outside the VbE community: The survey responses very clearly demonstrated that teaching about sustainability does impact learners and influence their values, behaviours, attitudes, and interests later in life. Therefore, a clear and powerful demand for a framework such as VbESD exists. After having seen the framework, this support and interest remained. Looking at the perception of feasibility of VbESD outside the VbE community, there is a visible trend of increasing feasibility perceived at increasingly local levels, especially amongst educators. Many educator respondents shared that globally, feasibility will be much more challenging with different curricula, education systems, knowledge, local contexts, impacts of climate change, and more, but that locally schools can lead by example and have the VbESD influence work its way up. Within an individual level, there are various willing participants to incorporate this model in their teaching, although there is also a common theme of educators believing that this work is more impactful at a

primary school level, and that for educators at higher levels, not as much impact can be delivered unless the students already have these values in place beforehand. Amongst non-educators, there are common views of bureaucratic and political barriers that may decrease its feasibility. Alongside worries to such barriers, however, exists clear overarching support and interest for VbESD's development.

Common themes within the survey results included the recognition that educational settings with more developed affective and sustainability education are needed and valuable; that educator support, knowledge, and training are the ultimate enablers of VbESD's implementation; that ready-made resources are crucial; that VbESD implementation must be integrative; that a lack of financial and social support from authority bureaucratic processes and conservative attitudes may be key barriers; and that if well-implemented, VbESD has significant potential to inspire, empower, and transform future generations and lead sustainable development.

6.2. Limitations of the Current Research

One significant limitation of this research is the lack of involvement and consultation from the VbE community. While there was overarching guidance and support from the IVET Foundation, the research timeline and planning did not allow sufficient time for deep, quality, and adequate representation, consultation, and involvement from VbE educators, affiliates, and advisors, who were originally a significant part of the research and development phase of the framework. Without a comprehensive consultation process with one of the main stakeholders and audiences of VbESD, the proposed framework can only be a preliminary working model at best. Next steps engaging the VbE community will be described in more detail in Section 6.3.

Related to the lack of VbE representation is also the limited perspective from experts in sustainability education, such as EE/EfS/ESD/etc., educators; curriculum designers; school management staff; and other individuals already within the sustainability education space and ecosystem. While the results are still valuable in understanding the unrivalled demand and support for VbESD on a public level, having their representation—especially in the SIVbESD—would significantly increase the validity of the framework to be applicable in real-world education settings.

Another limitation is the low number of participants of the SEVbESD and SIVbESD in general. Because the target population of the survey was the general public (with special interest in educators and members of the VbE community), the sample size needed for a 95% confidence level and 10% margin of error would be 97 participants. With 129 and 29 participants in the SEVbESD and SIVbESD, respectively, this target was satisfied with the SEVbESD. However, the margin of error almost doubles to 18% for the SIVbESD, calling for the need of follow-on research. Nonetheless, even with this increased margin of error, the key findings of the research hold strong and there is still a very valuable opportunity for the development and implementation of VbESD in the education system at all levels.

At the same time, there was a lack of diversity within the sample population, as their sources were mainly from personal connections, second-level connections, or individuals with a shared interest or experience (i.e., member of a shared Facebook group, connection from a shared event). While this does not pose a deep threat and limitation to the data, there is a possibility of sampling bias. In addition, it limits the statistical analyses (i.e., comparisons) that could be possible with larger sample sizes within each subpopulation. Next steps in expanding the surveyed population will be described in more detail as well in the next section.

6.3. Next Steps for the Development of VbESD

There are a variety of next steps for the development of VbESD; this article only presents the preliminary work that has been carried out, such as setting a groundwork for the framework and establishing baseline support from the community. The framework is

still in its early stage and a working model where theory will be shaped into actionable items and more tangible applications.

Further consultation with relevant stakeholders: Seeing that the VbESD framework has had limited consultation within the Values-based Education community (i.e., VbE advisors, affiliates, educators, and students), quality consultation with the VbE community presents a significant opportunity and next step for the further development of VbESD. The VbE community is a primary target audience for VbESD, mainly because VbE schools are already almost fully there and already have the mindset and training to best incorporate VbESD. In addition to consulting with the VbE community, the greater education community and other educators need to be consulted in order to understand how to structure the VbESD framework to address their barriers faced and how to best integrate it with existing non-VbE curricula. Experts in sustainability education and related curriculum design are another audience highly valuable to validate the VbESD model. Other stakeholders that are important for VbESD to consult include policy-makers, politicians, parents, climate activists, curriculum designers, and students. Additionally, 51% of respondents to the SEVbESD stated that they would be interested and willing to participate in a more in-depth conversation regarding VbESD's development. Each audience would provide valuable insight on how to design the VbESD framework to maximize its effectiveness and momentum. Engaging in conversations with these key audiences not only helps the VbESD framework's development, but it also simultaneously furthers its reach, engagement, visibility, and support such that the conversation can be brought to more and more audiences.

Further analysis of survey results and secondary objectives: The scope of this research did not provide the necessary time and resources to fully dive into the full potential of the survey results' analysis. A more in-depth analysis of both the SEVbESD and SIVbESD (i.e., secondary and additional questions/objectives) is possible and a significant next step for the development of VbESD, as it will provide deeper insight and understanding of its needs, barriers, and supports. Results from the SEVbESD can be used to identify and explore any correlations between a participant's previous experiences and their willingness or interest in VbESD. More specifically, possible trends between their demographic, whether or not they experienced VbE as a student, whether or not they practice VbE, whether or not they value sustainability, and how much knowledge and/or education around sustainability they possess can be explored. Another observation of interest would be identifying the most common perceived barriers to implementing VbESD, whether there is a difference in perception between implementing it on a general level and an educator-specific level, and where discrepancies lie. Examples of secondary questions of the SEVbESD include the following:

- Do various age groups, countries, or past or current educational experience with either values or sustainability result in greater or lesser support and/or interest for VbESD on the different levels?
- Is there a difference between educators and non-educators in their support for VbESD and perception of barriers on different levels? For example, what are the differences in perceived barriers between educators and non-educators? Between VbE practitioners and non-VbE practitioners? Between individuals with different levels of sustainability? Between individuals with different previous experiences or demographics?
- Is there a difference between educators and non-educators in their selection of important elements to include within the framework? If so, what are the differences?
- Are certain elements of values and sustainability education correlated with increased impact, and if so, which ones?
- Are individuals who have had more impactful values or sustainability education more likely to be supportive of VbESD?
- Do individuals usually choose the critical window of education as the same one they received values or sustainability education within, and is the impact they experienced another factor as well?

Development of the curriculum and learning objectives/competences: Seeing as VbESD's greater goal and picture is Education for Sustainable Development, its learning objectives for the VbESD curriculum will be based off of the "Learning for the Future: Competences in Education for Sustainable Development" as outlined by the UNECE [3] as well as the "Education for Sustainable Development Goals Learning Objectives" by UNESCO [2]. Both documents will be consulted and are equally important, because as the former document states, "the competences in ESD described in this document are those of educators and not of learners, although both are intricately related" [3]. The competences provide a very clear picture of what learners would experience if their educators possessed them, especially if supplemented with the learning objectives highlighted in the latter document. The UNECE recommends that the competences should be a basis for the review of curriculum documents and that approaches to educational practice should be supported by such curricula. These approaches are highly aligned with the development of a VbESD curriculum, and there is no doubt that a curriculum with both VbE and ESD influences would be powerful and transformational. A major next step for VbESD's development is to create such a 'Curriculum Guideline', such that VbESD can be easily integrated into any existing curriculum.

Educator training and professional development: In order to incorporate VbESD into a school, it needs the commitment and participation of everyone in the school, meaning that educator training is crucial for their success. The VbESD framework therefore needs to be supported by a high-quality training program for any interested schools. After developing the framework, the next step would be to develop the training program for interested schools, and how to adequately prepare a school and its staff to implement VbESD. Values-based Education already offers various types of training and consulting to support schools interested in implementing their approach, and collaborating with their organization would be highly valuable and a next step for the development of VbESD's educator development training programs. This element was identified throughout the survey as a key component to the success of VbESD, and it is imperative that the training is comprehensively and intentionally developed.

Ensuring the delivery of sustainable education, not simply sustainability education: There is increasing dialogue about the concept of sustainable education—knowledge delivery that ensures balanced economic and social development and fulfils the needs of future generations [6,7,68]. Through this lens, aspects of education that may not have been considered as related to sustainable development may emerge, such as equitable opportunity to access to the education in the first place. The development process of the VbESD framework therefore needs to examine any privileges that play a role in who is able to access such education. For example, socioeconomic statuses and financial barriers may play a role in elitism within education, and in that case—how can VbESD remain equitable and "leave no one behind", as the overarching principle of the SDGs? Having these considerations throughout VbESD's development stages will ensure that potential barriers are actively identified and mitigated.

Developing VbESD e-learning modalities: With e-learning modalities being more and more commonplace since the global COVID-19 pandemic, it would be valuable for VbESD to develop training within e-learning modalities. New forms of digital learning and modalities may motivate students further, such as using augmented reality technologies to stimulate virtuous behaviours through gaming dynamics [69,70]. As per the SIVbESD results, both synchronous and asynchronous modalities were of interest, and thus, asynchronous e-learning modalities for above-mentioned staff training will be explored further. A plan to integrate e-learning with in-person training will be created to maximize efficiency and effectiveness of the blended learning and training format.

Pilot programs: After the full development of the VbESD framework, training programs, resources, and action plan, interested schools can then adopt VbESD as pilot programs to evaluate its success, effectiveness, and areas for improvement. These pilot programs will be essential to determine the real-life application of VbESD and how its implementation can

be structured so that any school can implement it with as few barriers as possible. Seeing the closest communities of VbESD's audience are VbE schools and local Canadian schools, pilot programs will likely take part in both communities and combined feedback used to drive the final stages of VbESD's development.

Further research on the framework's effectiveness: Through the VbESD pilot programs and subsequent implementation, research to determine the framework's effectiveness and real-world added value will be instrumental in assessing the success of the framework as well as ensuring its continued improvement. Future research will include qualitative and quantitative investigations exploring whether ESD-related competencies and learning outcomes have been achieved, evaluations on the schools' sustainable practices, assessments of students' emotional and ethical intelligence, resilience, sustainability mindset, and leadership, innovation skills, and other indicators of ESD and sustainability as an intrinsic value within the school's students, staff, and collective culture.

7. Conclusions

In conclusion, there exists the groundwork and community-level support, interest, and motivation to build a comprehensive, feasible, and evidence-based framework to integrate an intrinsic value of sustainability into educational environments using a Values-based Education approach to Education for Sustainable Development. This article demonstrates this exact groundwork by providing the context, theory, concept, community-gathered data, and an explanation of fundamental pillars for such a framework titled Values-based Education for Sustainable Development (VbESD).

Through a literature review, it has been established that while sustainability education is a recognized necessity for sustainable development, its real-life implementation has had limited success. Various methods have been tried yet few quality, long-term successes have been documented. Values-based Education is an approach that has, on the other hand, been developed and successfully implemented in over a hundred schools.

This article successfully demonstrates the fundamental support and feasibility for the development of a framework for Values-based Education for Sustainable Development, as well as a preliminary working model of the VbESD framework using the principles, pillars, and model within Values-based Education for the outcomes of Education for Sustainable Development. Various next steps are also identified for further research and development of VbESD. Indeed, the development and implementation of a framework such as VbESD will take considerable consultation, intentionality, ambition, and active commitment, but as much as it is challenging, its manifestation will be rewarding, powerful, and transformative.

Education is the mechanism through which individuals and communities not only learn but unlearn values, attitudes, skills, and knowledge; adapt to and adopt new mindsets; reflect on and reflect from behaviours and actions; challenge existing norms and create new ones; inspire and empower others with their newfound insights; and catalyse innovation and social change. Education is the keystone conduit for all other SDGs, and it is only with quality education that the global society can thrive. Education needs to traverse the formal, informal, and non-formal; the cognitive, psychomotor, and affective; the hard skills and soft skills. But at the core of all thinking and behaviour lies values, which shape individuals' interactions with the world. When an individual possesses and lives a set of holistic, positive values, they will inherently also gain the skills and leadership to build a more sustainable community and world.

Values-based Education for Sustainable Development is an educational approach that combines the roots of what is needed—the development of positive values, quality education, and sustainable development—and delivers them to children's educational environments. With the proper development and implementation, VbESD can be the key to a world of “peace and prosperity for people and the planet” that the Agenda 2030 strives for [71].

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su16093562/s1>. References [72–76] are cited in Supplementary Materials.

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Article

Factors Influencing Technology Adoption in Online Learning among Private University Students in Bangladesh Post COVID-19 Pandemic

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Abstract: Technology acceptance in higher education, especially during and after the crisis of COVID-19, is very important in the current environment, especially in online learning adoption. This study aimed to determine the impact of performance expectancy, effort expectancy, social influence, and facilitating conditions on the adoption of the online line among university students in Dhaka in the post-pandemic period. In addition, the moderating role of voluntariness was also ascertained. In this quantitative study, primary data were collected using a survey method. The target population was students of private universities located in Dhaka, Bangladesh. There was a total of 130 respondents, and non-probability sampling was found to be more appropriate. Data were analyzed using the Smart-PLS system. The results revealed that effort expectancy was the most important predictor of intention to adopt online learning. The next significant predictor was facilitating conditions. However, it was found that performance expectancy and social influence were not significant predictors of intention to adopt online learning. Additionally, it was found that voluntariness was not a mediator. In terms of practical implications, educators and designers should focus on effort expectancy and facilitating conditions to increase online learning adoption.

Keywords: UTAUT; voluntariness; effort expectancy; intention to adopt; effort expectancy; social influence; facilitating conditions



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1. Introduction

The effect of the pandemic has taken the world by storm and affected our way of life, including the educational sector, since 2020. Mankind is possibly passing through the most difficult time since COVID-19 hit [1,2]. The COVID-19 outbreak has been declared a pandemic by the World Health Organization (WHO) [3]. Since this virus' effects are bad, infectious movement was controlled and completely restricted. Hence, COVID-19 affected human life and the education sector. This has become a global crisis and has caused turmoil in the social, political, cultural, and economic aspects of life [3]. Countries were forced to comply with strict measures such as a complete lockdown or partial lockdown. Face-to-face teaching and physical interaction were stopped. New circumstances forced educational institutions to stop face-to-face learning and introduce online or distance learning. The traditional concept of education changed dramatically, and many questions were raised regarding the introduction of the internet and technology [4,5]. While the outbreak of this pandemic has created much interest in e-learning, the selection of the right tool and adoption of technologies face many challenges [6].

Following the global trend and trying to break the COVID-19 chain, the government of Bangladesh took the initiative. Schools, colleges, and universities were declared closed, and introduced online classes, using online platforms such as Zoom, Google Meet or Microsoft Teams, among others [7]. The same trend has been observed worldwide, e.g., United States,

Canada, Washington, Australia, Germany, India, China, Japan, and many more [4,8–10]. In addition to flexibility, online education cost is lower compared to that of the traditional mode of education [11]. However, the technological foundation to provide online and digital education for Asian countries, particularly Bangladesh, was much different from that in the Western countries [12,13]. Though Asian countries place importance on online education using Android/iOS phones, these countries have some resource constraints. Amid growing concern and to ensure public health, the ministry of higher education and university grant commission (UGC) allowed public and private education universities to run online classes [2,14]. In addition, technology in higher education would develop a sustainable mechanism [15]. Studies [16,17] also show that online education is an exclusive mode of delivery and without examining the factors influencing the adoption of technology, it is a threat to the sustainable production of higher education in an emerging country such as Bangladesh. The outbreak of COVID-19 caused greater dependence on technological education; therefore, meaningful measures should be implemented to adopt technological education [17]. Where online education has become a necessity rather than a means to continue education [18], finding the factors influencing the adoption of online learning would certainly add sustainability in the post-pandemic era in Bangladesh.

2. Literature Review

Studies [7,19] have reported that 40% of students are attending online classes, while almost 50% of students cannot attend online classes due to a lack of device availability. While at a global scale, online learning allows students and academic institutions to enhance accessibility, interoperability, and flexibility of learning behaviors suitable to time and place [5,20,21], students in Bangladesh are way behind and gaps in economic conditions are wider [22]. The rapid advancement in information technology in education has increased the flexibility and functionality of higher learning [23,24]. However, under the post-pandemic situation, students, particularly private university students, were facing difficulties in adopting technology to receive an education. Most failed to embrace technology in education, while only a few provided online learning management systems. Scarcity of the resources of the teachers and students also affects the adoption of online education [25,26].

Online learning enriches the classroom experience [27–29] by identifying the factors influencing students in their online learning, which certainly add new experiences. Studies [29–32] show that unified theory of acceptance and use technology (UTAUT) is an effective tool to determine the factors influencing to adopt the technology. This valuable tool provides the university decision-makers with a better understanding, and the faculty members system designers with an understanding of the factors influencing the adoption of technology in higher education by the students [28,33].

There are 161 universities in Bangladesh, 108 universities of which are private, 50 are public universities, and 3 are international universities [34]. Private universities in Bangladesh play a pivotal role in the catering needs of higher education in Bangladesh. Studies report that some of the private universities in Bangladesh provide a good standard of quality education and an excellent teaching atmosphere [35]. Moreover, out of 108 private universities, more than 50 are located in Dhaka. Just as public universities did, private universities started to provide online education during the pandemic. Undoubtedly, online education is the most globally beneficial step during this pandemic. Online education allows students to participate outside the physical classrooms without any restrictions [36–38]. Unfortunately, students experienced many obstacles when they started online learning. Some of them have limited access to the resources, while others were not familiarized with online platforms. Several studies [18,36,39] indicated that students' intention to use online education is influenced by factors such as performance expectancy, effort expectancy, social influence, facilitating conditions and voluntariness.

This study aims to investigate the factors influencing technology adoption among private university students in Bangladesh using the theory of acceptance and use of tech-

nology (UTAUT) [40,41]. To study the student's intention to adopt technology, UTAUT emerges as one of the most widely accepted and applied models [42]. This particularly focuses on constructs such as as performance expectancy, effort expectancy, social influence, and facilitating conditions, which explains the intention to use information technology. All research hypotheses are indicated in Figure 1.

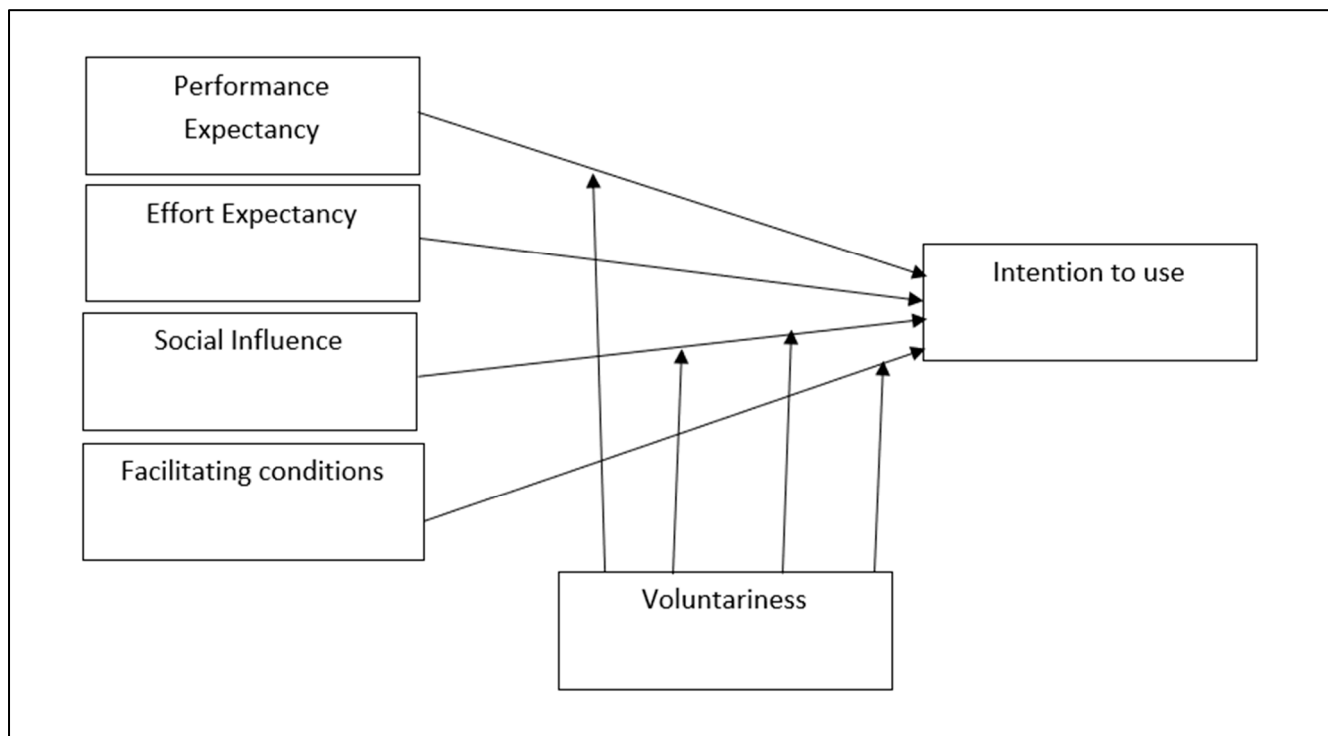


Figure 1. The research framework.

Performance expectancy is an important variable in determining learners' acceptance of online learning. Venkatesh et al. and Alrajawy et al. [41,43] defined performance expectancy as the extent to which a person believes that using an information system would help him or her benefit in terms of job performance. In the context of online learning, performance expectancy suggests that students will find online learning useful due to the opportunity that the online environment presents for easily gaining access to information and as a flexible mode of education [44]. Students can attend classes from anywhere at any time to substantiate their studies. Some studies reflect that performance expectancy strongly influences students to use online learning.

H1: There is a positive and significant relationship between performance expectancy and students' intention to adopt online learning.

Effort expectancy is similar to the construct of perceived ease of use appearing in the technology acceptance model (TAM). The author of [41] defined effort expectancy as the degree of ease that individuals think they will have when using an information system. Effort expectancy also refers to another variable from TAM, i.e., perceived ease of use, perceived complexity, and ease of use. In the context of online learning, effort expectancy will strongly affect the students' behavioral intention. Past studies [45,46] also validated that effort expectancy significantly and positively impacts an individual's intention to use technology. Refs. [44,47] posit that effort expectancy will positively affect the intention to use online education.

H2: There is a positive and significant relationship between effort expectancy and students' intention to adopt online learning.

Social influence (SI) is the extent to which users perceive that others important to them believe they should use a new information system. Social influence was divided into two dimensions: superior and peer influence [39]. In this study, superior influence refers to the student's influence, defined as the extent to which immediate faculty members, lecturers, or even fellow students directly encourage or motivate their students/friends to pursue online learning. Studies also reveal that SI significantly influences behavioral intention to adopt a system [44,45].

H3 : There is a significant positive relationship between social influence and intention to adopt online learning.

Facilitating conditions (FC) are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system [41]. Facilitating services being provided to users can affect the level of acceptance of new technology [39,48]. Facilitating conditions significantly affect the behavioral intention and use of online learning systems [44,49].

H4: There is a significant positive relationship between performance expectancy and acceptance of mobile learning.

Voluntariness to use refers to the use of technology or online platforms being perceived as free will [50]. Voluntariness is a dominant influence on user behavior [42,47,51]. Voluntariness is the extent to which potential adopters perceive the adoption as not mandatory. Voluntariness determines other factors that influence the user's behavior. Voluntariness is the context where the user will accept technology without any influence. This was used by the authors of [41] as a moderator, and the study revealed that technology adoption was significantly increased from 35% without a moderator to 55% with a moderator. In this study, this construct was used as moderating variable to see the influence of voluntariness in the online system on performance expectancy, effort expectancy, social influence, and facilitating conditions.

H5: Voluntariness to use moderates the relationship between performance expectancy and intention to adopt technology in online education.

H6: Voluntariness to use moderates the relationship between effort expectancy and intention to adopt technology in online education.

H7: Voluntariness to use moderates the relationship between social influence and intention to adopt technology in online education.

H8: Voluntariness to use moderates the relationship between facilitating conditions and intention to adopt online education.

3. Methodology

3.1. Research Design

The explanatory study and quantitative study sought to assess the influence of performance expectancy, social influence, effort expectancy, and facilitating conditions on intention to adopt online learning. In this study, voluntariness use was the moderator in all the direct relationships between the independent variables and dependent variables. Since measurements for the constructs were available to assess the hypothesized predictions of cause and effect, positivism was a more appropriate philosophy for this study [52]. It was important to use a deductive approach as the study started with theory, and hypotheses for testing were developed. In this study, self-administered questionnaires were employed to collect numerical data. The strategy used was a survey method, and the time horizon was cross-sectional as a snapshot of the data were collected. In order to analyze data, the SPSS tool and Smart-PLS software were used.

3.2. Target Population, Sampling, and Sample Size

The intended target population in this study consisted of post-graduate students from Bangladeshi universities in Dhaka. The target population was described as the people that qualified to participate in this survey [53]. A representative sample of the target population was recruited for this extensive study in order to provide the necessary data [52]. Nonprobability sampling was used as a sampling frame that could not be developed or obtained [52]. Convenience sampling was utilized as a list of prospective responders was not easily accessible. The formula proposed by [37] was used to determine the sample size. The minimum number of samples needed, 82, was determined using the formula “ $50 + 8m$,” where “ m ” stands for the number of variables. For structural equation modeling, the authors of [54] recommended sample size of two hundred.

3.3. Instrumentation

Two sections make up this questionnaire. Questions on the respondents’ background, including gender, marital status, and employment history, make up the first section of the survey. The respondent was questioned on whether they were post-graduate students in private universities in Dhaka, which was a filter question that was inserted. The constructs used in this study were intended to be measured via section B of the questionnaire. The questions were adapted from past studies [45,55]. Because it is simple to administer and simple for respondents to comprehend and reply to the questions, the interval scale (Likert type) was employed to measure the respondents’ responses.

3.4. Data Collection

This study used a survey method, and self-completed questionnaires were utilized to collect primary data [52]. Self-administered questionnaires were employed for this study because they enable faster data collection from a greater sample size. In addition, this method reached a wider geographical range [52]. Questionnaires were distributed manually and electronically to the qualified respondents in order to increase the response rate. Follow-up was performed. After a lapse of three months, 137 responses were received. Seven responses were removed due to missing data. There were 13 good questionnaires for data analysis. The questionnaires were distributed both manually and online in an effort to increase response.

3.5. Data Analyses

After the completion of data collection, the survey’s data were edited and cleaned up. The next step was to create an Excel file. The data were uploaded to SPSS and PLS statistical software for further analysis. The descriptive analysis was carried out with the aid of IBM SPSS software. The testing for reliability validity was carried out using the Smart-PLS tool. Next, the inferential statistics were produced using the Smart-PLS software package to test the hypothesis, including the mediation effect.

The consistency or reliability of data were evaluated using the Cronbach alpha value and the composite reliability index [56]. As a general rule, the reliability value of each construct must be at least 0.70 or higher [56]. The convergent and discriminant reliability was evaluated using the Smart-PLS approach. Ref. [57] asserts that if all the measurement model’s components are statistically significant, convergent validity is not compromised. The average variance extracted (AVE) for each construct served as the foundation for the convergent validity, and the value of AVE must be 0.5 or greater. Factor loadings were checked, and items with low factor loading were removed [56]. Discriminant validity evaluation was based on the multitrait–multimethod matrix: the heterotrait–monotrait ratio of correlations (HTMT). The authors of [58] stated that the HTMT approach is better than the traditional Fornell–Larcker criterion. The Smart-PLS software was used for hypothesis testing. The structural model provided the correlation coefficients and the significance level of the hypothesized relationships among the variables.

4. Results

4.1. Respondents Demographics

There were 130 respondents in this study. All the respondents were undergraduate and post-graduate students at private universities in Dhaka, Bangladesh. There were 85 male and 45 female respondents in this study.

4.2. Reliability

The degree to which a construct in this research was consistent with what it was meant to measure was considered to be its reliability [59]. Based on defined and validated metrics, the reliability score must be at least 0.70. Refs. [60,61] recommend a value of at least 0.6 as the minimum for internal consistency reliability. All of the constructs in this analysis, as shown in Table 1, had rho values better than 0.8. The composite with Cronbach's alpha was higher than 0.7. Therefore, reliability was established in this study.

Table 1. Construct validity and reliability SmartPLS version 3. Extracted by researcher.

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
EF1	0.810	0.810	0.888	0.727
FC	0.791	0.819	0.878	0.707
Intention	0.837	0.848	0.902	0.754
PE	0.869	0.870	0.920	0.792
Social Influence	0.852	0.853	0.900	0.693
Voluntariness	0.796	0.816	0.878	0.706

4.3. Convergent Validity

Based on data obtained from the Smart-PLS system, convergent validity was confirmed in this study. Convergent validity in this study refers to how well the construct converges to account for the variation of its elements [56]. In this study, the convergent validity of the concept was examined using the average variance extracted, frequently abbreviated as "AVE". The mean value in this study was calculated using the square loadings of each indicator on a construct. The Smart-PLS system results revealed that the AVE value was 0.5 and above, which is higher than 0.5. [56] set the minimum threshold value (0.5 and above). Items with factor loadings of below 0.5 were removed.

4.4. Discriminant Validity

To measure discriminant validity, the Fornell–Larcker criterion was used. According to the Fornell–Larcker criterion, the diagonal value must be greater than all the other values in the same row and column [56]. The constructs in Table 2 are distinct from each other. Therefore, the discriminant validity of the data in this study was clearly established.

Table 2. Fornell–Larcker criterion SmartPLS version 3. Extracted by researcher.

	Effort	FC	Intention	Performance	Social	Voluntariness
Effort	0.853					
Facilitating C	0.639	0.841				
Intention	0.823	0.727	0.868			
Performance Ex.	0.804	0.539	0.649	0.890		
Social Influence	0.8935	0.789	0.852	0.725	0.832	
Voluntariness	0.662	0.502	0.707	0.554	0.677	0.840

4.5. Multicollinearity

According to ref. [59], multicollinearity describes how much the other factors in the analysis are correlated or can be used to explain a particular variable. The presence of

high multicollinearity can affect the overall results. The presence of multicollinearity in this study was checked using the value of the variance inflation factor (VIF). According to the authors of [56], VIF values of five or more signify the presence of the multicollinearity problem. In this study, there is no problem with multicollinearity as the value of VIF is around three or below in Table 3.

Table 3. Variance inflation factor (VIF) SmartPLS version 3. Extracted by researcher.

Item	VIF
EF11	1.406
EF12	2.669
EF13	2.502
EF14	1.150
FC11	2.241
FC22	1.762
FC23	1.554
IOU111	2.398
IOU222	2.116
IOU333	3.170
IOU444	3.168
PE1	2.512
PE2	2.712
PE3	1.966
SI111	1.951
SI222	2.399
SI333	2.145
SI444	1.269
SI555	2.076
VTU111	1.952
VTU222	1.771
VTU333	1.528

4.6. Coefficient of Determination (R Square)

Based on the measurements, the model used in this study is good as shown in Table 4, the value of R square is high. Collinearity was not a problem either. Based on the coefficient of determination value (R-square), the endogenous construct, intention to use, had an R square value of 0.74. This means that the predictors account for 81.8% of the variance in the intention to use.

Table 4. Coefficient of determination.

	R Square	R Square Adjusted
Intention to adopt	0.818	0.811

4.7. Significance and Relevance of Path Coefficients

In order to assess the significance of path coefficients and test the moderation effects of the moderator, bootstrapping with a resample of 5000 was performed. The authors of [56] stated that the t-value must be considered in order to determine the significance of the relationship. The standardized beta (β) values and related t-values were checked. Ref. [56] shows a significant link using a t-value greater than 1.96 or a p-value less than 0.05. In this study, the first hypothesis, H1, examined the relationship between performance expectancy and the intention to use. The t-value was lower than 1.96, and the p-value was greater than 0.05, signifying an insignificant relationship. The second hypothesis, H2, examined the relationship between effort expectancy and the intention to use. The t-value was higher than 1.96, and the p-value was lower than 0.05, signifying a positive and significant relationship. The third hypothesis, H3, examined the relationship between social influence and the intention to use. The t-value was lower than 1.96, and the p-value

was higher than 0.05, signifying an insignificant relationship. The fourth hypothesis, H4, examined the relationship between facilitating conditions and the intention to use. The *t*-value was higher than 1.96, and the *p*-value was lower than 0.05, signifying a positive and significant relationship. Therefore, only hypotheses H2 and H4 were supported, and H1 and H3 were not supported.

The presence of moderation is shown when the strength direction of a relationship between two constructs depends on a third variable, and in this study, the third variable is voluntariness [62]. The moderating construct affects the strength or the direction of a relationship between exogenous and endogenous variables. Moderation occurs when the significance level of the interaction effect is less than 0.05. This effect will be termed significant; if it is greater than 0.05, then the effect will be insignificant. In this study, the *p*-value for all the moderating effects of the variable voluntariness was not significant. Therefore, hypotheses H5, H6, H7, and H8 were not supported. The summary of all hypotheses are shown in Table 5 and Figure 2.

Table 5. Path coefficients SmartPls version 3. Extracted by researcher.

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	<i>p</i> Values
Effort -> Intention to adopt	0.499	0.518	0.172	2.908	0.004
Facilitating -> Intention to Purchase	0.246	0.260	0.109	2.261	0.024
Moderating Effect EE to Intention -> Intention to adopt	−0.047	−0.035	0.208	0.227	0.821
Moderating Effect FC to Intention -> Intention to adopt	0.049	0.055	0.109	0.446	0.656
Moderating Effect PE to Intention -> Intention to adopt	0.130	0.150	0.136	0.952	0.341
Moderating Effect SI to Intention -> Intention to adopt	−0.194	−0.230	0.275	0.703	0.482
Performance -> Intention to adopt	0.112	0.117	0.119	0.942	0.346
Social -> Intention to adopt	−0.025	−0.064	0.231	0.108	0.914
Voluntariness -> Intention to adopt	0.178	0.191	0.078	0.022	0.022

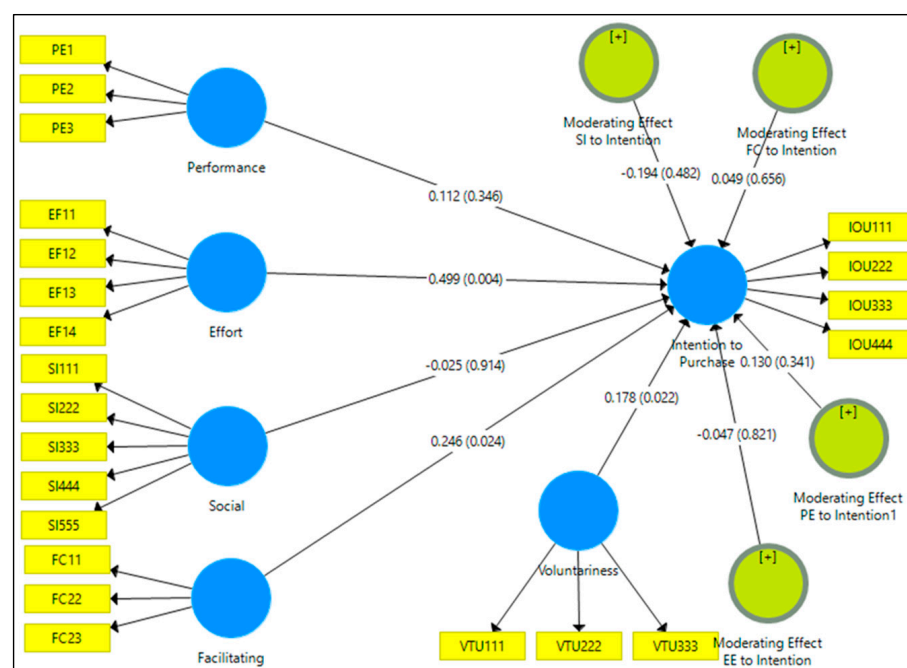


Figure 2. Path co-efficients diagram SmartPls version 3. Extracted by researcher.

5. Discussion Implications, Limitations, and Recommendations

5.1. Discussion

The aim of this study was to identify the factors influencing technology adoption in higher education in Bangladesh. The UTAUT model was used to determine the factors. The first hypothesis was to investigate the impact of the performance expectancy on the intention to use online learning in the post-pandemic period in Bangladesh. The direct effect of performance expectancy on intention to use was insignificant (p -value = 0.346). The results of this study deviated from past studies [32]. One explanation is that students are technology-savvy, and performance expectancy is no longer a concern. The second hypothesis examined the impact of effort expectancy on intention to use online learning (p -value 0.004). The results showed a significant relationship between effort expectancy and intention to use e-learning. This is consistent with past studies [45,46], which confirmed that effort expectancy significantly and positively impacts an individual's intention to use technology. The third hypothesis (H3) was to examine whether social influence predicts intention to use technology. The relationship between social influence and intention to use online learning was insignificant. The results deviated from past studies [31]. One possible explanation could be that social influence is no longer applicable as all students need to use online learning, particularly after the pandemic. The fourth hypothesis was to examine the impact of facilitating conditions on the intention to use online learning. The results showed that there was a significant relationship between facilitating conditions and intention to use online learning. This is consistent with past studies [44,49] that confirmed that facilitating conditions significantly and positively impact an individual's intention to use technology. The moderating effect of voluntariness was also tested. Voluntariness to use refers to the use of technology or online platform being perceived as free will [50]. Voluntariness was expected to influence the user's behavior [42]. In this study, the moderating role of voluntariness was insignificant. One possible explanation is that voluntariness is the extent to which potential adopters perceive the adoption as not mandatory. For the participants in this study, voluntariness was no longer an option.

5.2. Implications

The results of this study revealed that effort expectancy was the most important predictor of online learning among students in Dhaka, Bangladesh. This was followed by facilitating conditions as the second most important factor that influences online learning among students. Therefore, higher education institutions (HEIs) need to focus on the effort expectancy of students and facilitating conditions. HEIs should strive for learning systems that are easy to use and require low effort from the learners in Bangladesh. The students should be able to access learning systems without difficulty, and assistance or should be readily available. In addition, the system designers and architects should focus on increasing the confidence of students to use online learning. The study calls researchers to test the integrated UTAUT model in other electronic commerce (e-commerce) domains, such as online booking or online shopping websites. This brings us to the second most important predictor of online learning, which is facilitating conditions. The facilitating conditions provided should increase the belief of students in the infrastructure, other support systems should exist to support the use of a system, and should be readily available when they need it.

This study also has some theoretical contributions. The constructs in this study were based on the UTAUT theory, and this study provided some new insights and added to the current body of knowledge. Firstly, this study found that effort expectancy was the most important predictor of online learning among students in Dhaka, Bangladesh. In addition, this study revealed that social influence and performance expectancy are not significant predictors of online learning. It was also found that voluntariness was no longer a choice among students, and the moderation effect of voluntariness was not significant.

6. Limitations

It should also be noted that there were some limitations in this study. Firstly, the participants in this study were the students of private universities in Dhaka. This affects the generalizability of the results. For greater generalizability of results, it is recommended that this study be extended or replicated in other cities. This was a quantitative study that used a self-administered questionnaire. Therefore, the results depend on the honesty and emotions of the respondents. For better results, a mixed method study is recommended. An explanatory sequential study can provide more in-depth information, especially through the qualitative phase of the study. Therefore, an explanatory sequential study is recommended. This study generally looked at online learning. However, there are new technologies such as virtual reality, adaptive learning, and flipped classrooms that can be adapted to enable more interactivity and hybrid models. The new tools are changing teaching, learning, and assessment in several ways. Therefore, it is recommended that future studies include diverse instructional designs and technologies.

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Article

Life Cycle Assessment in Higher Education: Design and Implementation of a Teaching Sequence Activity

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Abstract: The latest studies show that to achieve the Sustainable Development Goals on education, there must be a focus on adequately training higher education students. In this work, we present a study about the Life Cycle Analysis of knowledge of products and processes of engineering students. This aspect is very relevant in engineering education since it has direct implications on sustainability. The first step was to identify what the learning problems were, and taking them into account, a specific teaching sequence was designed and implemented over three academic years. Two activities, on an increasing level of complexity, of the application of Life Cycle Assessment are shown in this paper. The first one is the Life Cycle Analysis comparison between two steel and polypropylene pieces. The second one is the Life Cycle Analysis comparison between three different ends of life of a polypropylene piece: mechanical recycling, incineration, and landfill. Data on the evolution of students' marks while solving a "one step more difficult project" throughout these courses have been collected. The results show a generalized learning by the students about Life Cycle Analysis.

Keywords: life cycle assessment teaching; life cycle inventory; engineering education; education teaching activities



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1. Introduction

From the field of study of this work, chemical engineering sustainability is closely related to the life cycle of products and processes. Knowing how to optimally evaluate (and calculate) the life cycle of something will avoid replacing parts or modifying processes, which would entail a high cost in materials with what this means for the environment and natural resources in general. This work arises from the need to evaluate whether it is possible to teach Life Cycle Assessment (LCA) in a way that allows students to have a deeper understanding of the process. The need for this study and the results obtained are substantiated below.

According to some authors [1–3], the design of education at a global level is not addressing the SDGs. However, these same authors put the focus of hope on higher education. Owen and Chankseliani and McCowan [4,5] explained that higher education plays a key role as a means to achieve goal number 4 on education. And one way to achieve it is by making students more aware of the need for sustainable processes, especially those developed in industry, which is the context of students who are training in engineering. Therefore, it is relevant to design university education that promotes quality (thorough SDG number 4).

Chemical engineering is one of the most important branches of industry since it provides a large number of products to society that are vital for its development and, therefore,

it is a degree closely related to sustainability. Due to the climate and resources crisis, chemical engineering must find solutions to provide society with sustainable products, that is, with the same quality but with less consumption of resources and emissions. To achieve this goal, chemical engineering must integrate the concept of the life cycle into systems and products and try to bring linear industrial products closer to cycles that generate the least amount of pollutants and wastes, and use these wastes as resources. For this reason, one scientific tool that has become essential for chemical engineers is the LCA that quantifies the environmental impacts of processes and products along their life cycles. By using this tool, it can be determined which stage of the life cycle of a process, or product, has the highest environmental impact and provide solutions to reduce it. As a result, and with the aim of training qualified professionals to solve real problems, during the last few years, LCA has become a mandatory subject in several chemical engineering university grade curriculums [6–9].

LCA has become so important that industries, administration, educational, and scientific communities usually include it in their projects and products to quantify the environmental impacts as a regular procedure [10]. Most of the LCA studies are performed with commercial software that are very useful when carrying out LCAs since they contain large databases and automatically transform the elementary inputs and outputs into Environmental Impact Indicators (EIIs). However, they also have the problem of performing all the LCA operations, omitting the fundamental steps such as the transformation of data to environmental indicators or the use of concepts as essential as the characterization factors or functional unit. Therefore, many times, LCA software (GaBi® Educational version v2022.2) users do not really know the steps that it performs or the basic concepts behind their results [11,12]. This often leads to a lack of in-depth understanding of the results obtained, which is crucial for the training of higher education students.

For these reasons, in this work, we have analyzed how to introduce a teaching sequence where the calculations of the LCA process are detailed, so that, although engineering students use calculation programs in their future work, they have a robust training in the calculation underlying those programs.

Some pedagogical LCA experiences on chemical and material engineering courses are described in the literature [13–19]. However, there is a lack of teaching material in the scientific literature or textbooks that provide examples of the basic LCA calculations made in spreadsheets. One possible reason for this, as pointed out by Burnley et al. [20], is that LCA is taught in many higher education institutions, but most of them do not publish the didactic material they use in their lessons. One of the few studies that provided the basic LCA calculations was Cosme et al. [21], although they were only for the related inventory to functional unit and not to calculate the EIIs from elementary flows. Furthermore, the calculations were made for isolated examples and not for an example that followed the idea of “red thread” as previously cited. There are also several LCA textbooks where LCA theory was explained [22–28] but these textbooks lack LCA calculations from the inventory to the EIIs. Maybe the only one that makes the calculations and provides some material to the teachers was the Wimmer and Züst [27] textbook where the ecodesign of a water kettle was performed via LCA.

The objective of this article is two-fold: on the one hand, based on the necessity described, two examples of the application of LCA have been designed in a very detailed way. On the other hand, to analyze the impact of the application of these activities’ sequence into the student’s marks over three years of teaching.

The researchers (authors of this article) have been teachers of the course for ten years. Therefore, the historical evolution of this course during this time can be described in order to introduce the necessity of this work. Since 13/14, the subject “Ecodesign” has been structured in a theoretical part in one half and the other half practical. The practical part has consisted of practices with the LCA GaBi® Education v2022.2 software in which students develop their own ecodesign projects using the LCA tool. During these years, the aforementioned phenomenon of a lack of basic knowledge of fundamental concepts of LCA

has been observed in students, which also resulted in low marks. The basic knowledge of the students was limited to reproducing the calculations with the LCA tools; however, when the context of the problem changed, they did not know how to solve it. These results were indicative of a lack of deep knowledge of the fundamental concepts that prevented the final step of the application of said concepts (generalization of learning).

As far as the authors know, this is the first time LCA teaching tools and spreadsheets with calculations are provided to assess engineering and science educational professionals regarding the correct understanding of the theoretical LCA concepts of their students.

2. Materials and Methods

2.1. Sample

The participants in this study were 34 students of “Ecodesign”, which is an optional course in the fourth academic year of the “Industrial Mechanical Design Engineer” university degree. This is a representative sample of the total number of students in the last few years. All of them were informed about the anonymous treatment of their marks in the subject, in order to be able to use them within this work.

2.2. Procedure

To achieve the two objectives set out in this study, on the one hand, the researchers proposed designing a sequence (composed of two steps) to facilitate the understanding of the calculations that were previously carried out using LCA tools. This design has taken care of even the smallest calculation, with the aim of cushioning the lack of knowledge in the steps. And on the other hand, to evaluate the effectiveness of this procedure, evaluation data have been collected at two moments in the process.

Since the 20/21 academic course, the methodology and examples of ecodesign were modified in order to facilitate deep learning about LCA for the students. As a final part of this development, the sequences of teaching relating to LCA that are presented in this article have been designed and implemented during three consecutive academic years (20/21 to 22/23) following the “red tread” idea and explain in detail the different LCA steps.

During the 60 h of on-site lessons, the teaching sequence designed is introduced within the 30 first part hours. Once this first part ends, the students complete a midterm exam. In this written exam, students were asked about solving LCA cases. The second part of the lessons (30 h) are practical and in front of the computer, which has the LCA software (GaBi® Educational version v2022.2) installed, and at the end of this part, the students must develop a project from which they obtain the final mark. This final project consists of a generalized application of their learnings where the students have to compile the elementary flows related to the fundamental flows and the functional unit; to convert the elementary flows into Environmental Impact Indicators (EIIs); to show and interpret the LCA results. That is a summary of all the treatments along the course. These projects were explained to the group and the researcher took observational notes.

3. Results

3.1. Sequence of Teaching Activities

The first LCA example is a comparison between two steel and polypropylene pieces. The second LCA example is a comparison between three different ends of life of a polypropylene piece: mechanical recycling, incineration, and landfill. This second example increases the calculations’ complexity and serves to explain the open-loop recycling of the steam and electricity generated on incineration and recycled PP granulate generated on a mechanical recycling process. The two LCA examples are explained step by step, with “paper, pen and calculator”, and using Excel sheets provided in the Supplementary Materials of this article. The four steps that ISO 14040 and 14044 [29,30] marked as essential for an LCA will be carried out. These steps are avoided by the LCA software (GaBi® Educational version v2022.2) but are essential for the correct understanding of LCA concepts. To show where

the results come from and thus avoiding simplistic interpretations, special emphasis is placed on the calculations.

Therefore, this section is going to be divided into the two LCA examples and into the four steps that make up the LCA: 1. definition of the objective and scope of the study; 2. Life Cycle Inventory (LCI); 3. Life Cycle Impact Assessment (LCIA); and 4. interpretation of the results.

3.1.1. Steel and Polypropylene Pieces LCA Example

Scope and Objective of the LCA

ISO 14044 [30] stipulated that in this first step, the LCA goal, functional unit used, limits of the study, EIIs used, and data sources have to be described. Regarding the goal, this LCA is going to determine the environmental impacts of the two different pieces of steel and polypropylene (PP) used. Specifically, the students have to solve the next problem: “One company wants to substitute one steel machinery piece by one of polypropylene. Steel piece weight is 2.3 kg and its lifetime is 1.5 years. Polypropylene piece weight is 0.75 kg and its lifetime is 0.56 years. For a machine working time of 20 years, determine which piece has less environmental impacts by LCA”.

The functional unit is the magnitude with which the reference flows of the system are calculated. Thus, the functional unit of this study is the use of the pieces (steel or PP) over 20 years. This study is carried out using a very simplified version of the databases provided by the educational version of GaBi Software v2022.2 and by the scientific literature. Regarding the inventories of the materials obtained in GaBi, the inputs and outputs that generate the greatest impact in each indicator have been compiled. The 16 EIIs recommended by the EU to carry out LCAs [31] and which are detailed in Table 1 are used. The first 12 EIIs take into account the impacts of the elementary outputs, and the 4 last impacts take into account the elementary inputs. In this study, only the manufacture and use stages of the life cycle of the pieces are going to be considered.

Table 1. Environmental impact indicators.

Environmental Impact Indicator	Abbreviation	Unit
Climate change	GWP	kg CO ₂ eq.
Ozone depletion	ODP	kg CFC-11 eq.
Respiratory inorganics	RI	Disease incidences
Ionizing radiation—human health	IR	kBq U235 eq.
Photochemical ozone formation—human health	POF	kg NMVOC eq.
Acidification terrestrial and freshwater	AC	Mole of H ⁺ eq.
Eutrophication terrestrial	EUT	Mole of N eq.
Eutrophication freshwater	EUf	kg P eq.
Eutrophication marine	EUM	kg N eq.
Cancer human health effects	HTC	CTUh
Non-cancer human health effects	HTNC	CTUh
Ecotoxicity freshwater	ECFW	CTUe
Land use	LU	Pt
Resource use. Mineral and metals	RDM	kg Sb eq.
Water scarcity	WU	M ³ world equiv.
Resource use. Energy carrier	RU	MJ

Life Cycle Inventory (LCI)

ISO 14040 [29] stipulated “inventory analysis involves data collection and calculation procedures to quantify relevant inputs and outputs of a product system”. This is the most complex stage of LCA. However, the use of software has made it much easier for LCA professionals since their databases provide extensive industrial processes with a high amount of reliable data. As has been said in the introduction, the most counterproductive part of this software is that it avoids calculating the adequacy of these data to the fundamental flow units (fluxes that link processes inside the technosphere) for each functional unit. By

this way, the LCA software (GaBi® Educational version v2022.2) eliminates a degree of knowledge about the system. Therefore, it is necessary to carry out the necessary operations to go from the data provided by the databases to the final compilation of the elementary inputs and outputs (from the ecosphere to the technosphere and vice versa) for a good understanding of the calculations made to obtain the Life Cycle Inventory.

That is the reason why, in this study, with a theoretical LCA teaching character, these calculations are carried out with only the help of a calculator and Excel files. Firstly, the number of pieces of each material are calculated, as follows: 13.33 steel pieces (20 years/1.5 years each steel piece) and 35.71 PP pieces (20 years/0.56 years each PP piece). With this in mind, and Table 2 that shows the inventories for the steel turning and plastic injection processes, it is possible to calculate the amounts of steel billet, PP granulate, and electricity necessary for each process (Figure 1). By this way, the reference flows refer to the functional unit of this study.

Table 2. Steel turning and plastic injection inventories (1 kg).

Input			
Material	Unit	Steel turning	Plastic injection
Electricity	MJ	3.31	6.64
Steel billet	Kg	1.36	
Plastic granulate	Kg		1.02
Output *			
Material	Unit	Steel turning	Plastic injection
Steel piece	kg	1	
Plastic piece	kg		1

* Steel and plastic scraps leave the systems as waste: 0.36 kg steel scrap, 0.02 kg plastic scrap.

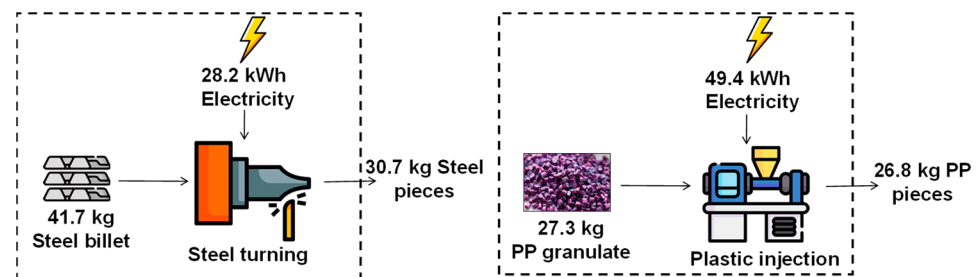


Figure 1. Steel turning and PP injection fundamental flows.

Steel pieces

Electricity

$$\frac{3.31 \text{ MJ electricity}}{\text{kg steel piece}} \times 13.33 \text{ steel pieces} \times \frac{2.3 \text{ kg steel pieces}}{\text{steel piece}} = 101.48 \text{ MJ} \times \frac{1 \text{ kWh}}{3.6 \text{ MJ}} = 28.2 \text{ kWh Electricity}$$

Steel billet

$$\frac{1.36 \text{ kg steel billet}}{\text{kg steel piece}} \times 13.33 \text{ steel pieces} \times \frac{2.3 \text{ kg steel pieces}}{\text{steel piece}} = 41.7 \text{ kg steel billet}$$

PP pieces

Electricity

$$\frac{6.64 \text{ MJ electricity}}{\text{kg PP piece}} \times 35.71 \text{ PP pieces} \times \frac{0.75 \text{ kg PP pieces}}{\text{PP piece}} = 177.83 \text{ MJ} \times \frac{1 \text{ kWh}}{3.6 \text{ MJ}} = 49.4 \text{ kWh Electricity}$$

PP granulate

$$\frac{1.02 \text{ kg PP granulate}}{\text{kg PP piece}} \times 35.71 \text{ PP pieces} \times \frac{0.75 \text{ kg PP pieces}}{\text{PP piece}} = 27.3 \text{ kg PP granulate}$$

Steel turning and plastic injection processes have fundamental flows as inputs and outputs (flows that come or go from/to the technosphere and should be provided/fed by/to other processes). If the fundamental flow is an input, it has to be connected to another process (steel billet, PP granulate, and electricity production). If the fundamental flow is an output (steel and plastic pieces), it has to leave the system or be used as an input by other processes. Fundamental flows are shown in the tables with a bold letter in this work and elementary flows (flows that come from the ecosphere (nature) to the technosphere (inputs) or flows that go from the technosphere to the ecosphere (outputs)) are in a regular letter. In Figure 1, the fundamental flows are inside the technosphere (dot lines) while the elementary flows (not shown) go from the ecosphere to the technosphere and vice versa. The LCA inventory step includes the elementary input and output flows' compilation related to the fundamental flows, which in turn refer to the functional unit. After the steel billet, electricity, and PP granulate fundamental flows' calculation, it is possible to compile the elementary inputs and outputs for both systems. Table 3 shows a simplified version of the inventories extracted from the Educational GaBi version, where only the most important elementary flows are selected. These are considered cradle-to-gate processes; therefore, they simulate the whole process from nature to the technosphere. For the steel billet production: mining and steel production; for the PP granulate production: crude oil extraction, cracking, and polymer manufacture; and for the electricity generation in Spain: the construction of the energy plants and the generation of electricity from several energy sources. In Table 3, it is possible to see that these processes have only elementary inputs and outputs, and one unique fundamental output flow (steel billet, PP granulate, and electricity).

Table 3. Steel billet (1 kg), PP granulate (1 kg), electricity generation from Spain grid mix (1 MJ), steam from natural gas (1 MJ), and NaOH (1 kg) inventories.

Inputs						
Material	Unit	Steel billet	PP granulate	Electricity	Steam	NaOH
Coal	MJ	16.37	2.1	0.42	2.85×10^{-3}	3.28
Crude oil	MJ	1.44	38.3	0.20	6.88×10^{-3}	1.24
Iron	kg	0.89				
Natural gas	MJ		26.2	0.54	1.17	5.32
Water	kg	323				
Outputs						
Material	Unit	Steel billet	PP granulate	Electricity	Steam	NaOH
Steel billet	kg	1				
Polypropylene granulate	kg		1			
Electricity	MJ			1		
Steam	MJ				1	
Sodium hydroxide	kg					1
Carbon dioxide	kg	1.98	1.53	0.09	0.069	1.12
Carbon monoxide	kg	0.017				
Chloride (aq)	kg	9.0×10^{-3}	0.11	6.67×10^{-4}	3.06×10^{-5}	0.025
Methane	kg	1.2×10^{-3}	6.9×10^{-3}	2.23×10^{-4}	2.23×10^{-4}	1.52×10^{-3}
Nitrogen oxides	kg	3.1×10^{-3}		5.0×10^{-4}	5.18×10^{-5}	2.05×10^{-3}
Sulphur dioxide	kg	2.6×10^{-3}		4.0×10^{-4}	1.85×10^{-5}	7.43×10^{-4}

Next, and as an example of the inventory calculation, the total amount of one elementary flow as crude oil is calculated.

Crude oil steel pieces

Crude oil steel billet

$$\frac{1.44 \text{ MJ Crude Oil}}{\text{kg Steel Billet}} \times 41.7 \text{ kg Steel Billet} = 60.1 \text{ MJ Crude Oil}$$

Crude oil electricity

$$\frac{0.20 \text{ MJ Crude Oil}}{1 \text{ MJ electricity}} \times \frac{3.6 \text{ MJ}}{1 \text{ kWh}} \times 28.2 \text{ kWh electricity} = 20.3 \text{ MJ Crude Oil}$$

So, the amount of crude oil elementary flow input for the steel pieces is $60.1 + 20.3 = 80.4$ MJ.

And the amount of crude oil for the PP pieces will be:

Crude oil PP pieces

Crude oil PP granulate

$$\frac{38.3 \text{ MJ Crude Oil}}{\text{kg PP granulate}} \times 27.3 \text{ kg PP granulate} = 1025.9 \text{ MJ Crude Oil}$$

Crude oil electricity

$$\frac{0.20 \text{ MJ Crude Oil}}{1 \text{ MJ electricity}} \times \frac{3.6 \text{ MJ}}{1 \text{ kWh}} \times 47.4 \text{ kWh electricity} = 35.6 \text{ MJ Crude Oil}$$

So, the amount of crude oil elementary flow input for the PP pieces is $1025.9 + 35.6 = 1061.5$ MJ. These calculations have been performed for all the inputs and outputs and compiled in Figure 2 for the steel and PP pieces. These data and calculations are also presented in Tables S1 and S2 on the Excel sheet “LCI & LCIA & Results” of the Excel file “Steel & PP Example” provided as Supplementary Materials to this article.

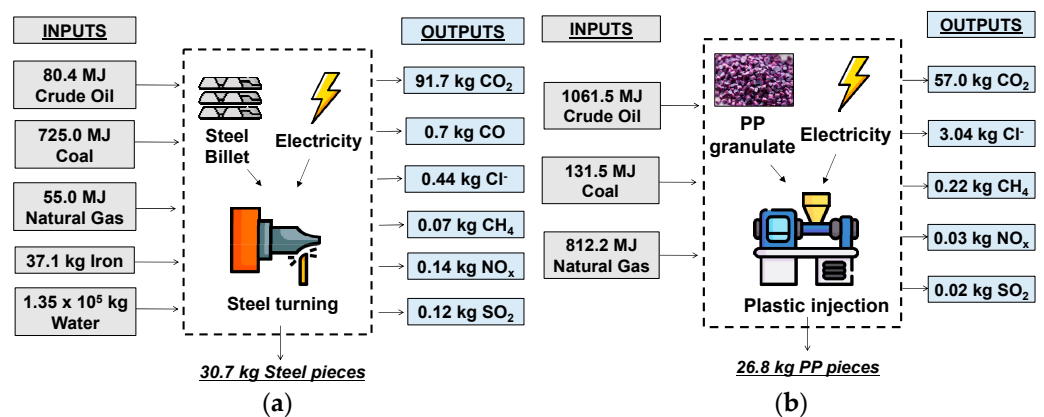


Figure 2. (a) Total inventory for steel pieces of the LCA educational example; (b) total inventory for PP pieces of the LCA educational example.

3.1.2. Life Cycle Impact Assessment (LCIA)

ISO 14040 [29] described this third LCA step as “the impact assessment phase of LCA is aimed at evaluating the significance of potential environmental impacts using the LCI results. In general, this process involves associating inventory data with specific environmental impact categories and category indicators, thereby attempting to understand these impacts”. As has been said in the introduction of this work, LCA software (GaBi® Educational version v2022.2) automatically transforms inventory data into EILs, and by this way, makes the LCA easier and simpler. However, for future professionals in sustainability, it is very important to understand the mechanism of this transformation, which entails a

deep knowledge of the LCA. The main process of the LCIA is the characterization step, in which the inputs and outputs of the elementary flows are transformed into EIIs. In this work, as has been said in the introduction, 16 EIIs recommended by the European Union are going to be used. The last update of the recommended EIIs made by the LCA European Platform is compiled on the Environmental Footprint v3.1. where the methodology for each EII calculation and the characterization factors used are described.

Table 4 presents the characterization factors extracted from the Environmental Footprint v3.1 methodology and used in this work. Only 11 of the 16 EIIs in Table 1 are going to be used because the inputs and outputs of this very simplified LCA only have an impact on these EIIs. Mainly, these characterization factors are the numbers that multiply the elementary flow to transform it to each EII. Characterization factors quantify the impact of the elementary flows into the different EIIs. For example, in this section, the value of the Global Warming Potential (GWP) in kg of CO₂ Eq. for the steel piece and for the PP piece is going to be calculated. In Table 4, it can be seen that only three elementary outputs have an impact on the GWP EII: carbon dioxide, carbon monoxide, and methane. So, the value of the GWP will be obtained after the multiplication of the value of these fluxes (Figure 2) by their respective characterization factors. The final values of the 11 EIIs for the steel and PP pieces are presented in Tables S3 and S4 on the Excel sheet “LCI & LCIA & Results” of the Excel file “Steel & PP Example” provided as Supplementary Materials to this article.

Table 4. Characterization factors (Environmental Footprint v3.1).

	GWP	RI	POF	AC	EUT	EUM	HTNC	ECFW	RDM	WU	RU
Inputs											
Coal											1
Crude oil											1
Iron									5.24×10^{-8}		
Natural gas											1
Water										4.30×10^{-2}	
Outputs											
Carbon dioxide	1										
Carbon monoxide	1.57		4.56×10^{-2}				1.08×10^{-6}	2.28×10^{-2}			
Chloride							4.68×10^{-8}	301			
Methane	36.8		1.01×10^{-2}				4.85×10^{-8}	0.32			
Nitrogen oxides		1.60×10^{-6}	1	0.74	4.26	0.39					
Sulphur dioxide		8.00×10^{-6}	8.11×10^{-2}	1.31							

Global Warming Potential steel pieces

Global Warming Potential CO₂

$$91.74 \text{ kg CO}_2 \times \frac{1 \text{ kg CO}_2 \text{ Eq.}}{1 \text{ kg CO}_2} = 91.74 \text{ kg CO}_2 \text{ Eq.}$$

Global Warming Potential CO

$$0.696 \text{ kg CO} \times \frac{1.57 \text{ kg CO}_2 \text{ Eq.}}{1 \text{ kg CO}} = 1.1 \text{ kg CO}_2 \text{ Eq.}$$

Global Warming Potential CH₄

$$0.074 \text{ kg CH}_4 \times \frac{36.8 \text{ kg CO}_2 \text{ Eq.}}{1 \text{ kg CH}_4} = 2.72 \text{ kg CO}_2 \text{ Eq.}$$

$$\text{GWP}_{\text{Steel pieces}} = 91.74 + 1.1 + 2.72 = 95.56 \text{ kg CO}_2 \text{ Eq.}$$

Global Warming Potential PP pieces

Global Warming Potential CO₂

$$57.04 \text{ kg CO}_2 \times \frac{1 \text{ kg CO}_2 \text{ Eq.}}{1 \text{ kg CO}_2} = 57.04 \text{ kg CO}_2 \text{ Eq.}$$

Global Warming Potential CH₄

$$0.224 \text{ kg CH}_4 \times \frac{36.8 \text{ kg CO}_2 \text{ Eq.}}{1 \text{ kg CH}_4} = 8.24 \text{ kg CO}_2 \text{ Eq.}$$

$$\text{GWP}_{\text{PP pieces}} = 57.04 + 8.24 = 65.3 \text{ kg CO}_2 \text{ Eq.}$$

Interpretation and Results

Figure 3 shows the contribution of the steel and PP pieces to the total 11 EII values. This way of presenting the results is necessary because the units of each EII are different (e.g., kg CO₂ Eq. for GWP and kg CGC-11 Eq. for ODP) and in very different orders of magnitude (Tables S3 and S4 on Supplementary Materials). From Figure 3, it is possible to conclude that the steel pieces have the highest impacts for 9 of the 11 EIIs. From Figures S1 and S2, in the document “Supplementary Materials” provided as Supplementary Materials to this article, where the contribution of each process to the total value of the steel and PP pieces is presented, it is possible to conclude that steel billet manufacture is the process with the highest impact. Regarding the PP pieces, the electricity used for the pieces’ injection is the maximum contributor to five of the nine EIIs on which this system has an impact, and the PP granulate for four of the nine EIIs, although this process is the cause behind why the PP pieces have more of an impact than the steel pieces for the Ecotoxicity Freshwater (ECFW) and Fossil Resources Use (RU) EIIs.

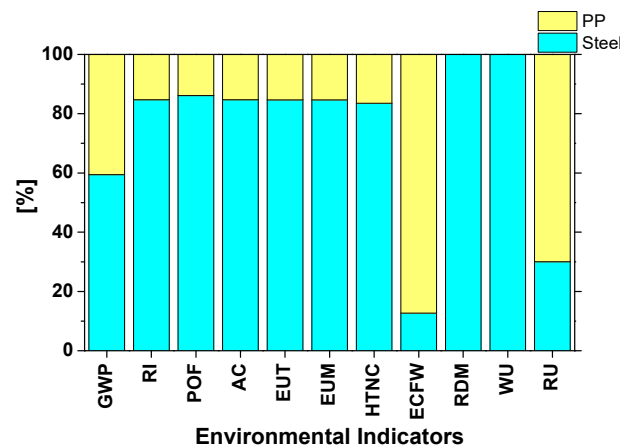


Figure 3. Contribution of steel and PP pieces to the total value of the 11 LCA EIIs.

3.1.3. PP End-of-Life Example

This section presents a comparative study of three different ways of treating 1 kg of a polypropylene waste piece: landfill, incineration, and mechanical recycling. This example increases the complexity of the calculations and serves as an introduction to recycling systems in LCA.

Scope and Objective of The LCA

This LCA aims to determine the environmental impacts of the three different ends of life of one PP piece. The functional unit of this study is defined as “1 kg PP waste piece end of life treatment”. Like in the PP and steel pieces’ example, the GaBi Educational version database is used. For the mechanical recycling process, the data were extracted from the

literature [32]. The EIIs used are the same as for the last example. In Figure 4, the three PP waste ends of life that are going to be studied are presented schematically.

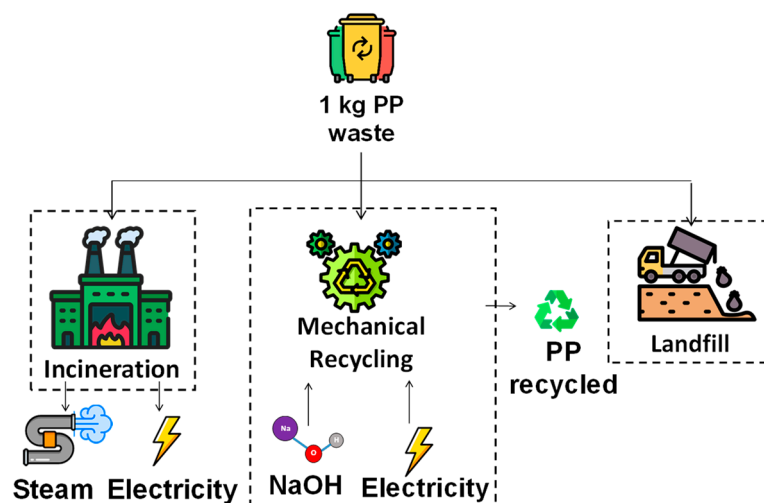


Figure 4. PP waste end-of-life (incineration, mechanical recycling, and landfill) LCA example.

Life Cycle Inventory (LCI)

Table 5 presents the inventories for the three end-of-life treatments considered. As can be seen, the landfill process does not require any fundamental flow or process that provides them, and only takes into account the elementary flows. The incineration PP process does not require any fundamental flows, but it releases two waste flows that can be used for other processes as fundamental flows (steam and electricity). The mechanical recycling process needs two fundamental flows (electricity and NaOH) and also produces a recycled PP granulate that can be used by other systems as the fundamental flow. LCA theory specifies that these waste and fundamental flows can be recycled in open or closed loops [12] with the aim of taking into account these flows avoid virgin materials' utilization. A closed-loop recycling process reinserts the flow into the system, and an open-loop recycling system considers that one different system outside of the limits of LCA uses waste flow as the input. In this case, the impacts should be subtracted because the systems outside of the LCA limits avoid using products from virgin materials. This is the case of this study where the steam, electricity, and PP granulate that are recycled are going to be considered as the open loop and be used by another system. Therefore, their production from virgin materials is subtracted from the initial system. So, for the inventory of the incineration of 1 kg of PP waste, it is necessary to subtract the elementary flows for the production of 11.9 MJ of steam and 6.68 MJ of electricity (Table 5).

As an example, the inventory of crude oil for the incineration of 1 kg of PP is going to be calculated as follows:

Crude oil inventory incineration

Crude oil used in incineration

$$\frac{0.102 \text{ kg crude oil}}{\text{kg PP waste}}$$

Crude oil avoided in electricity

$$\frac{6.68 \text{ MJ electricity}}{\text{kg waste PP}} \times \frac{0.20 \text{ MJ crude oil}}{1 \text{ MJ electricity}} = \frac{1.336 \text{ MJ crude oil}}{\text{kg PP waste}}$$

Crude oil avoided in steam

$$\frac{11.9 \text{ MJ steam}}{\text{kg waste PP}} \times \frac{0.00688 \text{ MJ crude oil}}{1 \text{ MJ steam}} = \frac{0.082 \text{ kg crude oil}}{\text{kg PP waste}}$$

$$\frac{\text{Total crude oil incineration}}{\text{kg waste PP}} = 0.102 - 1.336 - 0.082 = \frac{-1.32 \text{ MJ crude oil}}{\text{kg waste PP}}$$

Thus, in the incineration of 1 kg of waste PP, 1.32 MJ of crude oil is avoided mainly due to the recycled electricity produced. For the inventory of 1 kg of PP waste mechanical recycling, it is necessary to use the inventory for the production of sodium hydroxide, electricity, and PP granulate from the virgin materials (this last part should be subtracted). The crude oil inventory of 1 kg PP waste is calculated as follows:

Crude oil inventory mechanical recycling

Crude oil used in NaOH production

$$\frac{0.017 \text{ kg NaOH}}{\text{kg waste PP}} \times \frac{1.24 \text{ MJ crude oil}}{\text{kg NaOH}} = \frac{0.021 \text{ MJ crude oil}}{\text{kg waste PP}}$$

Crude oil used in electricity generation

$$\frac{1.15 \text{ MJ electricity}}{\text{kg waste PP}} \times \frac{0.20 \text{ MJ crude oil}}{1 \text{ MJ electricity}} = \frac{0.21 \text{ MJ crude oil}}{\text{kg waste PP}}$$

Crude oil use avoided in PP granulate

$$\frac{0.69 \text{ kg PP granulate}}{\text{kg waste PP}} \times \frac{38.3 \text{ MJ crude oil}}{\text{kg PP granulate}} = \frac{26.43 \text{ MJ crude oil}}{\text{kg waste PP}}$$

$$\frac{\text{Total crude oil incineration}}{\text{kg waste PP}} = 0.021 + 0.21 - 26.43 = \frac{-26.20 \text{ MJ crude oil}}{\text{kg waste PP}}$$

Thus, 1 kg of waste PP mechanical recycling avoids the use of 26.2 MJ of crude oil due to the recycled PP granulate. In Figure 5, the inventories for the incineration and mechanical recycling systems are compiled. The landfill system is not shown because it is the same as that presented in Table 5. In Tables S5 and S6, on the Excel sheet “LCI & LCIA & Results” of the Excel file “PP End of Life Example” provided as Supplementary Materials to this article, all these operations are presented. The negative values in the inputs mean that the use of the elementary flow inputs is avoided, and in the outputs, it means that the emissions of the elementary flow outputs are avoided.

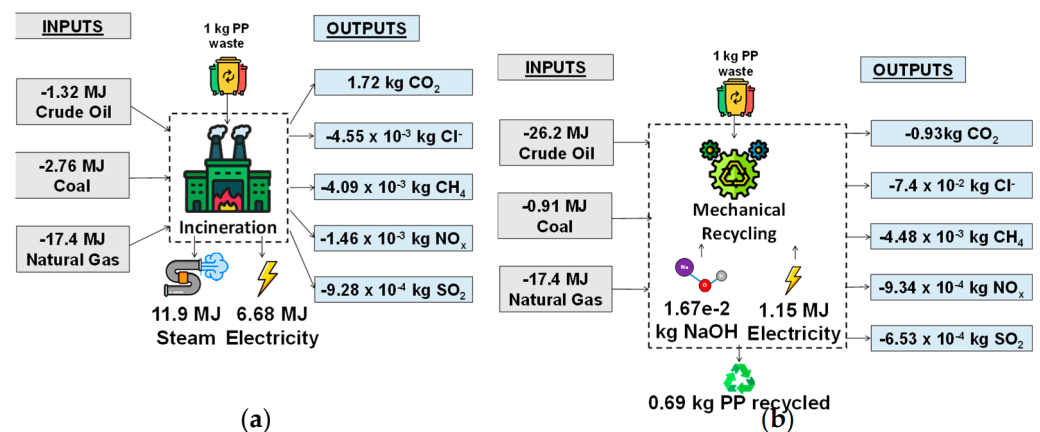


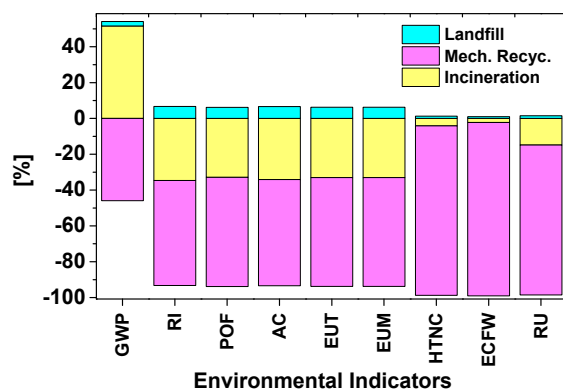
Figure 5. (a) LCI for the incineration of 1 kg of PP waste; (b) LCI for the mechanical recycling of 1 kg of PP waste.

Table 5. Inventories for PP incineration, mechanical recycling, and landfill (1 kg).

Inputs				
Material	Unit	PP Incineration	Mechanical Recycling	Plastic Landfill
Electricity	MJ		1.15	
PP waste	kg	1.00	1.00	1.00
Sodium hydroxide	kg		1.67×10^{-2}	
Coal	MJ	6.76×10^{-2}		6.38×10^{-2}
Crude oil	MJ	0.10		0.31
Natural gas	MJ	0.15		0.58
Outputs				
Material	Unit	PP Incineration	Mechanical Recycling	Plastic Landfill
Electricity	MJ	6.68		
PP (recycled)	kg		0.69	
Steam	MJ	11.9		
Carbon dioxide	kg	3.13		5.99×10^{-2}
Chloride	kg	3.38×10^{-4}		9.12×10^{-4}
Methane	kg	4.70×10^{-5}		3.27×10^{-4}
Nitrogen oxides	kg	1.51×10^{-4}		1.19×10^{-4}
Sulphur dioxide	kg	1.46×10^{-5}		9.63×10^{-5}

Life Cycle Impact Assessment (LCIA) and Results

Conversion of LCI into EII has been performed as before, multiplying the inputs and outputs by the corresponding characterization factors. In this example, only nine EIIs are going to be used because they are the ones on which the elementary flows have an impact. The characterization factors are the same as before (Table 5). In Tables S7–S9, on the Excel sheet “LCI & LCIA & Results” of the Excel file “PP End of Life Example” provided as Supplementary Materials to this article, the results for the three different ends-of-life processes for the nine EIIs with their calculations are shown. In Figure 6, the contribution of each end of life to the EIIs’ total values is shown. It is possible to conclude from this Figure 6 that mechanical recycling is the best end of life for the PP waste. Incineration also reduces the EIIs but to a lesser extent than mechanical recycling; however, it is worth noting that incineration increments the GWP value. Landfilling increments the value of the nine EIIs studied, but on the other hand, its GWP is lower than incineration. In Figures S3 and S4, in the document “Supplementary Materials” provided as Supplementary Materials to this article, the contribution of each process to the total value of the EIIs for the incineration and mechanical recycling processes is presented. From these figures, it is possible to conclude that the PP granulate recycling process is the one that reduces all the EII values for the mechanical recycling process, and regarding incineration, it is the steam recycling process that reduces the most EIIs. The incineration process is the main one responsible for the high value of the GWP for the incineration end of life.

**Figure 6.** Contribution of incineration, mechanical recycling, and landfill ends of life to the total value of the nine LCA EIIs.

3.2. Midterm and Final Students' Marks

As explained in the method section, in order to assess the learning of the students, a midterm exam was programmed after the theoretical part of the course was finished. A total of 50% of the final course mark will comprise the mark of this exam and the other 50% will be the mark of the project performed in the practical part. Figure 7 shows the marks obtained during the last three academic courses, within the midterm and final exams.

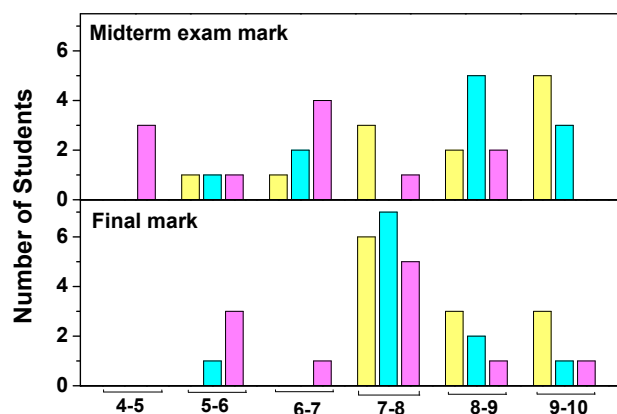


Figure 7. Midterm exam and final marks “Ecodesign” course for 20/21 (yellow), 21/22 (blue), and 22/23 (magenta) academic years.

As can be observed, the results obtained for the midterm exams have been highly satisfactory in the 20/21 and 21/22 academic years and only satisfactory in the 22/23 year. When the midterm exam marks were high, the final marks were also high (20/21 and 21/22 academic years), and the authors of this work believe that these final marks are good not only because the midterm exam mark contributes 50% to the final mark, but the students have assimilated the LCA fundamentals during the theoretical course part and applied them correctly into their ecodesign final projects. To achieve approval, the students had to be able to compile the elementary flows related to the fundamental flows and the functional unit, to convert the elementary flows into Environmental Impact Indicators (EIIs), and to show and interpret the LCA results.

4. Discussion, Conclusions, and Future Work

Sustainability is really close to the life cycle of products and processes. By knowing how to optimally evaluate (and calculate) the life cycle of something, engineers will avoid replacing parts or modifying processes that suppose a high cost in materials and natural resources in general [11,12]. In this article, two designed activities of LCA have been designed and carried out in one engineering degree to evaluate if these teaching activities favor the knowledge of the students about the LCA. Once these activities have been designed and validated over three consecutive courses, it can be concluded that these activities have favored learning about what Life Cycle Assessment is and the calculations regarding it. This can avoid incorrect interpretations of LCA results and will help future engineering professionals to choose the right options to achieve sustainable solutions.

The authors consider this paper also provides LCA teachers with didactic tools that serve to explain the theoretical foundations of LCA that the use of software can hide or hinder. To achieve the objective, two activities were developed. In the first one, the necessary steps to relate the inventory with the fundamental flows and the functional unit have been explained, and it is possible to conclude that how to adequate the inventory data to the functional unit of the LCA and how to transform the inventory data compiled on the LCI to EIIs by characterization factors by LCIA has been explained. In the second activity, which was a more complex example, the flows have been recycled in open-loop systems. As a conclusion, this exercise increases the complexity of the LCI and LCIA calculations

due to the open-loop recycling of the steam and electricity generated on incineration and the recycled PP granulate generated in the mechanical recycling process being included.

These activities provide students and LCA teachers with appropriate tools for a better understanding of LCA and interpretation of the results [20,21]. With these results, it can be concluded that spreadsheets have been a good teaching tool in order to explain the most fundamental theory of LCA, and if they have been correctly assimilated, provide the students with good tools to make an LCA and ecodesign. And on the other hand, the students have stated that to understand what they do, it is necessary to know the steps they take and their reasons [33]; therefore, this way of approaching the teaching of Life Cycle Assessment would help in that sense. The next step to this work is to design a more complex activity than those presented in this work, in which the use of three vehicles will be compared using LCA: diesel, electric, and hydrogen. Furthermore, to validate the results, samples of higher education students will be taken into account in future courses, for example, by extending this analysis for more courses.

In relation to the data obtained from the marks in the midterm and final exams, several conclusions have been reached. On the one hand, compared with the results of students in previous courses, it can be said that the grades are undoubtedly better. Throughout these last three academic years, in which the designed sequence has been implemented, all students have achieved marks greater than 5 points, both in the midterm and final test. It means that all of them have passed the course. But especially when students must apply what they had learned, throughout the development of the final project, it can be observed how the marks are higher (final marks). Understanding this final project as an evaluation test of their generalized learning, that is, the highest step of learning, it can be concluded that the sequence of activities designed and implemented for the teaching–learning of LCA is an effective didactic resource for the development of student learning in the context described in this work.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su16041614/s1>. **Word document.** Figure S1—Contribution of steel billet and electricity to the total value of steel pieces LCA 11 EIs. Figure S2—Contribution of PP granulate and electricity to the total value of PP pieces LCA 11 EIs. Figure S3—Contribution of incineration, and electricity and steam recycling to the total value of 1 kg waste PP incineration end of life LCA 11 EIs. Figure S4—Contribution of electricity, sodium hydroxide and PP recycling to the total value of 1 kg waste PP mechanical recycling end of life LCA 9 EIs. **Steel & PP Example_SM Excel document.** Table S1—Inventory Steel pieces example. Table S2—Inventory PP pieces example. Table S3—EIs Steel pieces example. Table S4—EIs PP pieces example. **PP end of life Example_SM Excel document.** Table S5—LCI Incineration 1 kg PP waste. Table S6—LCI Mechanical Recycling 1 kg PP waste. Table S7—EIs for the incineration of 1 kg of waste PP. Table S8—EIs for the mechanical recycling of 1 kg of waste PP. Table S9—EIs for the landfill of 1 kg of waste PP.

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Article

Examining the Role and Challenges of Sustainable Development Goals for the Universities in the United Arab Emirates

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Abstract: This study aims to explore the potential role of higher education institutions in the United Arab Emirates in driving the world's progress toward achieving the United Nations Sustainable Development Goals (SDGs). The objectives of the study also include examining the challenges faced by the universities while integrating the SDG into their systems. This study adopted a mixed-method study design by conducting interviews with deans (15) and a survey with faculty members (350) of the universities in the UAE. The most pressing challenges reported were difficulties in the identification of priorities for the most impactful SDGs for universities, reduction of the environmental footprints of universities, the lack of sufficient collaboration and communication among universities, tracking the progress of SDGs in the absence of reporting protocols, impediments to participation from cultural and societal factors, bureaucratic hurdles, and political and economic influence over prioritization of SDGs in universities' strategic planning. However, governmental change in economic and energy policy was highlighted as a favorable measure to accelerate the adoption of SDGs by the universities. Additionally, the results show that the scope of research and collaborative projects at the universities are limited and do not bring about any substantial change in society.

Keywords: higher education; UAE; UNSDGs; challenges



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1. Introduction

The United Nations (UN) formulated a global framework and agenda for 2030, envisioning transforming the world with sustainability. It derived seventeen goals, unanimously adopted and recognized as the United Nations Sustainable Development Goals (UNSDGs). These 17 SDGs collectively comprise 169 central targets of high importance that have been agreed upon by the member countries. These goals have been made to assure peace, justice, happiness, and fulfillment in life for all without fear of any threat or violence. The UN calls these goals universal actions for preserving the planet from the potential threats of climate, poverty, and inequality. The goals imply the embrace of corporate social responsibility in all regions of the world [1]. Nevertheless, Ali et al. [2] have asserted that in the BRICS nations (Brazil, Russia, India, China, and South Africa), the UNSDGs have not been realized in their letter and spirit. Among them, China is more concerned about realizing these SDGs, as it is reflected in its profit-making entities, its vision, and its efforts as compared to the rest of the BRICS countries.

More attention is given in the BRICS region to the goals of 'peace, justice, and strong institutions' and 'decent work and economic growth'; however, 'quality education', 'climate action', and 'life below water' have not received the attention they should be given in the BRICS region [2]. The UN SDGs envisage creating healthy communities that promote overall well-being. However, there has been a lack of coordination and integration among different sectors, and progress toward these goals has been slow, uneven, and limited to

certain regions, as highlighted by Saxena et al. [3]. The study by Saxena et al. [3] examines the difficulties and prospects concerning the relationship between the conceptualization, implementation, and evaluation of the UNSDGs. It suggests aligning theory, strategy, and operations, and focusing on transformative learning for education, organizational learning, and leadership. It also emphasizes increasing moral courage, the wise use of power and storytelling, fostering a sense of belonging, and taking an integrated and dialectic approach to create strong partnerships among public, private, and civil society sectors. As a result, long-term sustainability beyond 2030 could be materialized, along with the emergence of new ideas and solutions.

Another aspiration of today's world in agreeing upon the UNSDGs is to ensure corporate social responsibility. Corporate social responsibility (CSR) denotes the role of profit-making entities in being watchful of the repercussions of their operations on society and the environment. Researchers have identified various elements of CSR, including stakeholder engagement, enhancing the quality of life, promoting economic growth, ethical business practices, compliance with laws and regulations, voluntariness, respect for human rights, environmental protection, transparency, and accountability [4,5]. Therefore, organizations are gradually incorporating the SDGs into their CSR practices [6]. For instance, business schools have been integrating moral, corporate social responsibility, and sustainability concepts into their curricula for educating students, which assists in increasing their understanding, skills, and approach to addressing communal issues while pursuing their professional careers [7]. Moreover, Paletta and Bonoli [8] adopt a distinctive method in examining the role of universities, starting with the University of Bologna, in revising their courses, curricula, pedagogy, research curricula, campus management, and partnerships. These efforts were central to realizing the 2030 agenda, which explicitly takes into account the UNSDGs.

Paletta and Bonoli [8] assert that the university prepared a reporting tool to measure its progress related to the implementation of the UNSDGs, which was displayed on the occasion of the G7 Environment meeting that took place in Bologna in 2017. Similarly, in Portugal, graduate programs were representing the SDGs more as compared to undergraduate programs. These graduate programs were in the disciplines of nature and social and environmental sciences, along with the humanities [9]. Concerning the implementation of the SDGs in the UAE region, the MBR Solar Park has been archetypal in its profound ecological effect by using clean energy rather than fossil fuels, which are readily used in the region. The MBR Solar Park has contributed to a reduction in carbon emissions by 6.5 million tons. Moreover, it is expected to reveal a greater impact. The Park has also marked progress towards several SDGs, including SDGs 8, 9, 11, and 15 [10]. Despite an increase in gas production over the years, from 2010–2014 there was a substantial rise in demand ahead of economic development, a spike in demographics, and other development projects in the Middle East. Subsequently, the Kingdom of Saudi Arabia (KSA), Qatar, and the UAE have been encountering considerable energy deficiencies, mainly in natural gas resources [11].

For instance, it has been reported that for 2011, most of the Arab nations were far behind in the generation of renewable energy resources, which was $1000 \text{ m}^3/\text{capita}/\text{year}$, symbolizing the water poverty line. For these countries, i.e., KSA, Kuwait, Bahrain, Qatar, and Yemen, reserves were not more than $100 \text{ m}^3/\text{capita}/\text{year}$. Coupling factors such as population rise, rapid urbanization, and economic development resulted in a degenerative effect on these inadequate and scarce resources, while climate effect also had a clipping impact on these resources. All such factors led to an increased tendency of reliance on energy-intensive desalinated water [12].

More alarmingly, food security in the Middle East and North Africa region is worryingly obstructed by dwindling water resources and barren land occupation, all of which affect the availability and reliability of food [12]. The UAE ranks 35th, comparatively low, in the 2021 Global Food Security Index, and relies on imports to meet over 80% of its food needs [13]. The UAE has only achieved one of the Sustainable Development Goals, with

most not on track to be met by 2030. The country has plans to invest in projects aimed at reaching 50% clean energy by 2050. However, this study has identified a lack of clear strategies for achieving these targets. Further, this study has recommended governmental interventions for inter-organizational cooperation and the collaboration of other institutions to avoid conflicting plans and successfully achieving the outcomes [14]. There is a need for the UAE to find a permanent solution for desalination to address its water scarcity [15]. In the wake of the Abraham Accords, the UAE has established a USD 10 billion investment fund for coping with the pressing issues of water desalination and agricultural development via employing the modern water technology of Israel, as the UAE and Bahrain possess limited surface water reservoirs. Hence, they rely heavily on imported basic food items. In particular, the UAE and Bahrain possess the smallest arable land. While the UAE is motivated to achieve SDG 15, significant obstacles still exist [16]. Notably, many key indicators are lacking, making it difficult to accurately measure the country's progress. Additionally, the UAE must emphasize innovative strategies for achieving the SDGs, while also creating a sense of urgency to implement them more quickly in the climate-vulnerable region [17]. The findings of the study by Hansen et al. [18] were limited to Florida as it attempted to explore challenges and innovations in the integration of SDGs. Kestin et al. [19] published a report about the role of HEIs in the Asia-Pacific region. Pallant et al. [20] reviewed the strategies implemented by Allegheny College in Pennsylvania, United States of America, for SDG integration. It was also found that there was a minimal focus by the HEIs on four SDGs, namely, no poverty, zero hunger, clean water and sanitation, and climate actions [21]. The scope of other recent studies was limited to Italian state universities [22,23] and the Basque country [24].

Numerous studies attempted to explore the status of SDGs in the UAE. However, no study has identified the challenges faced by universities in the UAE in integrating and implementing the SDGs. Sigahi [25] also highlighted complexity and different paradigms in education. The same concern while asserting that despite an exponential proliferation of educational institutions in the world, the concept of sustainability has only become part of rhetoric, without concrete integration and implementation on the ground, leaving no substantial impact [25].

Consequently, the present study demonstrates the realization of the UNSDGs, the role of higher education institutions in implementing them, and the challenges along the way in the UAE. The results of this study will provide insights to the students, researchers, policymakers, decision-makers, and governmental entities that have been endeavoring to mitigate climate vulnerabilities. Moreover, the findings of this study will also be helpful as a blueprint for supranational organizations such as the European Union and the Association of Southeast Asian Nations to increase collaborative efforts with educational institutions to mitigate the climate repercussions in their regions. The structure of this study will be as follows: Section 2 will be a review of the literature, Section 3 comprises methodology, Section 4 will offer results, Section 5 will encapsulate discussion of the findings, and Section 6 will consist of the conclusion.

2. Literature Review

The United Nations Sustainable Development Goals (UNSDGs) were formed in 2015 as part of the 2030 Agenda for Sustainable Development. The UNSDGs were recognized as tackling the world's most pressing issues, i.e., poverty, inequality, and environmental degradation. More specifically, the 17 goals and 169 targets envision ending poverty, protecting the planet, and ensuring peace and prosperity for all by 2030 [26]. They were created to provide a shared vision and framework for action for all countries, including developed and developing countries, to address the social, economic, and environmental challenges encountered by the world [26]. In the following, a detailed account of these 17 SDGs has been provided.

2.1. Ending Poverty

The United Nations has a goal to eradicate poverty worldwide; however, current poverty rates are still high. Despite efforts from various organizations, recent data show a concerning picture. According to the UN, in 2013, people who had been living under the poverty line numbered 767 million, as they had been receiving wages of less than USD 1.90 [27].

2.2. Zero Hunger

Hunger begets poverty. UN reports indicate that the number of malnourished individuals worldwide has decreased from 15% (2000–2002) to 11% in 2014–2016. It resulted in a reduction from 930 to 793 million people [27].

2.3. Good Health and Well-Being

As highlighted by the UN, though substantial progress has been made in global health since 2000, the healthcare sector continues to struggle with illnesses and widespread suffering. To achieve the SDGs, all the regions of the world must meet their health targets by 2030 [27].

2.4. Quality Education

As stated by UN reports from 2014, the goal of providing quality education possesses prime importance. Despite 63% of the world's population of children having been enrolled in primary or pre-primary educational programs, the total enrollment ratio in developed countries was only 40% [27].

2.5. Gender Equality

The UN emphasizes the promotion of gender equality. However, there are disparities in gender equality statistics across the world due to differing definitions. Nevertheless, the UN observes deeply-rooted gender inequality across the world, which denies women and girls their rights and opportunities. From the period 2005 to 2016, 19% of women aged between 15 and 49 from 87 countries had shared their experiences of being victims of physical and/or sexual assault from their partners in the preceding 12 months. These findings specify a pressing issue that the UN's gender equality efforts aim to wrestle with globally [28].

2.6. Clean Water and Sanitation

The UN stresses guaranteeing access to potable water and improved sanitation worldwide. As per UN reports from 2015, a total of 6.6 billion individuals had access to better sources of potable water, and people with better sanitation numbered 4.9 billion. However, the majority of those without these amenities reside in developing states [27].

2.7. Affordable and Clean Energy

As per UN reports, accessing affordable and clean energy is a basic human right, but not all people have it. In 2014, 85.3% of people around the world had electricity, leaving 1.06 billion people, mainly those living in rural areas, without this necessity [28].

2.8. Decent Work and Economic Growth

According to the United Nations, ensuring decent work and promoting economic growth is an enduring challenge for countries, particularly in underdeveloped and less developed nations, due to scant resources and population expansion. The real GDP per capita growth globally during five years (2010–2015) was 1.6%, which was higher than the 0.9% during 2005–2009. In contrast, the average annual growth rate of real GDP per capita worldwide in 2020 was negative as a result of widespread lockdowns and disruptions to global trade and commerce [29].

2.9. Industry Innovation and Infrastructure

Infrastructure and industrial advancements are regarded as the foundation of sustainable economic growth. According to UN reports, in the year 2015, air transport was anticipated to reach USD 2.7 trillion, which was equal to a 3.5% share in global GDP. This level of growth is a challenge for underdeveloped nations, particularly those that are land-locked. The reports also indicated that the share of GDP attributed to manufacturing value added increased to 16.2% from 15.3% in 2016 [27].

2.10. Reduced Inequalities

In light of UN reports, equality is a vital element for sustainable development. From 2008 to 2013, 49 out of 83 countries with available data saw the income of the bottom 40% of the population growing at a faster rate as compared to the overall average. However, the level of inequality varies across countries [27].

2.11. Sustainable Cities and Communities

Universally, population growth in urban and rural areas is inadequate and uneven. The share of the urban population has risen globally. The UN envisages ameliorating living standards through its “sustainable cities and communities” indicator. According to UN data, 54% of the total population of the world lives in cities, and this is expected to rise to 5 billion by 2030 [27].

2.12. Responsible Consumption and Production

Manufacturers are mainly responsible for sustainably produced goods, but consumers also have a role to play in sustainable consumption. To promote sustainable consumption and production, the UN has designed awareness and legal initiatives. According to some reports published by the UN, domestic material consumption per unit of GDP rose from 1.2 kg to 1.3 kg between 2000 and 2010. Total domestic material consumption also increased to 71.0 billion tons in comparison with the previous limit of 48.7 billion tons during the same period [27].

2.13. Climate Action

Climate action is a topmost priority for nations worldwide. Many international organizations, including the UN, consider climate as a key constituent to achieving sustainability in developmental projects and have included it in their objectives. This is essential, as climate impacts many aspects of human life. UN reports indicate that in 2016, planetary warming reached a new high of 1.1 degrees Celsius above preindustrial levels, indicating rapid climate change. Some countries are using sustainable energy projects to protect their climate and some have discontinued production of carbon-based energy [27].

2.14. Life below Water

Organizations such as the United Nations have established programs aiming to optimize the development and utilization of marine resources. According to a UN report, global trends show a persistent decline in coastal waters due to pollution and eutrophication. The Transboundary Waters Assessment Program found that 16% of the 63 large marine ecosystems evaluated are at “high” or “highest” risk for coastal eutrophication [27].

2.15. Life on Land

Industrialization has brought about various challenges to life. The United Nations focuses on sustainable development to preserve life on land. The loss of forests has decreased, as more emphasis has been given to plantations backed by voluntary certification [27].

2.16. *Peace, Justice, and Strong Institutions*

Ensuring peace, justice, and strong institutions are vital goals of the UN. Research in 2015 showed that the number of victims of intentional homicide worldwide was between 5.2 and 6.7 per 100,000 people, emphasizing the need for more effective prevention [29].

2.17. *Partnership for Goals*

To achieve its sustainable development goals, the UN has established worldwide partnerships, which are part of its mission. In 2016, UN reports showed that there was an 8.9% rise in net official development assistance from the Organization of Economic Cooperation and Development (OECD)'s Development Assistance Committee, which was equal to USD 142.6 billion, signifying a breakthrough in this regard [29].

2.18. *The Role of Universities in Achieving the Sustainable Development Goals*

Higher education institutions (HEIs) are quintessential for sustainable development and implementing the 17 Sustainable Development Goals of Agenda 2030 [30]. It is considered a vital responsibility of HEIs to actively participate in achieving the SDGs. Universities are morally empowered to support the SDGs as part of their social missions and central purposes. Progress toward the SDGs in universities requires participation from various stakeholders, such as non-governmental organizations (NGOs), businesses, think tanks, and universities themselves, who bring expertise and knowledge to the table and assist governments in realizing what have become strategic goals in the wake of climatic devastation [30]. The policies and decision-making informed by academic experts and students are perceived to be more effective and consistent actions toward achieving the SDGs [31]. Universities and higher education institutions can greatly contribute to the success of sustainable development goals by providing scientific knowledge, evidence, and experience to inform policy-making at both national and international levels. They can act as a bridge between scientific and political communities to facilitate effective collaboration in decision-making and in developing a methodology, such as a framework, for implementing the SDGs. Nogueiro et al. [32] conducted a study to evaluate the significance of the Erasmus+ Programme and found that through 2030, there would be an increased relevance of quality education, gender equality, decent work, and economic growth among all the SDGs. Another recent study by Nogueiro et al. [32] investigated the significance of the Erasmus+ Programme for implementing SDGs for sustainability in HEIs. The findings articulated that through total quality management, synergies can be created between HEI goals and SDG implementation [33]. Ferguson et al. [34] also conducted a case study to examine the role of HEIs in realizing SDGs in the West Indies. The findings of this case study revealed that through a strong emphasis on SDG 4 (education), the implementation of other SDGs could be expedited. Universities are often viewed as models to follow [15,24] and are considered exemplary places to research and experiment with sustainable approaches and practices in various aspects of their operations—education, campus management, institutional policies, reporting, community engagement, and research. The potential impact that universities can have on the SDGs is extensive. Previous research has emphasized the need to recognize the benefits of incorporating the SDGs in crucial aspects of university operations such as (a) research and innovation, (b) education, (c) governance and campus management, and (d) community involvement and outreach. Adopting the SDGs should not be deemed a burden but rather an opportunity. The UN SDGs are widely supported by governments, businesses, investors, and civil society, making them a globally recognized framework. Thus, universities can leverage this support and reap benefits such as showing their impact as a sustainable institution, crafting connections with external stakeholders, growing demand for education on sustainability and the SDGs, and accessing new funding opportunities via the identification of challenges.

3. Materials and Methods

3.1. Study Design and Sampling

This study adopted a mixed-method study design by conducting interviews with deans and surveys of faculty members at universities in the UAE. The researchers have opted to employ this study design due to its robustness, incorporating both qualitative and quantitative methods to collect data and conduct an analysis in one study [35]. This study design enables the researchers to grasp complex areas of scientific inquiry with the help of statistical analysis numbers and charts. According to Rossman and Wilson [36], such studies assist in policy research to solve real-life problems with social sciences in focus while observing the world through multiple angles. These advantages surpass the benefits of other eclectic research methods, as mixed-method studies provide the perspectives of the stakeholders directly involved in policy-making in contrast to a single method or qualitative study. In the context of the present study, this approach will help to encapsulate not only the perspectives of the main stakeholders but also take into account real-life observations of faculty regarding the role of HEIs in instilling sustainability. This study employed a purposive sampling technique to recruit 15 deans from different disciplines from universities in the UAE. For survey participants, the researchers employed random sampling to recruit teachers from public universities in the UAE as a representative of a large study population. This sampling technique was employed to recruit a small and random percentage of the entire population, reflective of the entire data set [37]. A survey questionnaire was sent online to the teachers at the universities. Using Raosoft 2007, an online sample size calculator, the recommended sample size of the study was 313. A total of 380 questionnaires were sent online. Out of these, only 350 responses were included due to their complete responses.

3.2. Study Procedures

The researchers identified universities with relevant research or academic programs in environmental science, sustainability, or engineering for recruiting professors and deans who had expertise in climate change in the UAE. This helped to ensure a representative sample of perspectives on climate change in the UAE. Also, only universities having a research office or a research committee were included, so that it could assist the study procedures of recruiting participants and obtaining ethical clearance. The study was carried out from 14 November 2022 to 15 December 2022.

3.3. Study Tools

Semi-structured interviews were conducted with deans to gather their perceptions and experiences regarding the role of higher education institutions in realizing the UNSDGs in the UAE (Appendix B). The interviews were conducted in person and via video call and were audio-recorded. An interview guide was developed and provided to ensure that all participants were asked the same questions and to ensure that the interviews were structured. The guide included open-ended elements to obtain detailed responses, perceptions, and experiences regarding the role of higher education institutions in realizing the UNSDGs from the participants in the UAE. However, the researchers drafted both the survey and interview questionnaires based on the extensive review of the literature. The services of two academic experts were acquired, who suggested modifying the questionnaires. Acting upon their suggestions, the researchers modified the questionnaires and adopted them for the study (Appendix A). The survey questionnaire comprised a five-point Likert scale spanning Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree.

3.4. Reliability and Validity

For validity, the researchers acquired the services of academic experts. For reliability, the reliability coefficient was measured through Cronbach's alpha, which came out to be more than 0.7 (Table 1), which signaled that the questionnaire was fit to adopt for the study [38].

Table 1. Stability Coefficient.

Cronbach's Alpha	N of Items
0.787	19

3.5. Data Analysis

The data collected from the interviews were recorded and analyzed using a thematic analysis approach. The analysis involved identifying common themes and patterns in the data and organizing the data into meaningful categories. These themes included sustainability in curriculum integration, campus sustainability, student engagement, community engagement, collaboration and partnerships, governmental policy, resources, and funding. On the other hand, descriptive statistics were measured using SPSS version 27.

3.6. Ethical Considerations

Before conducting the study, the authors obtained approval from the Institutional Review Board of _____ University with IRB Number _____. Participants were informed of the study's purpose, the data collection methods, and how the data were used. They were also informed of their right to withdraw from the study at any time and their data confidentiality.

4. Results

Table 2 presents the demographic details of the survey participants. The mean age of the participants was 45.12 ± 7.930 . The majority of the study participants were male (188), while there were 162 females in this study. Moreover, the majority of the participants were aged between 54–55 years, with the majority of the participants having more than 5 years' experience.

Table 2. Demographic details of the participants.

Items	Frequency	Percent
Age		
32	10	2.9
33	13	3.7
34	17	4.9
35	12	3.4
36	9	2.6
37	14	4.0
38	13	3.7
39	13	3.7
40	8	2.3
41	8	2.3
42	13	3.7
43	14	4.0
44	11	3.1
45	14	4.0
46	12	3.4
47	10	2.9
48	11	3.1
49	12	3.4
50	14	4.0

Table 2. *Cont.*

Items	Frequency	Percent
51	12	3.4
52	14	4.0
53	15	4.3
54	19	5.4
55	19	5.4
56	15	4.3
57	13	3.7
58	15	4.3
Total	350	100.0
Gender		
Male	188	53.7
Female	162	46.3
Total	350	100.0
Years of Experience		
5.0	214	61.1
6.0	21	6.0
7.5	49	14.0
8.0	66	18.9
Total	350	100.0

Table 3 presents the results of the descriptive statistics of the survey responses, wherein the participants highlighted a greater level of awareness among the students and faculty regarding the implementation of the SDGs in the UAE. Regarding the extent of the integration of SDG policies in UAE universities, the majority of the participants' responses showed that the integration was not considerable. Despite this, the availability of adequate financial resources showed that financial resources were not a considerable challenge for the implementation of SDGs. Also, collaboration and partnership were present among the universities and different stakeholders, which was contrary to the absence of the political will of the government to accelerate the pace of the integration of SDGs while assisting the universities. According to the results, the staff and faculty are fully trained to support the university's initiative to implement the SDGs into their systems. However, regulatory frameworks were found to be the areas to pay attention to. More importantly, the participants viewed the complexities and interconnectedness of SDGs as posing challenges for universities. In addition, the challenges recognized by the participants included the identification of priorities for the most impactful SDGs, reduction of the environmental footprints of universities, the lack of sufficient collaboration and communication among universities, tracking the progress of SDGs in the absence of reporting protocols, impediments to participation posed by cultural and societal factors, bureaucratic hurdles, and political and economic influence over the prioritization of SDGs in university strategic planning. However, the results revealed that change in governmental economic and energy policy could be a factor in accelerating the implementation and desired change in terms of the successful implementation of SDGs.

Table 3. Descriptive statistics.

	Items	Frequency	Percent
SQ1	Disagree	142	40.6
	Agree	23	6.6
	Strongly Agree	185	52.9
	Total	350	100.0
SQ2	Neutral	221	63.1
	Agree	50	14.3
	Strongly Agree	79	22.6
	Total	350	100.0
SQ3	Strongly Disagree	4	1.1
	Disagree	310	88.6
	Agree	36	10.3
	Total	350	100.0
SQ4	Disagree	328	93.7
	Agree	22	6.3
	Total	350	100.0
SQ5	Strongly Disagree	39	11.1
	Disagree	230	65.7
	Neutral	26	7.4
	Agree	55	15.7
	Total	350	100.0
SQ6	Strongly Agree	10	2.9
	Strongly Disagree	298	85.1
	Disagree	20	5.7
	Strongly Agree	22	6.3
	Total	350	100.0
SQ7	Strongly Disagree	1	0.3
	Disagree	294	84.0
	Agree	39	11.1
	Strongly Agree	16	4.6
	Total	350	100.0
SQ8	Disagree	60	17.1
	Agree	64	18.3
	Strongly Agree	226	64.6
	Total	350	100.0
SQ9	Strongly Disagree	69	19.7
	Disagree	183	52.3
	Agree	64	18.3
	Strongly Agree	34	9.7

Table 3. *Cont.*

	Items	Frequency	Percent
SQ10	Neutral	152	43.4
	Agree	60	17.1
	Strongly Agree	138	39.4
	Total	350	100.0
SQ11	Agree	292	83.4
	Strongly Agree	58	16.6
	Total	350	100.0
SQ12	Agree	52	14.9
	Strongly Agree	298	85.1
	Total	350	100.0
SQ13	Disagree	17	4.9
	Neutral	44	12.6
	Agree	182	52.0
	Strongly Agree	107	30.6
	Total	350	100.0
SQ14	Neutral	82	23.4
	Agree	73	20.9
	Strongly Agree	195	55.7
	Total	350	100.0
SQ15	Disagree	25	7.1
	Neutral	47	13.4
	Agree	278	79.4
	Total	350	100.0
SQ16	Disagree	152	43.4
	Neutral	155	44.3
	Agree	43	12.3
	Total	350	100.0
SQ17	Neutral	8	2.3
	Agree	29	8.3
	Strongly Agree	313	89.4
	Total	350	100.0
SQ18	Disagree	4	1.1
	Neutral	31	8.9
	Agree	23	6.6
	Strongly Agree	292	83.4
	Total	350	100.0
SQ19	Strongly Disagree	3	.9
	Neutral	20	5.7
	Agree	47	13.4
	Strongly Agree	280	80.0
	Total	350	100.0

4.1. Results of Thematic Analysis

4.1.1. Sustainability Integration in Curriculum

Table 4 presents the demographic details of interview participants. The majority of the interviewees were male and aged between 46–50.

Table 4. Demographic details of interview participants.

Age	Frequency	Percent
46–50	10	67
51–55	05	33
Total	15	100
Gender	Frequency	Percent
Male	12	80
Female	3	20
Total	15	100.0
Years of Experience	Frequency	Percent
12–16	06	40
17–21	03	20
22–25	06	40
Total	15	100

Participants said that so far sustainability has been integrated into the curriculum but further changes could be made to better align these changes with the UNSDGs. One of the participants asserted that “I support the integration of the United Nations Sustainable Development Goals (UNSDGs) into the UAE university curriculum. I believe that it is important for universities to play a role in educating future leaders about the importance of sustainable development and how it can be achieved”. While talking about the need for sustainability in the curricula, another participant asserted, “The integration of the UNSDGs into the curriculum would help to raise awareness among students about the various sustainability challenges facing our planet, and provide them with the necessary knowledge and skills to address these challenges”.

4.1.2. Campus Sustainability and Student Engagement and Activism

Regarding the actions taken by higher education institutions to reduce their environmental footprints, such as energy efficiency, recycling, and sustainable procurement, participants discussed the initiatives. One of the participants vowed that “the UAE has set ambitious targets for renewable energy and sustainable development as part of its National Agenda. In line with these efforts, universities in the UAE are incorporating sustainability into their curricula, offering courses and programs focused on environmental sustainability, renewable energy, and sustainable development”. Moreover, “many universities in the UAE have taken steps to make their campuses more sustainable, such as implementing energy-efficient technologies and promoting environmentally-friendly practices such as using paper bags, waste management for. . . I think recycling purposes!” As part of student engagement, it was contended by a professor that “students in environmental studies departments in UAE universities likely attend seminars as part of their coursework. Seminars are a common way for students to learn about current research, trends, and developments in their field of study”.

However, one stated that “most of the students usually do not attend these seminars due to their lack of interest or the seminars do not provide useful, pragmatic and actionable insights”. Thus, it has become a challenge for universities to ensure the attendance and interest of the students in these seminars. In addition, a professor pinpointed and suggested

that “although there are workshops that are more appealing to students as part of students’ engagement, there is a need to broaden the scope of these workshops in the form of their social action projects as part of their academic coursework”. More importantly, one participant highlighted that energy-efficient buildings, waste-management programs, recycling, and sustainable food options are the most important aspects to consider in campus sustainability while increasing the admission there.

4.1.3. Community Engagement, Collaboration, and Partnerships

Participants deliberated how higher education institutions engage with the community and contribute to sustainable development through outreach programs, volunteerism, and partnerships with local organizations. Participants discussed the significance of collaboration and partnerships between higher education institutions, businesses, governments, and other organizations to achieve the UNSDGs. “The students need more exposure to the industries during their coursework that must be practical but not academic only”, a participant stressed. Participants observed that “sustainability fairs must be launched and the students must be given access and resources to build small-scale infrastructural facilities such as libraries, cafeterias, and small vehicles that are sustainable and carbon-free, inside the campuses”. In the views of the participants, “allowing and encouraging such initiatives at the university level will increase start-ups in the UAE too as start-up economy is becoming popular in Israel and India”. The professors were also concerned about importing agricultural and water desalination technologies from other countries.

According to them, “it is better to look for international cooperation and collaboration rather than depending on the imported technologies as the geographical, economic and other national conditions sometimes vary and do not align with the home country”. Thus, some have called it “a challenge to persuade the concept of local problems with local solutions to over the harsh effect of climate change”; especially, “...to encourage the students to find the solutions for achieving sustainability in their country”.

4.1.4. Governmental Policy, Resources, and Funding

Participants were strong advocates of policies and the role of government in providing further space to higher education institutions in the UAE. For them, “it is the most important aspect that the government builds the state-of-the-art research institutes in the universities for ensuring the SDGs such as ending poverty, quality and scientific education, and environment; for me, it will be the first step toward right direction. . .” Despite some universities have separate research centers “with the collaboration of both the national and international organizations, the follow-up and implementation of these research institutes on the practical ground is not satisfactory”. “There are intellectual barriers, and lack of spirit and commitment that impede the productivity and implementation of these research institutes”. It was opined that “the government needs to initiate dialogues with universities and provide them with policy guidelines to tackle with the pressing issues of food insecurity, water scarcity, and climate-induced national disasters”.

If the focus of the government is to find local solutions through institutional collaboration, it will be a favorable and productive initiative instead of importing and outsourcing the solutions. Currently, the universities and their research centers must research sustainable agriculture and water recycling side by side with methods of water desalination, a participant highlighted. Also, “it is the need of the hour to prevent over-consumption and realize the potential and need of sustainable consumption in the UAE society as a whole”.

4.2. Strengths and Limitations

The present study determines the role of higher education institutions in the UAE in implementing and achieving the UNSDGs. This study asserts that these institutions have a critical role in ensuring sustainability takes a substantive role worldwide. This study highlights the potential weaknesses of this resource-rich region and pinpoints the areas of improvement in the views of experts and academicians while conducting face-to-face

interviews for more practical observations. Theoretically, these findings add to the existing body of knowledge related to the role of educational institution in the UAE. These findings can be generalized in the context of the states neighboring the UAE due to similar geo-economic and socio-political factors. However, the sample of participants was smaller. Therefore, future studies can be conducted with the quantitative study design and a greater sample size in the UAE and other regions.

5. Discussion

This study highlights the significant role that higher education can play in promoting sustainability and the implementation of the UNSDGs. By integrating sustainability into their curricula, universities can educate and raise awareness of the importance of sustainability among students and the broader community. These findings are similar to the study by Boarin et al. [39] that analyzed the perceptions of university students about the role of their universities in greater sustainability. The study further asserted that sustainability integration across the universities of three regions—Oceania, Europe, and North America—varied and was dependent on their regional focus and goals. However, these findings are in contrast to the study by Ebaid [40], who investigated the views of undergraduate accounting students at universities in Saudi Arabia. They expressed their lower or limited understanding regarding sustainability, as their curriculum of accounting education was not integrated with sustainability.

Further, the present study stresses collaboration between universities, businesses, and the government to achieve the UNSDGs. By working together, universities can leverage their resources and expertise to make a greater impact on sustainability initiatives. The role of universities in conducting research and developing innovative solutions to address environmental challenges and promote sustainability cannot be ignored. By investing in sustainability research, universities can help drive progress in this critical area and make a positive impact on the world, as reported by Menon and Suresh [41].

This study highlights the importance of student involvement in sustainability initiatives. By providing opportunities for students to volunteer, intern, and participate in community outreach programs, universities can help students develop the skills and knowledge they need to make a positive impact on the world. The views of the participants are in line with the study by Hayles [42], who has substantiated the positive outcomes of an internship program as one of the ways campus-based sustainability activities at the University of Wales emboldened students to take charge of and implement real change with green initiatives.

However, it was asserted that there is still a need to promote thinking about local problems and local solutions and increase follow-up by research institutions with real change. Also, it is indispensable to initiate follow-up programs to the workshops and seminars in order to realize and observe the capacity, real change, and weaknesses of the existing systems and frameworks. However, the participants were concerned about the governmental policy of importing expertise and technology rather than developing institutional collaboration [43].

The present study has revealed that currently, universities in the UAE have been facing challenges related to funding availability, reduction in environmental footprint, and a dearth of communication and collaboration. Also, it reported the absence of any mechanism that could help to identify development of SDG adoption and rules and procedures to report progress. Implementation was also hampered by cultural and societal factors, bureaucratic hurdles, and political and economic influence over the prioritization of SDGs in university strategic planning. These findings are similar to the results of Lafuente-Lechuga et al. [44], which identified that major restructuring was needed to integrate sustainability in curricula using mathematical techniques. Also, the study by Leal Filho et al. [17] has similar findings, in which they stress increasing inter-university collaboration with more research, and revealed that students had a lack of inspiration and motivation regarding the adoption of SDGs in their learning. Contrary to the findings of the present study, Chisingui and

Costa [45] have concluded that according to their thematic analysis of biology teachers, the SDGs were not integrated yet. Argento et al. [46] asserted that for integrating SDGs, joint efforts and institutional cooperation were the two most important elements to ensure. Moreover, this study encapsulated insights from deans of public universities in the UAE, who have expressed the prominent role students can play in campus sustainability through community engagement, collaboration, and partnerships of HEIs with other institutions to help ensure sustainability. However, they identified the need for a more robust and focused governmental policy, allocation of resources, and funding in this regard. This study provided insights from the stakeholders of the universities, who have suggested the ways and highlighted the needed actions, resources, and procedures that can help to integrate and implement sustainability in higher education. These findings add up to the suitability of educational literature, which has been inadequately explored and discussed, as highlighted by Alam [25]. It can be implied that sustainability must be adopted as a new focus, as it will help to employ constructive means and optimization of resources, because all over the world, HEIs have been facing a scarcity of resources and shortages of available funds. Therefore, it is high time to realize the prospects of education and sustainability interchangeably, and consider sustainability the prime focus or panacea to most of the problems and challenges originating in the governance and public spheres, with an enhanced role for HEIs.

6. Conclusions

To sum up, universities in the UAE have been facing multiple challenges, i.e., a lack of resources, funding, knowledge, rules, and policies set by the government, with an inclusive focus. Further, the findings highlighted that in the absence of the active engagement of students, it has become difficult to adopt SDGs in HEIs. Also, the level of awareness of the implementation of SDGs was optimal in the HEIs of the UAE. This study of the role of higher education in the UAE and the significant challenges faced by its universities underscores the critical role that universities can play in promoting sustainability and making a positive impact on the world by countering the identified challenges. By working together, universities, businesses, and the government can help to achieve the UNSDGs and create a more sustainable future for all. Based on the participant interviews, most UAE universities have fully or partially integrated sustainability into their curriculum. Although some UAE universities already have state-of-the-art institutions and have been receiving funding for their research work, the implementation is not enough. Similarly, in UAE society as a whole, at all the tiers of government, there is a need to encourage local solutions to local problems with institutional collaboration, rather than focusing on creating reliance on imported technologies. By realizing the needed resources and governmental responsiveness, UAE universities can perform exemplary actions and bring real change to tackle climatic impacts on the region.

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Appendix A

SQ1: The level of awareness regarding the SDGs

SQ2: The extent of integration of SDGs

SQ3: Availability of financial resources

SQ4: Collaboration and partnership

- SQ5: Availability of data and metrics to measure progress
- SQ6: Alignment between academic progress and research
- SQ7: Training of staff and faculty
- SQ8: Awareness and engagement of students
- SQ9: Regulatory policy and frameworks
- SQ10: Complexities and interconnectedness of the SDGs
- SQ11: Identifying priorities for the most impactful SDGs
- SQ12: Reducing environmental footprints
- SQ13: Lack of sufficient collaboration and communication
- SQ14: The absence of reporting protocols
- SQ15: Government's lack of will as a barrier
- SQ16: Cultural and societal factors
- SQ17: Bureaucratic processes' impact on agility and responsiveness
- SQ18: Political and economic influence over the prioritization of SDGs
- SQ19: Impact of change in the economic and energy policy of the government

Appendix B

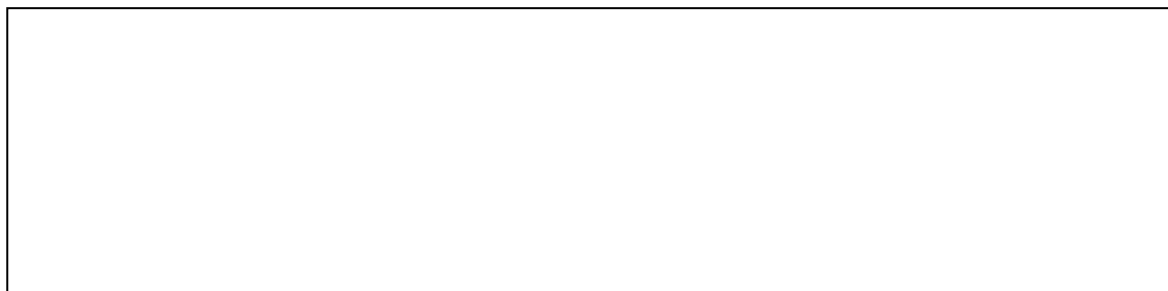
Interview Questionnaire

1. What is the role of sustainability integration in educational curricula of HEIs?

2. What role can students play in campus sustainability?

3. How are community engagement, collaboration, and partnerships of HEIs with other institutions helpful in ensuring sustainability?

4. Highlight the potential role of governmental policy, resources, and funding in this regard.



----End of Interview----

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Article

E-Waste Recycling Behavior in the United Arab Emirates: Investigating the Roles of Environmental Consciousness, Cost, and Infrastructure Support

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Abstract: This study examines whether consumers' behavior affects e-waste recycling in the UAE. This paper provides a theoretical model of e-waste recycling behavior based on the theory of planned behavior (TPB), and it goes on to analyze the impact of environmental consciousness, infrastructural support, and costs in e-waste recycling. To assess this study's constructs, a survey instrument is created. The theoretical model is tested using data gathered from a survey of UAE residents. PLS-SEM (partial least squares structural equations modeling) is used to assess the data. The results support the use of the TPB in the e-waste recycling behavior context. Furthermore, this study shows intriguing findings regarding the effect of environmental consciousness, perceived infrastructural support, and the cost of e-waste recycling. Environmental consciousness shows a positive moderation effect on the association between e-waste recycling attitudes and intentions. This finding implies that the environmental consciousness of residents should be increased to translate e-waste recycling intentions into behavior. Environmental consciousness can be enhanced through training programs. Furthermore, special sustainability courses in higher education that focus on improving environmental awareness among students will have a lasting impact. This study supports the positive moderation effect of perceived infrastructure support on the association between recycling intentions and behavior.

Keywords: e-waste recycling behavior; environmental consciousness; cost of recycling; infrastructure support; theory of planned behavior; UAE



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1. Introduction

The awareness of and emphasis on managing various kinds of waste worldwide are continuously on the rise, even though challenges related to policies, resources, and infrastructure remain the same. However, the challenges that developing countries face in waste management significantly differ from those of developed countries. In developed countries, resources do not pose constraints for waste management. However, the development of appropriate policies that encourage waste collection and disposal still needs to be strengthened. On the contrary, developing countries need to build resources and infrastructure and formulate policies that favor the proper management of various kinds of waste. Furthermore, developing countries must overcome the additional pressure of several environmental health issues.

E-waste is one of the most rapidly increasing wastes faced by all the countries across the globe, as it produced 50 million tons of e-waste in 2018. The United Arab Emirates

(UAE) is a top-ranking country in the production of e-waste. According to the United Nations Global Waste Monitor Report from 2016, the per capita e-waste production in the UAE amounted to 17.2 kg, with the total quantity of e-waste equaling 134,000 tons. The UAE government has taken several initiatives to combat the generation of e-waste and dispose of the collected e-waste through proper systems and practices. One of their major initiatives is to divert 70% of solid waste collected from landfills. Furthermore, the UAE government implements different initiatives targeted towards managing e-waste with the participation and support of the private sector as well.

Even though these initiatives will result in a reduction in the harmful effects of e-waste generation, a constant increase in the consumption of electronic gadgets supported by the rise in disposable incomes; the development of cost-effective e-waste management techniques; a lack of public awareness about the significance of e-waste management; and inadequate policies that encourage e-waste disposal in appropriate ways make e-waste management a challenging task for all countries, especially developing countries.

Most of the research related to e-waste recycling has been conducted in China, followed by the USA and India [1,2]. Research into consumers' e-waste recycling behaviors has applied various behavioral theories (e.g., theory of planned behavior (TPB), behavioral reasoning theory (BRT), norm activation theory, and valence theory) and investigated the fundamental factors around the applied theory. Additionally, researchers have extended the applied theory with various other contextual factors. For example, a study by Dhir et al. [3] in Japan applied the valence theory and extended it by investigating the moderating effect of consumers' past experiences with contacting recycling centers, government agencies, and second-hand sellers. Similarly, Nadarajan et al. [4] also extended the valence theory and conceptualized all the factors as antecedents of e-waste recycling intention and found that perceived convenience, environmental concern, willingness to change, and subjective norms have significant direct effects on e-waste recycling intention. Recent research by Lyu et al. [5] investigated online e-waste recycling in China and integrated the elaboration likelihood model, innovation diffusion theory, and social cognition theory. They investigated the moderating effects of privacy, price fairness, and environmental concerns and identified a negative moderation effect of these variables. Another study by Mohamad et al. [6] in Malaysia investigated e-waste recycling behavior by extending the TPB with direct effects of environmental consciousness, perceived convenience, and moral obligation on e-waste recycling intention and found that only perceived convenience and moral obligation had significant effects.

One of the significant observations from previous research is that the studies on e-waste recycling behavior are limited in examining moderation effects [1]. Most studies emphasize the direct or mediation effects of the factors contributing to e-waste recycling intention. Environmental consciousness is one of the important factors that have the potential to shape e-waste recycling intention [7–11]. This study proposes to investigate the moderation effect of environmental consciousness on the relationship between antecedents, such as attitudes, subjective norms, and perceived behavioral control, and e-waste recycling intention. This specific finding would imply the inclusion of the concept of sustainability in school and higher education curriculum so that students at a young age are aware of the causes and consequences of environmental degradation [12]. The findings of this study would imply an emphasis on science education in the secondary school curriculum in order to achieve sustainable development goals [13] as it has the potential to improve the environmental consciousness of students with different socioeconomic statuses (SESs). A study conducted in Finland by Sammalisto et al. [14] among undergraduate students confirmed that studying courses on sustainability resulted in improved sustainability behavior in the students. Higher education institutions should assume the role of educating all the stakeholders of society about sustainability to inculcate pro-environmental behavior, including e-waste recycling [15]. Furthermore, consciousness of the environment could drive educational institutions to work on research projects with the objectives of environmental protection and natural resources [12].

Another important observation from previous research is that the studies in this area are limited in diagnosing how the gap between e-waste recycling intention and behavior could be bridged [16,17]. In this study, we investigate the moderation effect of the perceived cost of e-waste recycling and infrastructure support in the relationship between e-waste recycling intention and behavior.

Therefore, this study addresses the following two research objectives: The first one is to investigate the moderation effect of environmental consciousness on the association between the antecedents of the TPB (attitudes, subjective norms, and perceived behavioral control) and e-waste recycling intention. The second is to examine the moderation effects of infrastructure support and costs of e-waste recycling on bridging the gap between e-waste recycling intention and behavior. Additionally, there are limited studies on understanding consumers' recycling behavior in the Middle Eastern region. This study is novel in attempting to address this research gap and integrates the relevant factors driven by the UAE context in understanding consumers' e-waste recycling behavior. This paper further discusses the basis of our proposed theoretical model and hypotheses development; the methodology used for data collection, analysis, and results; discussions; and implications in the subsequent sections.

2. Literature Review

Many researchers have studied e-waste recycling behavior in the past. Generally, the basic psychological needs theory [18], theory of planned behavior (TPB) [19,20], norm activation theory [21], social cognitive theory [22], social capital embeddedness theory [23], and behavioral research theory [24] have been applied to investigate the factors that affect e-waste recycling behavior. Some researchers combined any of the two theories. For example, Wang et al. [25] applied both the TPB and norm activation behavior theory, and Dhir et al. [26] applied both the TPB and behavioral reasoning theory. In addition to the application of variables included in the respective theories, variables such as environmental consciousness and assessment [16,27] and demographic variables [16,28] have also been investigated. It is evident from past research that the complexities of human behavior necessitated the researchers to go beyond one model to understand human behavior in a specific context.

Among the theories mentioned above, the TPB has been widely used in the e-waste recycling context. Most researchers use the TPB as the base model, as it explains the fundamental structure of the behavioral process, and customize this theory to suit the context and purpose of the research. This customization is essential to provide context-specific policy-level implications towards a sustainable environment and healthy lifestyle. For example, in Brazil, Echegaray and Hansstein [16] found significant effects of environmental assessment and awareness of environmental problems on e-waste recycling behavioral intention along with the variables of the TPB.

Researchers have identified a variety of determinants for the formation of e-waste recycling intention. Yadav et al. [29] applied the BRT to examine e-waste recycling intention in India and posited inconvenience, the lack of a support system, and emotional attachment as the 'reason against' e-waste recycling and posited self-image, perceived negative effects, and salvage value as the 'reason for' e-waste recycling and found a direct correlation of these reasons with the intention to recycle e-waste. Interestingly, they found a significant positive effect of social and moral norms on attitudes towards e-waste recycling. They also found a moderating effect of self-efficacy on the association between 'reason for' and the intention to recycle and the association between attitude and the intention to recycle. Similarly, Dhir et al. [26] also applied the BRT to identify factors impacting e-waste recycling intention and included environmental and personal benefits as the 'reason for' e-waste recycling and included risk, image, value, and usage barriers as the 'reason against' e-waste recycling. They investigated the effects of the reasons on attitude and the intention to recycle e-waste. They further examined the moderation effects of environmental assessment and awareness on the relationship between the 'reason for' recycling e-waste and intention,

the ‘reason against’ recycling e-waste and intention, and attitude and intention. Wang et al. [28] investigated e-waste recycling intention in China by applying the TPB and found positive direct effects of attitudes and environmental awareness on e-waste recycling and negative effects of income, costs of recycling, and perceptions of informal recycling on e-waste recycling. Another study by Wang et al. [30] in China examined the effect of economic motivation on e-waste recycling intentions and found that it had a significant impact on e-waste recycling intentions. Kumar [27] examined the effect of convenience on recycling intentions in India and China and surprisingly did not find an effect in neither country. The author attributed the lack of availability of convenient facilities to this non-significant effect.

It is generally acceptable that information about environmental degradation and its associated long-term consequences is easily accessible to the consumers of electronic devices through different channels, including social media. Concerns about the environment play important roles in shaping the behavior of individuals towards environmentally friendly consumption and disposal. Realizing its importance, in previous studies, researchers have assessed the effect of environment-related factors on recycling behavior [11,16,31]. Consumers’ concerns about environmental problems and their attitudes and intent towards reducing these problems are conceptualized as environmental consciousness [11,31,32]. Considering the abundant usage of electronic devices among consumers who are expected to have a good understanding of the environmental issues created by e-waste, their level of environmental consciousness is expected to play an essential role in the study of e-waste recycling behavior.

Most studies (except for a few; for example, [16,17]) only investigated the intention to recycle e-waste; limited attention was given to e-waste recycling behavior. The relationship between intention and behavior towards e-waste recycling is under-explored. In a study conducted by Echegaray and Hansstein [16] in Brazil, it was found that there was a higher level of intention to recycle e-waste (average rating of 4.7 on a five-point scale); however, merely 6% of the respondents ended up recycling their unused electronic devices. This statistic is reported to be only 11% in China, as per the studies by Wang et al. [33] and Yang et al. [34]. Similarly, another study conducted by Arain et al. [35] in the USA found that 80% of the respondents did not use formal e-waste recycling mechanisms, even though they knew the importance of recycling e-waste.

The gap between intention and behavior has been investigated in other pro-environmental behavior contexts, such as green purchase [36], energy conservation [37], and recycling [38]. The researchers focused on institutional, situational, and psychological factors to examine how intention is translated into behavior. Rausch and Kopplin [36] found the moderation effect of perceived economic and aesthetic risks on the relationship between sustainable clothing intention and behavior. Mack et al. [37] examined the roles of prompted commitment, implementation information, and guided process monitoring to narrow the intention–behavior gap in the context of electricity saving. Park and Lin [39] found that the intention–purchase gap for consuming recycled products depended on perceived consumer effectiveness and utilitarian value. Satisfaction and trust based on previous experience with consuming organic food were found to bridge the intention–behavior gap [40]. Goldsmith et al. [41] found a moderating effect of price sensitivity on the association between green purchase intention and behavior. Similarly, Ran and Zhang [17] found a significant moderation effect of price sensitivity on the association between mobile phone recycling intention and behavior. Research studies also highlight the role of access to facilities and government support in bridging the green intention–behavior gap [42].

3. UAE Context

E-waste generation in Gulf Cooperation Council (GCC) countries has grown significantly over the past forty years. GCC countries are mostly oil-based economies, and the economic growth in these countries resulted in population growth due to the residence of expatriates from across the world. An increase in population combined with higher per capita income resulted in an increase in the generation of e-waste. In 2018, Alghazo

et al. [43] estimated that GCC countries generate 857 KT (kilo tons) of e-waste with a growth rate of 3–5% every year. The studies conducted by Rene et al. [44] and Alghazo et al. [43] opined that GCC countries are limited by a lack of e-waste inventory, proper assessment of e-waste quantities, and policies and facilities to manage and recycle the generated e-waste. Attia et al. [45] conducted a study in Dubai, UAE and found that most respondents store unused mobile phones at home, with each household storing an average of 3.85 mobile phones. They also estimated that 208.53 tons of mobile phone waste could be generated in Dubai by 2030.

In UAE, there is a growing concern about e-waste among the authorities, and its Center of Waste Management in Abu Dhabi (Tadweer) categorized e-waste separately in its waste classification policy [43]. The Ministry of Environment, UAE has endorsed private sector participation in e-waste recycling. For example, a company called Enviroserve, located in Dubai Industrial Park, has established one of the world's largest e-waste recycling and processing plants with the capacity to recycle 39,000 tons of e-waste per year [43].

There are limited studies on e-waste recycling behavior in the UAE. For example, Attia et al. [45] analyzed e-waste awareness and disposal behavior and estimated the potential of mobile phone waste in Dubai. Their study included the magnitude of e-waste awareness and the extent of e-waste disposal among the respondents of a cross-sectional survey in Dubai. Furthermore, Aboelmaged [46] applied the TPB and added recycling habits as one factor that impacts e-waste recycling intentions in the UAE.

4. Conceptual Model and Hypotheses Development

The conceptual model highlighting all of the predictor variables that determine e-waste recycling behavior is shown in Figure 1. Broadly, the model suggests that attitudes, subjective norms, and perceived behavioral control determine e-waste recycling intentions, which further lead to recycling behavior. The model proposes the moderation effect of environmental consciousness on the predictor variables and e-waste recycling intentions. Furthermore, the cost of recycling and infrastructure support moderate the association of recycling intention with e-waste recycling behavior. The rationale for choosing these specific hypotheses is discussed.

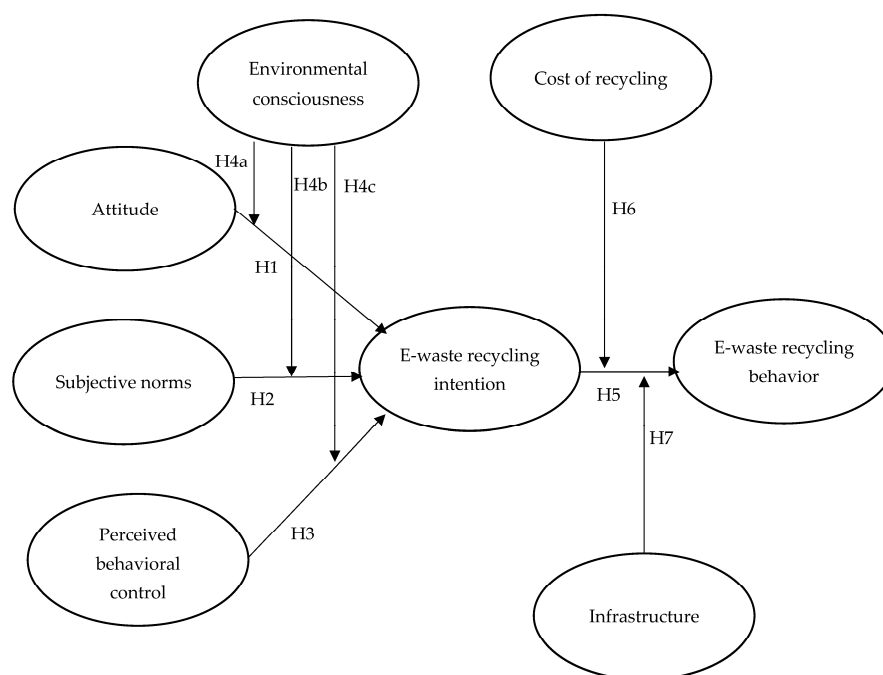


Figure 1. Conceptual model of e-waste recycling behavior.

Attitude draws theoretical background from the expectancy–value theory. It is an outcome of the psychological assessment and belief towards a particular object, issue, or entity reflected in terms of preference or no preference. According to the TPB, attitude determines an individual's intentions to behave in a particular manner [20,47]. It has been validated in several studies that favorable attitudes towards the environment are precursors for an individual's willingness to engage in behavior that protects the environment. For example, Wang et al. [48] identified that consumers' buying attitudes towards remanufactured products positively impact their purchase intentions. Previous studies on e-waste recycling [27,30,46] have also established a positive effect of e-waste recycling attitudes on e-waste recycling intentions. Thus, the following is hypothesized:

H1. *E-waste recycling attitudes will have a positive effect on e-waste recycling intentions.*

Subjective norms are acceptable levels of an individual's behavior determined by society, including reference groups [20]. Individuals in a society are bound to follow subjective norms, which influence their beliefs, ideas, emotions, opinions, and judgments. Due to this process, individuals succumb to social pressure, which can affect individuals either positively or negatively. The norms permit individuals to engage or not to engage in a particular behavior [49,50]. Previous research studies have established that subjective norms lead to pro-environmental behavior. For example, Kianpour et al. [51] found a positive effect of subjective norms on the intention of consumers to return end-of-life electronic products. Similarly, Wang et al. [30], Kumar [27], and Aboelmaged [46] demonstrated a significant positive association between subjective norms and e-waste recycling intentions. Therefore, H2 is proposed.

H2. *Subjective norms will have a positive effect on e-waste recycling intentions.*

Perceived behavioral control is about having self-confidence about a particular behavior [20]. This confidence is rooted in one's ability based on past experience and perceived difficulty. According to the TPB [20], behavioral control determines one's intentions to perform a specific behavior. Several research studies on pro-environmental behavior have validated the effect of behavioral control on behavioral intentions. For example, Taylor and Todd [52] found that behavioral control significantly impacted intentions towards household recycling behavior in waste management. Perceived behavioral control determined an individual's intentions to engage in construction and demolition waste recycling in a study conducted by Jain et al. [11] in India. Similarly, previous studies on e-waste recycling (for example, [27,30,46]) established a link between perceived behavioral control and e-waste recycling intentions. Therefore, the following is hypothesized:

H3. *Perceived behavioral control will have a positive effect on e-waste recycling intentions.*

Environmental consciousness is 'a kind of mentality that reflects an individual's value judgment about environmental concepts such as environmental protection, environmental policy, and environmental management' [53] (p. 149). In this study, environmental consciousness is defined as an individual's degree of concern towards environmental issues and problems [11,54,55]. Environmental consciousness influences environmental attitudes [9]. Individuals with greater levels of environmental consciousness are found to behave in an environmentally responsible way. Several research studies have proven that environmental consciousness plays a vital role in pro-environmental behavior (e.g., [56–58], green purchasing (e.g., [59]), and consumption (e.g., [60]) and recycling behavior (e.g., [11]). Lin and Chang [59] investigated the moderation effect of environmental consciousness on green product consumption. They demonstrated that environmental consciousness significantly moderates the effect of product type (green products versus regular products) on product usage amount. Garvey and Bolton [61] found an interaction effect of environmental consciousness on pro-environmental behavior.

In the context of e-waste recycling, Thi Thu Nguyen et al. [62] found a positive direct effect of environmental awareness on e-waste recycling intention. In a study in Nigeria,

Nduneseokwu et al. [63] investigated the direct effect of environmental knowledge on the intention to participate in formal e-waste collection.

Kautish et al. [64] established that environmental consciousness significantly moderates the influences of perceived behavioral control, environmental friendliness, and perceived effectiveness on green purchases. In contrast with Kautish et al. [64], we argue that environmental consciousness moderates the association between the antecedents of the TPB, including attitudes, subjective norms, and perceived behavioral control, and e-waste recycling intention. Because behavioral intention precedes actual behavior, it is expected that environmental consciousness has a higher likelihood of strengthening intentions than behavior. Several previous research studies have established a positive effect of environmental consciousness on pro-environment behavioral intentions [7–9,11,65].

The effects of attitudes, subjective norms, and perceived behavioral control on e-waste recycling intentions will be higher for individuals whose environmental consciousness is higher. In the context of e-waste recycling, the moderation effect of environmental consciousness on the association between the antecedents of the TPB and e-waste recycling intention has not yet been explored. Previous studies confirmed the moderating effect of environmental consciousness on the relationship between antecedent variables and behavioral intentions. For example, Lin et al. [53] demonstrated the moderating effect of environmental consciousness on the positive relationship between trust and intentions of purchasing IT products. Similarly, de Leaniz et al. [58] found that consumer environmental consciousness moderates the effect of green image on behavioral intentions.

Therefore, the following hypotheses are proposed:

H4a. *Environmental consciousness moderates the relationship between attitude and e-waste recycling intentions.*

H4b. *Environmental consciousness moderates the relationship between subjective and e-waste recycling intentions.*

H4c. *Environmental consciousness moderates the relationship between perceived behavioral control and e-waste recycling intentions.*

The TPB posits that behavioral intentions predict actual behavior [19]. Intentions have proven to be precursors of behavior in several studies on pro-environmental behavior. For example, Webb et al. [66] found that behavioral intentions towards energy saving positively influence household energy-saving behavior. Jain et al. [11] validated the association between construction and demolition waste recycling intention and actual construction and demolition waste recycling behavior. Gilal et al. [67] found that consumers' integrated motivation towards e-waste disposal led to actual disposal behavior. Thus, the following is hypothesized:

H5. *E-waste recycling intention will have a positive effect on e-waste recycling behavior.*

Even though consumers' e-waste recycling intentions lead to actual recycling behavior, as hypothesized in H5, factors such as the cost of recycling and infrastructure support would play important roles in converting recycling intentions to actual behavior. Kirwy and Mecking [68] investigated the moderation effect of behavioral cost on the relationship between the motivation for healthy eating and the actual consumption of organic food. The cost of production was found to be one of the limitations preventing consumers from engaging in pro-environmental behavior [69]. When the costs are low, pro-environmental behavior is more likely to happen [70]. Lower-income households tend to save more energy as they cannot afford higher energy costs [71]. Infrastructure support towards recycling provides convenience and reduces the travel distance to collection points. Meneses and Palacio [72] found that the convenience of recycling encourages recycling behavior. Higher repair costs deter consumers from engaging in pro-environmental behavior and encourage consumers to buy newer electronic products in India [73]. Wang et al. [74] found that higher operational costs are one of the barriers to Internet-based e-waste collection systems in

China. A reduction in the travel distance to collection points offers convenience, and it provides a reduction in the time cost in addition to improving recycling behavior [75]. A study conducted in Beijing city, China revealed that taking care of specific portions of e-waste recycling costs affects residents' behaviors towards recycling [33]. In a study conducted in a Midwestern USA university, Arain et al. [35] demonstrated that the convenience and cost of recycling are the most important factors that affect e-waste recycling behavior. In the situation of a higher cost of recycling, the effect of e-waste recycling intentions on e-waste recycling behavior would be weakened. Furthermore, in higher levels of perceived infrastructure support, the effect of e-waste recycling intentions on e-waste recycling behavior would be strengthened.

Thus, the following hypotheses are postulated:

H6. *The cost of recycling moderates the relationship between recycling intentions and behavior.*

H7. *Infrastructure support moderates the relationship between recycling intentions and behavior.*

5. Materials and Methods

5.1. Questionnaire

The measures for the constructs included in the model have been widely used in previous studies in the field. The environmental consciousness construct was measured with the scale used by Huang et al. [56] and Bittar [31]. Attitude towards e-waste recycling were measured with the scales used by Aboelmaged [46] and Dhir et al. [26]. The subjective norms construct was measured with the scales used by Wang et al. [30] and Aboelmaged [46]. Perceived behavioral control was measured using a scale from Kumar [27]. E-waste recycling intention was measured with the scales used by Wang et al. [30], Thi Thu Nguyen et al. [62], Dhir et al. [26], and Aboelmaged [46]. The cost of recycling was measured with a scale used by Thi Thu Nguyen et al. [62]. Infrastructure support was measured with a scale used by Nduneseokwu et al. [63]. All the constructs were measured on a seven-point Likert scale. The questionnaire was prepared, including measures of all the constructs and classification information. Five subject matter specialists assessed the prepared questionnaire to check the content validity of the questionnaire, and all the identified inconsistencies were removed. Furthermore, the refined questionnaire was pretested with a sample of 30 respondents. The pretesting process helped to rectify any language issues in the questionnaire.

5.2. Sample and Data Collection

The institutional research committee approved the final questionnaire for ethical clearance, and it was then deployed for a cross-sectional survey among UAE residents.

The sample size used in previous studies in the area was used as one of the factors to determine the sample size in addition to the requirement of the statistical technique to be used for this study. We planned to achieve a sample size of 500 people for this study with respondents from all the major states of the United Arab Emirates. We used a convenience sampling method to select the respondents. The questionnaire was prepared on Google Forms, and the link to the questionnaire was shared with the prospective respondents. The survey was conducted during the period of August–November 2022. The list of prospective respondents was gathered through referrals and from other respondents as well. The survey was self-administered and the respondents independently filled in the questionnaire by accessing the Google Forms link. At the beginning of the questionnaire, on Google Forms, the respondents were provided with a brief description of the purpose of the study and were informed that their participation in the study was voluntary and all information would be kept confidential. Next, the respondents were specifically asked whether they would like to participate in the study. A total of 732 people were contacted, out of which 471 people provided responses, which resulted in a response rate of 64.34%. After discarding incomplete responses of 15 respondents, the sample size achieved for the study was 456.

6. Analysis and Results

The first level of data analysis was performed to understand the sample characteristics. Table 1 contains information on the sample's characteristics. Around 61% of the respondents were male, and the remaining respondents were female. Around 32% of the respondents ranged in age from 18 to 25, 25% of the respondents were in the age category of 26–36 years, and around 23% ranged in the age category of 37–47 years. Around 19% of the respondents were above the age category of 48 years. Around 59% of respondents had a bachelor's education, while around 15%, 17%, and 10% had school, master's and PhD educations, respectively. A total of 44.52% of respondents were Dubai residents, while 23.25%, 20.83%, 7.24%, 2.19%, and 1.97% were residents of Abu Dhabi, Sharjah, Al Ain, Ajman, and Ras Al Khaimah, respectively. A total of 47.59% and 42.11% of respondents replied that they were fully and partially aware of the concept of e-waste management, respectively. Only 10.31% of respondents replied that they had no idea about this aspect. A total of 69.52% of respondents answered that they possessed left-over electronic devices at home.

Table 1. Sample characteristics ($n = 456$).

Characteristics	Frequency	Percentage
Gender		
Male	279	61.18
Female	177	38.82
Age		
18–25	147	32.24
26–36	114	25.00
37–47	106	23.25
48–59	62	13.60
60 and above	27	5.92
Education		
School	68	14.91
Bachelor's	267	58.55
Master's	77	16.89
PhD	44	9.65
City of residence		
Dubai	203	44.52
Abu Dhabi	106	23.25
Sharjah	95	20.83
Al Ain	33	7.24
Ajman	10	2.19
Ras Al Khaimah	9	1.97
Awareness of e-waste management		
Fully aware	217	47.59
Partially aware	192	42.11
No idea	47	10.31
Possession of left-over electronic devices		
Yes	317	69.52
No	139	30.48

A second level of analysis was performed to assess the reliability and validity of the constructs used and to validate the hypotheses proposed in this study. This analysis was performed with the help of partial least squares structural equations modeling (PLS-SEM) using SmartPLS 4.0. Table 2 shows the loadings of the items with their respective constructs and their cross-loadings with the other constructs. A factor loading of more than 0.60 and a cross-loading value lower than that of the factor loading were required to establish the convergent and discriminant validity of the constructs [76]. In the initial analysis, two items of environmental consciousness constructs were found to have factor loading values of less than 0.60 and cross-loading values higher than the factor loading, and these items were removed from further analysis. All items in Table 2 had factor loadings greater than the 0.60 cut-off and had cross-loadings that were less than the respective factor

loadings, indicating that the constructs included in this study had sufficient convergent and discriminant validity.

Table 2. Factor loadings and cross-loadings of the items.

Factors/Items	ATT	SN	PBC	EC	RI	CR	INF	RB
Attitudes (ATT)								
ATT1	0.72	0.19	0.21	0.13	0.23	0.02	0.21	0.14
ATT2	0.75	0.13	0.24	0.19	0.24	−0.03	0.15	0.16
ATT3	0.80	0.12	0.22	0.20	0.29	−0.05	0.21	0.14
ATT4	0.79	0.06	0.32	0.20	0.30	−0.03	0.19	0.18
ATT5	0.72	0.00	0.25	0.16	0.21	−0.01	0.15	0.17
Subjective norms (SN)								
SN1	0.09	0.76	0.14	0.08	0.25	−0.11	0.20	0.21
SN2	0.11	0.76	0.11	−0.02	0.27	−0.06	0.24	0.17
SN3	0.09	0.72	0.11	0.05	0.27	−0.13	0.25	0.12
SN4	0.07	0.71	0.07	0.04	0.20	−0.11	0.19	0.16
SN5	0.12	0.74	0.10	0.02	0.27	0.00	0.23	0.18
SN6	0.10	0.71	0.14	0.07	0.26	−0.08	0.20	0.22
Perceived behavioral control (PBC)								
PBC1	0.21	0.13	0.73	0.03	0.38	−0.11	0.26	0.20
PBC2	0.26	0.09	0.71	−0.04	0.36	−0.21	0.27	0.22
PBC3	0.30	0.07	0.75	−0.04	0.35	−0.08	0.28	0.20
PBC4	0.20	0.17	0.73	0.03	0.39	−0.13	0.33	0.25
Environmental consciousness (EC)								
EC1	0.18	0.04	−0.01	0.71	0.06	−0.04	0.04	0.06
EC2	0.15	0.04	−0.02	0.77	0.09	−0.05	0.02	0.09
EC3	0.22	0.02	−0.03	0.75	0.07	0.07	−0.02	−0.04
EC4	0.20	0.04	0.04	0.71	0.05	−0.05	0.06	0.09
EC5	0.13	0.07	0.03	0.76	0.08	−0.02	−0.04	0.03
EC6	0.16	0.00	−0.03	0.72	0.06	0.04	0.05	0.03
EC7	0.20	0.03	−0.01	0.71	0.06	0.03	0.02	0.03
EC8	0.17	0.06	0.00	0.70	0.05	0.07	−0.05	0.01
EC9	0.17	0.05	−0.01	0.76	0.09	0.01	0.03	0.05
Recycling intention (RI)								
RI1	0.28	0.27	0.41	0.09	0.79	−0.14	0.58	0.29
RI2	0.27	0.29	0.34	0.12	0.76	−0.20	0.55	0.30
RI3	0.27	0.30	0.33	0.08	0.78	−0.19	0.59	0.32
RI4	0.26	0.21	0.40	0.03	0.78	−0.15	0.54	0.38
RI6	0.27	0.29	0.47	0.05	0.77	−0.11	0.51	0.29
RI7	0.24	0.27	0.40	0.07	0.77	−0.11	0.55	0.36
Cost of recycling (CR)								
CR1	0.00	−0.07	−0.19	0.04	−0.15	0.80	−0.17	−0.22
CR2	−0.04	−0.09	−0.10	−0.04	−0.14	0.81	−0.18	−0.26
CR3	−0.03	−0.11	−0.15	0.02	−0.17	0.77	−0.20	−0.21
Infrastructure support (INF)								
INF1	0.17	0.26	0.33	−0.04	0.60	−0.17	0.80	0.34
INF2	0.21	0.22	0.33	0.06	0.59	−0.15	0.81	0.35
INF3	0.24	0.25	0.31	0.00	0.57	−0.19	0.79	0.30
INF4	0.16	0.22	0.27	0.03	0.51	−0.24	0.80	0.31
Recycling behavior (RB)								
RB1	0.21	0.21	0.28	0.06	0.40	−0.17	0.37	0.78
RB2	0.24	0.18	0.22	0.08	0.38	−0.20	0.33	0.78
RB3	0.12	0.22	0.26	0.00	0.39	−0.29	0.35	0.83
RB4	0.08	0.23	0.21	−0.02	0.27	−0.25	0.26	0.75
RB5	0.13	0.13	0.23	0.06	0.27	−0.25	0.34	0.79
RB6	0.14	0.15	0.13	0.06	0.17	−0.21	0.19	0.65
RB7	0.18	0.08	0.21	0.06	0.21	−0.13	0.23	0.61

ATT: attitudes; SN: subjective norms; PBC: perceived behavioral control; EC: environmental consciousness; RI: recycling intention; INF: infrastructure; CR: cost of recycling; RB: recycling behavior.

Table 3 provides the statistics related to reliability and other convergent and discriminant validity measures. A reliability analysis was performed through Cronbach's alpha, which was expected to exceed the cut-off of 0.70 [76]. All the constructs used in this study surpassed the minimal threshold of 0.70, which establishes the reliability of the constructs of this study in a satisfactory manner. The convergent validity was tested through the average variance extracted (AVE) by the constructs. To establish satisfactory convergent validity, the AVEs should be more than the minimum threshold of 0.50 [76]. All the constructs surpassed the minimum threshold of 0.50; thus, the convergent validity of the constructs was proven satisfactorily. The discriminant validity was tested using Fornell and Larcker's [77] criterion. As per this criterion, the square root values of the AVEs of the constructs were expected to be higher than their respective inter-construct correlations. In Table 3, the square root values of the AVEs of the constructs are shown in the diagonal in bold. All of the constructs were found to have higher square root values of the AVEs than their inter-construct correlations, thus confirming the discriminant validity of the constructs used in this study.

Table 3. Construct reliability and validity.

Constructs	Cronbach's Alpha	AVE—Convergent Validity	Discriminant Validity (Fornell–Larcker Criterion)							
			Inter-Construct Correlations and the Square Root of AVE in the Diagonal							
			ATT	SN	PBC	EC	RI	INF	CR	RB
Attitude (ATT)	0.81	0.57	0.76							
Subjective norms (SN)	0.83	0.54	0.13	0.73						
Perceived behavioral control (PBC)	0.71	0.53	0.33	0.16	0.73					
Environmental consciousness (EC)	0.89	0.54	0.23	0.05	−0.01	0.73				
Recycling intention (RI)	0.87	0.60	0.34	0.35	0.51	0.09	0.78			
Infrastructure (INF)	0.71	0.63	−0.03	−0.11	−0.18	0.01	−0.19	0.79		
Cost of recycling (CR)	0.81	0.64	0.24	0.30	0.39	0.02	0.71	−0.23	0.80	
Recycling behavior (RB)	0.87	0.55	0.21	0.24	0.30	0.06	0.42	−0.29	0.40	0.74

ATT: attitudes; SN: subjective norms; PBC: perceived behavioral control; EC: environmental consciousness; RI: recycling intention; INF: infrastructure; CR: cost of recycling; RB: recycling behavior.

To validate the hypotheses proposed in this study, two PLS-SEM structural models were examined; the first was used to test the model's main effects, and the second was used to test the proposed model's moderation effects. The results of the main effects of the structural model are presented in Table 4. The explanatory power of the structural model is shown by the R^2 value. The main effects model of our study includes two dependent variables: e-waste recycling intention and recycling behavior. The R^2 value related to the dependent variable, recycling intention, is 0.359. Around 36% of the variation in recycling intention was explained by independent variables such as environmental consciousness and attitudes, subjective norms, and perceived behavioral control towards e-waste recycling. The R^2 value related to recycling behavior is 0.235. Around 24% of the variation in recycling behavior was explained by independent variables such as recycling intention, cost of recycling, and infrastructure support. The Q^2 value confirms the predictive relevance of the model, and it should be more than zero [76]. The Q^2 values related to the dependent variables, recycling intention and recycling behavior, are 0.212 and 0.125, respectively. As these values are found to exceed the value of zero, the main effect model was found to confirm predictive relevance. Table 4 shows the standardized path coefficients, which represent the significance of the association of the independent variable with the dependent variable. All of the independent variables related to H1, H2, and H3, such as attitudes (path co-efficient = 0.157; p -value < 0.01 level), subjective norms (path co-efficient = 0.260; p -value < 0.01 level), and perceived behavioral control (path co-efficient = 0.415; p -value < 0.01 level) towards e-waste recycling, were found to have a significant positive effect on recycling intentions, thus confirming all of these hy-

potheses of our study. The hypothesis related to the effect of recycling intention on recycling behavior, H5, was validated (path co-efficient = 0.180; p -value < 0.01 level).

Table 4. Results of main effects structural model.

Dependent Variable: Recycling Intention					Dependent Variable: Recycling Behavior				
Hypotheses	Independent Variables	Std. Path Coefficients	<i>t</i> -Value	Hypothesis Supported?	Hypotheses	Independent Variables	Std. Path Coefficients	<i>t</i> -Value	Hypothesis Supported?
H1	Attitudes	0.157	3.424 **	Yes	H5	Recycling intention	0.180	3.573 **	Yes
H2	Subjective norms	0.260	6.969 **	Yes		Cost of recycling	−0.201	4.192 **	Yes
H3	Perceived behavioral control	0.415	9.485 **	Yes		Infrastructure	0.180	2.595 **	Yes
	Environmental consciousness	0.046	1.020						
R ²	0.359				R ²	0.235			
Q ²	0.212				Q ²	0.125			

** p value < 0.01 level.

A second PLS-SEM analysis was performed to validate the moderation effect hypotheses of our study, H4a, H4b, H4c, H6, and H7. The results of the moderation effect structural model are shown in Table 5. The moderation effect of environmental consciousness on the association between TPB constructs and recycling intentions and the moderation effect of the cost of recycling and infrastructure support on the association between recycling intentions and recycling behavior were tested. The R² values related to the dependent variables, recycling intention and recycling behavior, are 0.377 and 0.247, respectively, thus establishing the explanatory power of the models. The Q² value was also found to be satisfactory (Q² value related to recycling intention = 0.221; Q² value related to recycling behavior = 0.127), confirming predictive relevance. The hypothesis related to the moderating effect of environmental consciousness on the effect of attitudes towards e-waste recycling and recycling intention was positively significant (path co-efficient = 0.142; p -value < 0.01 level), validating H4a of our study. However, the moderating effect of environmental consciousness on the effects of subjective norms and perceived behavioral control on recycling intention was found to be non-significant. Hence, H4b and H4c of our study were not supported. The moderating effect of infrastructure support on the effect of recycling intention on recycling behavior was positively significant (path co-efficient = 0.117; p -value < 0.05 level). Hence, H7 of our study was supported. However, the moderating effect of the cost of recycling on the effects of recycling intention and behavior was found to be non-significant. Hence, H6 of our study was not supported.

Table 5. Results of moderation effects structural model.

Dependent Variable: Recycling Intention					Dependent Variable: Recycling Behavior				
Hypotheses	Independent Variables	Std. Path Coefficients	<i>t</i> -Value	Hypothesis Supported?	Hypotheses	Independent Variables	Std. Path Coefficients	<i>t</i> -Value	Hypothesis Supported?
	Attitudes	0.194	4.052 **			Recycling intention	0.243	3.461 **	
	Subjective norms	0.269	7.014 **			Cost of recycling	−0.188	4.137 **	
	Perceived behavioral control	0.381	8.405 **			Infrastructure	0.254	3.288 **	
	Environmental consciousness	0.033	0.761		H6	Recycling intention X cost of recycling	0.037	0.806	No
H4a	Attitudes X environmental consciousness	0.142	2.866 **	Yes	H7	Recycling intention X infrastructure	0.117	2.0269 *	Yes
H4b	Subjective norms X environmental consciousness	−0.008	0.188	No					
H4c	Perceived behavioral control X environmental consciousness	−0.094	1.805	No					
R ²	0.377				R ²	0.247			
Q ²	0.221				Q ²	0.127			

* p value < 0.05 level; ** p value < 0.01 level.

7. Discussion

7.1. Theoretical Implications

The recycling of e-waste is an important sustainability issue worldwide, and several studies have investigated e-waste recycling behavior among consumers. However, there are limited studies from the Middle Eastern region. This study attempted to integrate all the relevant factors influencing e-waste recycling behavior in the UAE. This study applied a well-known consumer behavior model, known as the theory of planned behavior, as an overarching framework. The proposed model investigated the effects of attitudes, subjective norms, and perceived behavioral control towards e-waste recycling on e-waste recycling intention and investigated the further effect of recycling intention on e-waste recycling behavior. The proposed model also examined the moderation effect of environmental consciousness on the effects of attitudes, subjective norms, and perceived behavioral control on recycling intention. Furthermore, the model examined the moderation effects of the perceived cost of recycling and infrastructure support on the effect of recycling intention on recycling behavior. The proposed model was validated with survey data collected from 456 UAE residents using PLS-SEM. The analysis results suggest that six of the proposed nine hypotheses were supported (H1, H2, H3, H4a, H5, and H7).

H1 of our study examined the positive effect of attitudes towards e-waste recycling on e-waste recycling intention, which was supported. This finding is consistent with previous studies on e-waste recycling in other contexts (e.g., [26,28,30,78]). H2 examined the positive effect of subjective norms regarding e-waste recycling on e-waste recycling intention, which was supported. Similarly, H3 examined the positive effect of perceived behavioral control towards e-waste recycling on e-waste recycling behavior, which was supported. Both of these findings are consistent with those of previous works in the literature that applied the theory of planned behavior in the context of e-waste recycling behavior (for example, [17,30,46]).

The hypothesis (H4a) related to the moderating effect of environmental consciousness on the association between attitudes towards e-waste recycling and e-waste recycling intention was supported. The role of environmental consciousness in pro-environmental consumption behavior has been studied in various contexts since the construct was initially examined in the study by Schlegelmilch et al. [79] on green purchasing. Environmental consciousness is a broader construct and has been examined for its moderating effect on the association between the antecedents (attitudes, subjective norms, and perceived behavioral control) and behavioral intentions of a specific context, such as green purchasing (e.g., [59]) and pro-environmental behavior (e.g., [58]). In the context of construction and demolition waste recycling behavior, Jain et al. [11] applied the norm activation theory and used environmental consciousness as an antecedent variable of recycling intention. Wang et al. [26] examined environmental awareness as an antecedent to e-waste recycling in China. However, the studies investigating the role of environmental consciousness in the association of antecedents of e-waste recycling with e-waste recycling intentions were limited. The finding of a positive moderation effect of environmental consciousness on the positive effect of attitudes towards e-waste recycling on e-waste recycling intention is aligned with previous research on pro-environmental behavior. For example, in a study by Dhir et al. [26] on e-waste recycling that applied the behavioral reasoning theory, although the environmental consciousness construct was not used, they tested the moderating effect of environmental assessment and awareness on the effect of attitudes on the intention to recycle and found a significant positive moderation effect of environmental awareness.

This finding on environmental consciousness highlights the call for sustainability in education by offering educational programs and research activities to enhance environmental consciousness among students and the academic community [12]. When sustainability in education is addressed, emphasizing science education at the secondary level could result in higher levels of environmental consciousness [13]. Sustainability in education is concerned with the interplay of social and environmental systems, which necessitates interdisciplinary thinking abilities, and these abilities could be developed through real-life

problem-oriented learning abilities [80]. A study by Jeronen et al. [81] prescribed outdoor education, which involves field trips and nature studies, to develop such abilities. This finding also implies sustainability in education in terms of identifying the ways and means of designing environmental awareness messages for students [82]. Environmental consciousness among students could be improved through extra-curricular activities in addition to courses on environmental education [83]. Even though the concept of sustainability has been addressed in different academic disciplines, to effectively institute sustainability in education, the curriculum must be integrated across the campus using an interdisciplinary approach [84]. Holst [85] argues in favor of whole institution approaches for sustainability in education, which ‘means that aligning all functional components of educational organizations (e.g., campus management, curriculum design, or community partnerships) with sustainability becomes a core objective of organizational development’ (p. 1016).

The moderation effects of subjective norms and perceived behavioral control were found to be non-significant, and therefore, H4b and H4c of our study were not supported. This could be because factors such as subjective norms and perceived behavioral control are related to society and are not innate to an individual. Because the attitude towards e-waste recycling is individual-specific, environmental consciousness appears to affect attitude more than the other antecedents of e-waste recycling intentions.

H5 of our study relates to the positive effect of e-waste recycling intention on e-waste recycling behavior. This hypothesis was found to be supported in our study. This finding is consistent with other studies on pro-environmental behavior that have applied the theory of planned behavior. For example, Sweeney et al. [86] found a positive effect of energy-saving motivation on energy-saving behavior. Delcea et al. [87] found a positive effect of e-waste recycling intention on e-waste recycling behavior in Romania.

H6 of our study relates to the moderating effect of the cost of e-waste recycling on the effect of recycling intention on recycling behavior, which was not supported. However, the cost of recycling was found to have a negative effect on e-waste recycling behavior, thus suggesting that the perceived cost of e-waste recycling decreases e-waste recycling behavior. The hypothesis related to the moderation effect of perceived infrastructure support for e-waste recycling on the positive effect of recycling intention on recycling behavior (H7) was supported. Although previous research investigated the effect of convenience or infrastructure support on pro-environmental and recycling intention and behavior (e.g., [33,35,75]), only our study established the moderation effect of infrastructure support on the association between e-waste recycling intention and behavior. This finding broadly addresses the gap in the research in identifying the factors that help bridge the gap between e-waste recycling intention and behavior and clarifies its role more succinctly. This finding supports the previous research of Thukral et al. [2], Wang et al. (2019) [30], and Chen et al. [42], who found that infrastructure was one of the major barriers to the implementation of e-waste recycling and management.

7.2. Practical Implications

This study’s findings provide avenues for several practical implications to policymakers in promoting e-waste recycling intention and behavior. Importantly, policymakers should give importance to enhancing attitudes towards recycling by way of communicating the ill effects of not recycling e-waste. While doing so, agencies should also focus on enhancing people’s environmental consciousness through regular messaging using publicly available communication mediums, including digital and social media marketing. Furthermore, the sustainability education course curriculum should emphasize various forms of environmental degradation and various initiatives that help protect the environment [12]. This would improve students’ environmental consciousness and strengthen the positive effect of the attitude towards e-waste recycling on intention. Sustainability in education should also emphasize research related to sustainable production and consumption, and educational institutions should assume the role of disseminating research

findings related to sustainability to all stakeholders [12]. Policymakers should emphasize prioritizing secondary science education to build sustainability in education [13]. The curriculum on sustainability in education should promote nature connectedness as it improves pro-environmental behavior and sustainable well-being [88]. Sustainability in education should be taught using new teaching approaches focusing on mindfulness, compassion, and sustainability to enhance inner transformation [89].

Policymakers should also plan to arrange short-term seminars to train individuals regarding the dos and don'ts related to e-waste recycling, as this training would enhance individuals' control over their e-waste recycling behaviors. The government and pro-environment organizations should also continue to conduct public awareness campaigns against the detrimental effects of unsafe e-waste disposal. Furthermore, the higher education sector can also play a significant role in improving the level of awareness towards the environmental impact of e-waste by way of offering specific courses for students. Particularly, the current practice in the UAE of offering courses on sustainability under the category of General Education in all bachelor's programs needs to be strengthened with topics related to the impact of e-waste [90]. These initiatives could have a lasting impact on students regarding sustainable development issues, particularly responsible production and consumption. As perceived behavioral control was found to positively impact e-waste recycling intention, implementing sustainability in education with a focus on the harmful effects of e-waste will improve students' self-efficacy at a young age so they can develop e-waste recycling intention. The sustainability education course curriculum should emphasize how e-waste harms all living organisms, including humans. The curriculum should include how the unsafe disposal of e-waste results in air and water pollution and how these pollutants in air and water bodies could lead to various harmful effects on all living organisms. Sustainability in education should focus more on text forms of communication related to e-waste recycling, as the research by Nanath and Kumar [82] found that the text form was more persuasive and impactful in changing students' attitudes than showing them a video. Policymakers should identify the barriers and challenges in adopting sustainability in education [91]. Sustainability education teachers should be trained to teach using new methodologies involving indoor and outdoor learning activities [92]. This requires a transformation in institutions' approaches towards teaching and learning sustainability that involves collaboration in developing curricula and multicultural orientation, integrating the concept of social justice and environmental responsibility [93].

Policymakers should also implement strict rules and regulations so that people would have tendencies to follow the norms related to e-waste recycling that are acceptable to government authorities and society in general. The findings imply that policymakers should gain confidence in their measures to improve e-waste recycling intention as it leads to a favorable consequence of e-waste recycling behavior. The findings imply that policymakers should reduce the perceived cost of e-waste recycling as it reduces e-waste recycling behavior. Furthermore, policymakers should continue their efforts in improving infrastructure support that would provide convenience to individuals to engage in e-waste recycling behavior. This would also help to translate individuals' e-waste recycling intentions into behaviors.

8. Limitations and Future Research

Even though the study's findings provide a number of theoretical and practical implications, one needs to be aware of the study's limitations while applying the findings. Importantly, the study was conducted in the UAE, where the consumption of e-devices is very common, leading to regular e-waste generation at the household level. Therefore, it may be possible to assume a higher level of general awareness of the consequences of e-waste generation and the need for safer ways of e-waste recycling. When the study results are applied in other contexts, due consideration of these aspects may be required. The R^2 values of e-waste recycling intention and recycling behavior in our study are 0.359 and 0.235, suggesting that around 64% of the variation in recycling intention and 76% of the

variation in recycling behavior in our study were revealed by factors that were not included. Still, there are a variety of factors not included in our proposed model that could affect e-waste recycling intention and behavior. Future research could focus on these aspects that influence e-waste recycling intention and behavior. For example, future research could focus on factors such as psychological ownership of the environment and frugal consumption that limits the generation of e-waste.

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Article

Community Readiness in Implementing Sustainable Tourism on Small Islands: Evidence from Lombok, Indonesia

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Abstract: Implementing sustainable tourism development is an essential part of the strategy to achieve the 2030 Sustainable Development Goals and inclusive, sustainable economic growth. This research aimed to examine the level of readiness of the community to carry out sustainable tourism development, especially community-based tourism on small islands, such as Lombok Island, Indonesia. More specifically, the objectives of this study were as follows: first, knowing the level of community readiness in carrying out sustainable tourism development; second, knowing the various dimensions that influence sustainable tourism development; third, understanding the role of stakeholders in sustainable tourism development. Furthermore, the role of the education sector in increasing community readiness for sustainable tourism development is an exciting matter to study. The method applied in this research used mixed techniques, a combination of quantitative and qualitative approaches. Quantitative methods were used to determine the level of community readiness in sustainable tourism development. A qualitative approach was used to determine the various factors that influence the development of community-based tourism and to determine the role of stakeholders in the development of community-based tourism. Community readiness for sustainable tourism development is high in terms of economic, social, cultural, environmental, and symbolic capital aspects. Economic, social, cultural, and natural elements influence sustainable tourism development. Stakeholders who play a role in developing sustainable tourism in the research area are the government, the private sector, universities, non-governmental organizations, and the media. The results of this study can be used to create a government policy related to sustainable tourism development.

Keywords: sustainable tourism; stakeholders' role; community preparedness; Lombok; Indonesia



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1. Introduction

World leaders agreed to include tourism development in the 2030 Sustainable Development Goals agenda, as contained in the goals related to inclusive and sustainable economic growth, responsible consumption, and the conservation of life in the waters (Goals 8, 12, and 14). This goal is justified because tourism development has grown into a sector with great potential. In recent decades, tourism has become the sector with the highest growth [1,2]. However, in its development, the tourism sector is inseparable from various weaknesses and shortcomings and has even had an unexpected impact. There is very little evidence that tourism can reduce poverty, especially in pockets of poverty [3]. One of the factors suspected to be the cause is the unequal relationship between tourism actors in the village and investors and other tourism actors from outside. Inequality between economic and social capital is common [4]. The 2022 Sustainable Development Report by the United Nations stated that Indonesia's achievement of the SDGs is 69.16%. However, compared to other countries in Southeast Asia, Indonesia ranks fifth, below Thailand, Vietnam, Singapore, and Malaysia. This information means there are still many programs that must be improved so that Indonesia can achieve the SDGs by 2030, according to the targets that have been set. Sustainable tourism development is included as part of the program in the SDGs. According to several researchers [5–8], this imbalance problem can be overcome

through education, namely by increasing people's access, including that of people with low incomes, and by aligning the learning curricula of educational institutions more closely with the principles of sustainable tourism development. However, according to Alam [5], such an imbalance is also a problem in the world of education, which must be addressed first. Therefore, one of the suggestions is to apply the principles of equity and sustainability in educational institutions so that people with low incomes have the same access as other citizens and communities to opportunities for education and higher education.

UNWTO estimates that by 2030, the number of travelers worldwide will reach 1.8 billion people [9,10]. Various anticipatory programs need to be encouraged. If not, damage in various fields caused by tourism will be unavoidable, such as damage to natural resources and the environment, economic loss, degradation of cultural values, and even loss of cultural heritage and its uniqueness [10,11]. It is the background for the growth of the idea of developing eco-friendly tourism, better known as sustainable tourism. In UNWTO's view, what is meant by sustainable tourism is a tourism activity that still pays attention to aspects of social, environmental, and economic sustainability both for the present and for the future [12]. The goal of sustainable tourism is to improve the short and long-term welfare of the surrounding community, meet the demands of visitors, and at the same time, protect or maintain the environment. According to A. Guizzardi et al. [13], the primary indicator of the success of sustainable tourism development is the preservation of natural, environmental, and cultural resources. In addition, tourism has a comparative advantage that can trigger economic growth in an area.

The problem is that precisely applying sustainable tourism is not easy. As a result, failures in tourism development based on sustainability, including, in this case, environment- and culture-based failures, often occur [14,15]. Moreover, the development of tourism in various places causes damage to the environment and even culture. Therefore, it is essential to have good planning that prioritizes aspects of sustainability [16].

S. Guo et al. [17] stated that sustainable tourism development faces many challenges, including infrastructure, processes, procedures, and the equipment needed. Building a balance between the environment, society, and economy is not easy. Tourism development is very dynamic and continues to experience changes in developing and developed countries [18]. In later developments, various creations grew in the tourism community to anticipate different challenges and failures in sustainable tourism development. One is the emergence of the concept of community-based tourism development. Implementing this concept is expected to prevent or reduce various negative impacts of tourism activities [19]. Community-based tourism essentially manages tourism from the community for the community. At the same time, it educates tourists to love the environment and not damage the various social and cultural attractions in tourist destinations [20]. The World Wide Fund for Nature (WWF) defines community-based tourism as the mastery and management of tourism by the local community; most of the benefits obtained are also enjoyed by the local community [21].

Lombok Island is an island whose tourism has only begun developing in Indonesia. Its location close to the island of Bali gives this island very high value and potential for development. The government designated the Mandalika Area on Lombok Island as a National Super Priority Area. Now, the international Moto GP event has begun to be held in this area and is predicted to bring in more than 100,000 tourists every time the Moto GP is held. Lombok Island is also known as a Halal Tourism Area. On 20 October 2015, the World Halal Travel Summit in Abu Dhabi, United Arab Emirates, awarded Lombok two designations at once, namely as the World's Best Halal Tourism Destination and the World's Best Halal Honeymoon Tourism Destination [22].

The Provincial Government of West Nusa Tenggara has designated 99 villages as Tourism Villages. This policy aims to develop rural tourism to prepare West Nusa Tenggara, particularly Lombok Island, as a national priority tourist destination. Three of the 99 Tourism Villages are located in Jerowaru District, where this research was conducted. The three

villages are Sekaroh, Jerowaru, and Seriwe. Most of these villages have high potential in the tourism sector but are still in the preparation stage, still developing tourist destinations.

1.1. Research Purposes

Tourism studies on these small islands are still attractive, considering several factors, first, in terms of the characteristics of small islands that are vulnerable to disasters but rely on natural tourism as the primary source of livelihood for the population. Second, it is essential to pay attention to the population's readiness level for tourism development, primarily community-based tourism, to anticipate various negative impacts of tourism development. Understanding this readiness level is very important to design a community-based tourism development framework in the future. In this study, readiness means people's knowledge of and behavior toward community-based tourism concepts and principles. Third, research on the locus of small islands is still very significant, considering that Indonesia has more than 15,000 small islands stretching from Sabang to Merauke, from the western tip to the eastern end of the archipelago, with various social and cultural characteristics, and their respective natural environments.

Although research on community-based tourism has been conducted in various parts of the world, very few researchers have made small islands their locus of study; among the few are the study by Giampiccoli and O. Mtapuri [23]. It is stated that tourism on small islands is like a double-edged sword. On the one hand, it can increase economic growth, but also, on the other hand, it can reduce and even destroy the community's economy [24]. Furthermore, it is explained that the challenges that become issues in small islands can be classified into four categories: the small island size, remote location, vulnerable environment, and other socio-economic factors. In addition, many of these islands have limited natural resources, and their dependence on external resources is very high [25]. Other concerns of academics regarding these small islands are their carrying capacity, community participation, and environmental policies [23,26].

Globally, there are around 180,000 islands of various sizes and tourism potential. However, only about 90 islands are larger than 10,000 square kilometers. The rest are small islands with unique characteristics, which are outermost, left behind, or even have exotic characteristics as attractive tourist destinations [25,27]. Few small islands in the world rely on tourism as the backbone of their economy, including in the context of poverty alleviation.

Therefore, based on the description above, it can be explained that this research is fundamental to assessing community readiness for sustainable tourism development on small islands, such as Lombok Island, Indonesia. Knowing the level of preparedness of the community to carry out sustainable tourism development is essential to avoid the possibility of negative impacts from tourism, as happened in other places. Examining how education plays a role in increasing community readiness for sustainable tourism development is no less critical.

More specifically, the objectives of this study are as follows: (1) to determine the level of community readiness in developing sustainable tourism; (2) knowing the various factors, including education, that influence sustainable tourism development; and (3) knowing stakeholders' role in sustainable tourism development.

1.2. Literature Review

Community-based tourism development is a strategic instrument as a means of development. To examine this matter more deeply, we must explore the extent to which tourism is a determining factor in social and economic change and even culture. According to several researchers, M. del Río-Rama et al. [21], M. Cawley et al. [28], and F. Zach and P. Racherla [29], one of the factors that also influences tourism development is the network factor. Therefore, tourism actors should be able to build a network outwardly with fellow tour operators and non-governmental organizations committed to tourism development.

According to S. Asker et al. [30], and N. B. Salazar [31], community-based tourism (CBT) development has been developed since the 1990s to increase local community partici-

pation in tourism development. In addition, through expanding the role of the community, it is hoped that the concept of sustainable development will be more effectively implemented so that not only will economic benefits be obtained, but also, at the same time, there will be the preservation of natural resources and cultural values that are the treasures of the local community. Giampiccoli and O. Mtapuri [23] highlight the development of conventional tourism compared to community-based tourism in Vietnam. According to them, there must be a balance between the two types of tourism. With community-based tourism, it is hoped that it will involve more micro, small, and medium enterprises (MSME) actors in the accommodation and food sectors. This is in line with government policies related to economic openness, empowerment, and poverty alleviation [1,32].

V. Rachmawati et al. [33] mentioned that the CBT concept could be an effective model for providing benefits to local communities. S. Nitikasetsoontorn [34] explains that seven factors are the key to the success of CBT: community participation in decision-making processes, local ownership, collective responsibility, leadership, governance, uniqueness, and the ability to be different. In the view of E. Ruiz-Ballesteros [35], CBT is an intelligent strategy to build and increase community resilience in realizing social and environmental sustainability. Research by Ballesteros and Tejedor examines the interrelationships between CBT implementation and community resilience in social ecosystems. Their research also makes small islands their locus, namely the island of Floreana in the Galapagos archipelago.

In the opinion of T. Dangi and T. Jamal [36] and E. So and R. Spence [37], CBT is expected to increase local community participation, improve management and service quality in the long term and bring benefits to the community in the field. In other words, CBT is expected to implement the principles of sustainable development and community development in general. However, in the implementation process, management by local communities requires work. Especially in suburban areas, help and support from outsiders are still needed [38].

2. Materials and Methods

This study used a mixed-methods approach. According to P. Clark [39] research with a mixed-methods approach has its philosophical assumptions and information-seeking framework. Moreover, this method has clear instructions for collecting and analyzing data from various sources. According to [40], mixed methods have multiple advantages in solving complex problems because they integrate the philosophical frameworks of post-positivism and interpretivism, aligning qualitative and quantitative data to be explained meaningfully.

Mixed methods also offer flexible logic and methodologies and a deeper understanding of a simple study [41]. Other researchers, G. Enosh et al. [42] and S. Dawadi [43], stated that with mixed methods, researchers could explain answers to their research questions quite broadly and in-depth. Through a quantitative approach, extensive information can be obtained and used to generalize a situation. News or issues can be explored in more depth using a qualitative approach. In the context of this research, a quantitative approach will be implemented to obtain data to answer objective 1: knowing the level of community readiness for sustainable tourism development. Meanwhile, a qualitative approach is used to obtain data and answer objective 2, namely, to identify the various dimensions that influence sustainable tourism development, and objective 3, to know the role of stakeholders in sustainable tourism development.

2.1. Data Collection Technique

Data collection methods used in this study were as follows. (1) Observation was used to directly observe the activities carried out by the research object closely. (2) A questionnaire was used as a data collection technique that gave the respondents a set of questions or written statements to answer. This questionnaire was used for the process of collecting quantitative data. The respondents selected to answer the questionnaire questions were community members involved in sustainable tourism activities in the research area.

The data were processed by interpreting them in the form of numbers with the help of SPSS 16.0, making it easier for researchers to analyze the data obtained. (3) Documentation was used to obtain data and information in the form of books, archives, documents, written numbers, and pictures in the form of reports and information that could support the research. Documentation was used to collect data and then reviewed. These data were collected through various sources of written data related to objective issues and other supporting data. (4) To obtain qualitative data, in-depth interviews were held with selected key informants using the following considerations [44]: (a) informants have authority and know and understand tourism activities around the location; (b) informants carry out activities within the scope of the tourism area; (c) informants have enough time to be asked for information; (d) informants who are not in a state of illness or experiencing other health problems; (e) informants are considered to understand the tourism development under study.

Seven key informants were selected in this study: the village head, the Forest Farmers' Group (KTH) head, the hamlet head, the parking attendant, one tourism manager, and two traders. Then, the data collected were analyzed based on the stages of analysis referring to Miles and Huberman [45], namely reduction, presentation, and conclusion.

2.2. Research Sample

This research was conducted in Jerowaru District. The villages used as research locations were Sekaroh, Jerowaru, and Seriwe. The consideration was that in Jerowaru District, only three villages have been designated as Tourist Villages based on West Nusa Tenggara Governor Decree No. 050.13-366 the Year 2019. For quantitative data collection, the sampling technique was used. The sampling technique used was quota sampling. Quota sampling is a sampling method in the category of non-probability sampling, which does not provide equal opportunities for each element or member of the population to be selected. Quota sampling is a technique that first determines the number and specific characteristics of targets that must be met [44]. The features of the samples taken in this study were those who are directly or indirectly involved in tourism activities. Because this research was a type of correlational research, the sample size comprised 60 people. According to Sugiyono [44], the number of appropriate samples for a correlational study is in the range of 30 to 500. The consideration for using quota sampling was that the number of those directly involved in tourism activities could not be known with certainty. Meanwhile, the accidental sampling approach was used to select respondents, namely interviewing those found at the research location who were considered to meet the requirements for respondents.

2.3. Data Analysis

To measure community readiness in community-based tourism development or sustainable tourism, we used four variables: economic capital, cultural capital, social capital, and symbolic capital. Indicators for each variable can be seen in Table 1 below.

Table 1. Level of Community Readiness.

Variable	Indicator
Economic capital	Banking transaction tools
	Media to obtain information
	Trends in using mobile phone
	Mobile phone ownership
	Ability to use mobile phone
	Availability of houses as lodging
	Planned tourism facilities
	Owned tourism facilities

Table 1. *Cont.*

Variable	Indicator
Cultural capital	Opinions about education
	Support for education
	Knowledge of the Jerowaru tourist village
	Part of Pokdarwis
	Experience working in the tourism sector
	Foreign language skills
	Interaction ability
Social capital	Responses when there are tourists
	The intensity of visiting neighbors
	Participation in community events (customs/traditions)
	Involvement in promoting tourism
	Acceptance of cooperation with external parties
	Obedience to village rules
	Upholding local values
Symbolic capital	People who are trusted to solve problems
	Deliberating and decision-making figures in the village
	The need for a special tourist rule system
	Participation of government officials in community activities
	Participation in community activities
	The ability of leaders to lead democratically

Resources: Purwanto and Sulistyastuti [46].

The questions were developed based on the indicators in Table 1 above. For instance, we asked whether respondents had a bank account and could use mobile phones for economic capital. We also asked them whether their houses were available for tourism, etc. For social capital, we asked respondents about their social relations, response when there are tourists, etc. Each question had alternative answers, “Yes” or “No”. Then, the percentages of respondents that answered “Yes” or “No” to each question were calculated. From the accumulated answers, conclusions were then drawn, as shown in the following table (Table 2).

Table 2. Community Readiness Level Categories.

Percentage (%)	Category
11–41	Low
41–71	High
71–100	Very high

The categories above were obtained with the highest percentage value minus the lowest percentage value, namely 11%, and the result was 89%; then, the interval distance was found by dividing $89/3 = 29.6$, which was rounded up to 30. The result yielded the categories shown above.

As for qualitative data, the data analysis process was carried out through three parallel activity flows [41]. First, data reduction, which is defined as a selection process focusing on simplification, abstracting, and transforming “rough” data that emerges from written records in the field, was performed. The data obtained in the area were extensive; for this

reason, it was necessary to record them carefully and in detail. As stated, the longer a researcher is in the field, the more complex and complicated the data. For this reason, it is necessary to conduct data analysis through data reduction immediately. Reducing data means summarizing, choosing the main things, focusing on the essential items, and looking for themes and patterns. Thus, the reduced data provide a clear picture and make it easier for researchers to collect further data and look for them when needed. The second activity was the presentation of data. After the data were reduced, the next step was displaying the data. For example, in qualitative research, data presentation can be achieved with brief descriptions, charts, relationships between categories, and the like. The third activity involved reaching conclusions. Initial conclusions are still temporary and will change if no substantial evidence is found to support the next data collection stage. However, if the collection of data is pursued at an early stage, conclusions can be formulated.

Informants are research subjects who can provide information about the phenomena or issues raised in the research. To select informants, researchers used a purposive technique. According to Sugiyono [44], the purposive sampling technique is to choose informants with in-depth information and knowledge about the aspects of the data sought. In this study, the researchers classified the informants as follows: First were key informants. Key informants know in depth the issues being researched and understand various matters related to the background and implemented policies. In this case, the key informants were the head of Sekaroh Village and the head of the Pink Lestari Forest Farmers Group. Second were main informants. A main informant is an informant who knows in depth the problem being researched and is directly involved in the activity that is the object of research. The main informants included managers of tourism activities in the Pink Beach tourist area. Third were supporting informants. Supporting informants are people who interact directly with the environment around tourist objects in the research area. Supporting informants in this study were traders, parking/ticket attendants, and the community around the research area. The researchers documented the list of informants as part of the research report, but the list is not shown in this paper.

3. Results

3.1. Characteristics of Respondents

An explanation of the characteristics of respondents can be seen in Table 3. Based on the distribution of respondents based on gender, it can be seen that the ratio of male and female respondents was balanced (50:50)%. Based on marital status, of the 60 respondents, 95% of respondents were married, and the rest were single, widowers or widows.

Table 3. Characteristics of Respondents.

Characteristics	Total	Percentage
Gender		
- Male	30	50
- Female	30	50
Marital status		
- Never married	1	1.7
- Married	57	95
- Divorced	1	1.7
- Widow/Widower	1	1.7
Age (years)		
- 15–25	4	6.7
- 26–35	8	13.3
- 36–45	27	45
- 46–55	15	25
- >55	6	10

Table 3. *Cont.*

Characteristics	Total	Percentage
Education		
- Never attended school	1	1.7
- Not finished elementary school	2	3.3
- Finished elementary school	14	23.3
- Not finished junior high school	0	0
- Finished junior high school	17	28.3
- Not finished senior high school	3	5
- Finished senior high school	23	38.3
- One-year diploma	0	0
- Two-year diploma	0	0
- Three-year diploma	0	0
- University graduate	0	0
Average income (IDR)		
- <500,000	38	63.3
- 500,000–1,500,000	22	36.7
- 1,500,000–2,500,000	0	0
- 2,500,000–3,500,000	0	0
- >3,500,000	0	0

Based on age, the distribution of respondents included 45% aged 36–45 years, 25% aged 46–55 years, 13.3% aged 26–35 years, 10% aged >55 years, and only 6.7% aged 15–25 years. Most of them did not finish High School in terms of educational level. Only 28.3% finished their Junior High School. Based on average income, 63.3% of respondents earned below IDR 500,000 per month. At the same time, 36.7% had an income of around IDR 500,000–1,500,000 per month.

3.2. Analysis

Community Readiness Level

From the results of the research, data related to the level of readiness of the community in carrying out sustainable tourism development were obtained, as shown in the following table.

Table 4 below shows the level of community readiness in carrying out sustainable tourism development for each variable measured in this study, where economic capital and social capital were in the very high category, while cultural capital and symbolic capital were in the high category.

Table 4. Results of Level of Community Readiness.

Variable	Indicator	%	Mean	Category
Economic capital	Banking transaction tools	100	77%	Very high
	Media to obtain information	100		
	Trends in using mobile phones	98		
	Mobile phone ownership	90		
	Ability to use mobile phone	90		
	Availability of houses as lodging	65		
	Planned tourism facilities	51		
	Owned tourism facilities	20		

Table 4. Cont.

Variable	Indicator	%	Mean	Category
Cultural capital	Opinions about education	93%	52%	High
	Support for education	93%		
	Knowledge of the Jerowaru tourist village	94%		
	Part of <i>Pokdarwis</i>	11%		
	Experience working in the tourism sector	14%		
	Foreign language skills	26%		
	Interaction ability	34%		
Social capital	Responses when there are tourists	87%	79%	Very high
	The intensity of visiting neighbors	83%		
	Participation in community events (customs/traditions)	76%		
	Involvement in promoting tourism	43%		
	Acceptance of cooperation with external parties	79%		
	Obedience to village rules	87%		
	Upholding local values	90%		
Symbolic capital	Honor and fame		60%	High
	People who are trusted to solve problems	74%		
	Deliberating and decision-making figures in the village	57%		
	The need for a special tourist rule system	57%		
	Participation of government officials in community activities	57%		
	Participation in community activities	57%		
	The ability of leaders to lead democratically	59%		

Results of the study (2023).

1. Economic capital

Based on the results of the analysis, as shown in Table 4 above, it can be seen that the level of readiness of the community in the research area to carry out community-based tourism development or sustainable tourism in terms of economic capital variables was included in the very high category with a rate of 77%. It indicates that the people in the research area are economically ready to implement community-based or sustainable tourism.

Economic capital consists of two indicators, namely, facilities and infrastructure. Facilities are one of the things that must be considered in tourism development. Few villages in Indonesia have tourism potential but find it challenging to develop because adequate facilities and infrastructure do not support them. From the existing data, the facilities for tourism in the research area were reasonably adequate. Tourism facilities owned independently by the community included one hotel/inn, four restaurants, one snorkeling/diving equipment rental business, and 14 others (sea transportation such as boats), which are used for tourism and visits to the islands around the pink beach. Meanwhile, several community homes could be used as lodging for tourists. This is a form of community participation in sustainable tourism management that can benefit the community.

Tourism infrastructure includes natural and human resources that tourists need. Infrastructure in tourism is as critical as facilities, so these two things must be available and will determine the sustainability of tourism in the future. Based on the data analysis from this study, the infrastructure was in the category of adequate access to the village, allowing

easy passage using both land and sea transportation. Meanwhile, the latest information or news was available on TV, social media, and the internet. This was consistent with the research results where 54.2% of respondents had the latest information and news through TV, and the rest through social media and the internet. Water sources in the study area were also diverse, but some people struggled to obtain a clean water supply. The research area is a dry land with minimal fresh water sources.

2. Cultural capital

Next was cultural capital, where from the results of this study, the mean percentage of the indicators was 52%, which placed it in the high category. In contrast to the “very high” category, this category indicated that the level of community knowledge was high, but the level of skills was relatively low. There were two indicators of cultural capital, namely knowledge and skills. These indicated that the levels of knowledge and skills of the community influence whether the community in the study area is ready or not to carry out sustainable tourism development. Therefore, the community, and especially the tourism community, must possess knowledge and skills, because these are very important for the sustainability of tourism.

The people in the research area generally understood the importance of education. From the data obtained from this study, 100% of respondents considered education essential and supported their children in the pursuit of education. This indicated that the respondents fully supported their children’s education and pursuit of the highest possible level of education, with the hope that their children will have better jobs than their parents. Thus, cross-generational social mobility will likely develop with better livelihoods for the next generation. Knowledge was also related to local community knowledge about tourism development in the research area. Knowledge indicators can reflect the awareness of the community itself or the level of outreach from the village government to the community regarding community-based tourism development. Based on the research results, 95% of respondents knew that the government had designated the research location to become a tourist village for sustainable tourism.

Community skills in the research area can be viewed in terms of three sub-indicators: experience working in the tourism sector, foreign language skills, and the ability to interact with tourists. Based on the research results, 14% of respondents had work experience in the tourism sector. However, this showed that there are still relatively few people who have skills in the field of tourism, so there is a need for training to increase people’s insights and skills related to tourism and the tourist village itself.

In terms of ability, in this case, foreign language skills and the ability to interact with tourists still need to be improved. However, based on the study’s results, it was found that as many as 26% of respondents could speak a foreign language, and 34% had experience interacting with tourists. Community education also influences community readiness because the higher the level of a community’s education, the better its citizens understand tourism and are more likely to play a role in providing creative and up-to-date ideas for tourism sustainability. Therefore, although from the data obtained, there were differences in the indicators of knowledge and skills, in general, it could be concluded that in terms of cultural capital, the level of community readiness to implement sustainable tourism was high.

3. Social capital

Regarding social capital, the analysis results showed that this variable was included in the very high category with a mean rate of 79%. This meant that the people in the research area, from the perspective of social capital, were ready to implement the principles of community-based tourism toward sustainable tourism. There were three indicators of social capital: values/norms, social relations, and trust. The findings indicated that the levels of values/norms, social relations, and trust in the research area between communities, communities and government, and communities and tourists can influence the level of community readiness to carry out sustainable tourism development.

Values and norms must exist and be adhered to by society, as they strongly influence the relationships and interactions between citizens. Without explicit norms and sanctions, relations between people tend to degenerate into chaos. This phenomenon can result in anomie, where individuals in a society tend to do whatever they want. It also applies to tourism activities. As experienced in other areas, tourism can hurt the economic and social life of a community. In addition, it is feared that it will bring about a shift in existing local values and norms due to the entry of tourists into the village with their own culture (especially Western culture), especially in terms of dress and other behaviors. Therefore, with the existing rules and values in society, the tendency for these negative impacts to occur can be prevented.

Data from this study showed that 95% of respondents felt it was necessary to prepare a system or special rules for visiting tourists to limit their behavior so that local community values can be maintained and are not affected by tourism activities. Besides that, tourists and local people are expected to respect each other. In another part of this study (Table 4), 90% of respondents answered that the people in the research area still upheld existing local values by participating in local traditions (76%) passed down from generation to generation. Communities that do not comply with existing local values will be subject to social sanctions in the form of ridicule from other communities and even ostracism. Regarding compliance with existing regulations, 100% of respondents replied that they complied. They believe that the village government, as the body chosen to lead the community, should be able to prevent things that are not desirable and contrary to the values and norms of local society. Various regulations that have been instituted are believed to be able to prevent chaos and bring order.

Social relations are an essential form of social capital the tourism community owns. Social connections are marked by a typology with group characteristics and orientation. Social groups are usually traditionally formed based on lineage and similarities in beliefs. Social relations between tourism actors must be good so that tourism activities can run smoothly and increase mutual trust between tourism actors. Based on the study results, 100% of respondents helped and attended when there were celebrations, circumcisions, weddings, and other social activities—the community benefits in the form of money, food, and labor. The social relations of the community in the research area and the culture of gotong-royong have always been powerful. This was shown from the respondents' answers to questions about visits with neighbors, where 83% stated that they often visit neighbors' homes, and even 18.6% stated that they very often see neighbors to sit or eat together.

From the research data related to responses when meeting tourists who visit Jerowaru, as many as 96.7% of respondents answered that they were friendly toward tourists with greetings and smiles or even by waving to them. This shows that limited foreign language skills did not cause people in the study area to behave poorly toward tourists. Community involvement in promoting their location as a tourist destination still needs to be improved. However, based on the research results, 43% of respondents were involved in promoting tourism. Participation from the community, especially by youth and the millennial generation, is needed to help in promotional activities, primarily through social media, which is currently very popular among youth.

Communities in the research area trusted the village government to manage tourism and the proceeds from tourism activities. BUMDES (enterprise institution owned by the village) handles the management and distribution of tourism proceeds with a stipulation of the amount of distribution based on mutual agreement. Regarding cooperation with external parties, the community in the research area was very open. This was confirmed by the research results, where 85% of respondents agreed to accept cooperation with outsiders.

Based on the discussion above, it can be concluded that in terms of social capital, from the indicators of values/norms, social relations, and public trust in the research area, respondents were ready to develop sustainable tourism. The local values of the people in the research area were positive and very much needed in tourism activities. Likewise, some

norms or rules were used to regulate the behavior of people and tourists so that community members can control the course of tourism activities.

Apart from that, the indicators of social relations between the community and other communities, the community and the government, and the community and tourists/outside were excellent. Social relations can be used as social capital to help smooth tourism activities. Good social relations can also generate good trust and contribute to the smooth running of activities and the sustainability of tourism.

4. Symbolic capital

Finally, regarding symbolic capital, the mean value of the indicators was 60%, placing it in the high category. This shows that the influence of leadership, honor, and fame on community responses is dynamic. Symbolic capital had three indicators, namely leadership, integrity, and fame. These showed that the form of one's leadership, people who are respected, and people who are well-known in the community can influence whether or not the community is ready to implement a development program.

Based on the results of the study, 59% of respondents answered that the leaders in the research area could lead democratically. This finding showed that the performance of village leaders, in this case, the village head, was quite good in the eyes of the community. Another research result that supported this statement was the response by 57% of respondents that the village government was involved in community activities. Again, this showed that the community viewed government leadership in the research area as good and in line with community expectations.

Honor and fame are related to the figures most respected and known by the public. The results showed that 86.7% of the respondents answered that the village head was the most dominant decision-maker. The village head was also a trusted figure in solving community problems. This phenomenon confirms the results of the research, where 60% of respondents answered that the village head is a figure trusted by the community to solve problems. Based on the description above, a conclusion can be drawn that how a leader leads, people who are respected, and people who are famous/famous in the community, in this case, the village head, can influence the response or responses of the community regarding development. Therefore, there is a role for suggestions and the charisma of the village head in ensuring that the community will always follow and support what is considered good and right by village leaders.

3.3. Influential Aspects

To understand more deeply the level of community readiness for sustainable tourism development, five essential aspects are discussed below. These four aspects are economic, social, cultural, environmental, and political. The relationships of these aspects were investigated by interviewing several informants using a qualitative approach.

1. Economic Aspect, consisting of three indicators

a. Funds for development

Information obtained from informants indicated that for sustainable tourism development, the sources of funds were the village government and the Forest Farmers Group, which manages the tourism in that area. This information was revealed from an interview with the village head and the head of KTH Pink Lestari during in-depth discussions on 8 October 2022.

b. Creating jobs in the tourism sector

One of the principles of sustainable tourism is being able to create jobs as well as generate income for residents. In other words, tourism development can create jobs for the surrounding community. This information was confirmed by the head of KTH Pink Lestari and another informant in the study location.

2. Social Aspect

a. Improved quality of life

As with changes in the economic sector, tourism also brings social and economic changes. Our informants in the study area mentioned that tourism increases people's income and quality of life.

b. Increased community pride

An increase in community pride or community acceptance of tourists visiting tourist attractions was expressed by an informant. The informant stated that the community in the study area is quite open to visitors. People feel pride in their village, which has been a tourism destination in the region.

c. Building stronger community organizations

They are strengthening community organizations in tourism areas tasked with managing and developing tourism potential so that dreams can be realized. This willingness requires supporting the community itself. Therefore, according to the informant, local tourism institutions such as the KTH organization are needed.

3. Cultural Aspect

a. Encouraging people to respect different cultures

At a tourist location, tourists usually bring their own culture from one place to another, including in existing tourist attractions. However, the most important thing is how the community respects these cultures. This phenomenon was expressed by an informant who acknowledged the cultural variety brought by the visitors. He said that outside cultures must be appreciated by the community, and at the same time, it must maintain its own.

b. Facilitating the development of cultural exchange

In the tourism area of Sekaroh Village, tourists bring their own culture. Therefore, with the presence of local and foreign tourists, cultural exchanges often occur, as stated by one of the informants.

4. Environmental Aspects

a. Carrying capacity

The carrying capacity, or the maximum capacity for visitors to the area, needs to be understood as one of the principles of implementing sustainable tourism. As one of the informants explained, since the tourism destination is a conservation area, people must pay attention to the carrying capacity of the region. This is one of the principles of sustainable tourism development.

b. Raising awareness of the need for conservation

Increasing awareness of the need for conservation around tourist areas is essential to maintain natural ecosystems. It is said that this understanding is not only for the local community itself but also for the visitors.

3.4. The Influence of Education on Sustainable Tourism

Curriculum development must be based on cultural values in society, in addition to knowledge, technology, politics, and the economy [47]. Furthermore, Print [48] states that culture is also a target to be achieved in implementing curriculum development. From this view, it can be concluded that the education sector is not only an instrument in sustainable tourism development but also a target that will be affected when tourism develops.

Research by Saliman et al. [49] concluded that the development of tourist villages in the research area positively impacted the development of local culture and the world of education. To minimize the adverse effects that can occur in tourist areas, it is advisable to apply the principles of sustainable tourism development. One of the principles of the

sustainable tourism program is the availability of an environmentally conscious education mechanism for visitors and the local community. This is stated in the Regulation of the Minister of Tourism of the Republic of Indonesia Number 14 of 2016, which regulates the arrangement of sustainable tourism destinations [50,51].

Zeki Akinci et al. [52], in their research on students of the Department of Tourism at Akdeniz University, concluded that higher education has a positive effect on the development of behavioral attitudes of students toward the world of tourism. In the context of the role of the curriculum in educational institutions, this study examined the extent to which the educational process has succeeded in changing student expectations, perceptions, and satisfaction during study in the tourism department. It was found that the students felt that the educational process they experienced fulfilled their expectations toward tourism.

According to Amoah and Baum [53], the process of continuing tourism education in Turkey has been augmented with various technological and infrastructure tools needed to develop modern and sustainable tourism. Furthermore, increasing human resources capacity is also continuously carried out in addition to issuing regulations related to restrictions on foreign workers in the tourism sector.

Idajati et al. [54] examined the factors influencing the form and level of community participation in developing geo-tourism in Wonocolo Village, Bojonegoro Regency. From their research, they concluded that the educational variable for visitors is at the functional level, together with infrastructure and local government policies. At the same time, the education variable for local communities is at the incentive level or below the functional level. This research shows how vital the role of education is in developing sustainable tourism.

In their research on turtle conservation in Bali, Nurhayati et al. [55] analyzed the extent to which turtle conservation education programs correlate with sustainable marine tourism in Bali. This study concluded that the respondents' education levels significantly influenced their awareness of the importance of turtle conservation in the study area. In other words, the higher a person's education level, the better their understanding of the importance of conservation activities for preserving natural resources. Furthermore, it was noted that environmental education programs are still needed. Therefore, ecological education programs must be able to be implemented on an ongoing basis, either by integrating them with the existing formal education curriculum or through informal education, such as short courses or outreach in existing tourist areas [56].

The research reports described above show that the education sector plays a significant role in sustainable tourism development.

3.5. The Role of Stakeholders in Tourism Development

The role of stakeholders is needed in efforts to develop tourism in Sekaroh Village. If the development program is well designed, it can potentially increase regional income. Stakeholders in the ecotourism sector include anyone who influences and is influenced by tourism development. They are residents, the government, community groups, the private sector, tourists, and other parties not directly related to tourism development. From the results of observations in the field and various forms of information obtained as part of this research, the stakeholders involved and their roles and functions in developing sustainable tourism in the research area can be explained. Some of the things that were found in the research concerning the presence of various parties in the development of sustainable tourism in the research area can be explained as follows.

1. Government as Regulator

In this context, the government includes the village, district, provincial, and central governments. Each level of government has its authority as mandated by laws and regulations concerning regional government. The government's role as a regulator is to prepare guidance to balance the implementation of development through the issuance of the necessary rules, both in the framework of structuring existing tourist destinations and in the context of regulating various aspects of institutional tourism governance. In general, the government has the authority to issue multiple fiscal policies that can incentivize specific

tourist destinations to develop faster, for example, by providing subsidies to airlines to pilot flights to newly opened tourist areas. As another example, the government can provide support or assistance to travel agents to lure tourists to visit, especially tourists from foreign countries.

2. Government as Facilitator

Aside from being a regulator, the government can also act as a facilitator by providing various facilities needed in structuring and developing a tourist destination. The findings of this research should be a concern of the government. The government should facilitate various limitations in the research area so that the potential of the tourism framework can be immediately operationalized. As a relatively new area in tourism, the research area has various supporting facilities that are inadequate, such as public transportation, good parking lots, and other public facilities. In human resource development, the government has the capacity and authority to improve the ability and quality of tourism managers, both at the managerial level and at the level of executors and supervisors in the field. In optimizing the government's role as a facilitator, local governments also need to encourage the participation of other parties or competent stakeholders in developing tourism facilities and infrastructure. The government must also promote coordination and cooperation between stakeholders, such as the private sector, universities, civil society (NGOs), and the media.

3. Involvement of the Private Sector

The involvement of the private sector in tourism development, including sustainable tourism, will accelerate the development process. This involvement is in accordance with the principles of sustainable tourism. Tourism development should be able to create jobs and increase people's incomes. As investors, elements of the private sector have potential that can be utilized economically to carry out various activities for structuring destinations and managing tourist areas with the government and the community. However, the principles of ownership by the community and activities driven by the local community should still be promoted.

From research conducted by Elmo et al. [57], it was concluded that the private sector could play a role in developing sustainable tourism as long as it can contribute and or gain economic benefits. Besides that, the aspect of corporate resilience, both economically and socially as well as environmentally, is also a determining factor in whether a private company can grow.

4. Higher Education Institution Involvement

Sustainable tourism development is science-based development. Therefore, in implementing sustainable tourism, the role of universities is vital. Universities can collaborate with the local community from the initial phases of sustainable tourism development, such as exploring potential, planning development, and even identifying development models that can be implemented. In addition, lecturers and students can be directly involved in related learning programs on campus.

The role of higher education institutions is oriented more toward developing and establishing the direction of sustainable tourism. As researched by Qian et al. [58], six significant themes need attention in developing sustainable tourism: climate change, behavioral studies, poverty reduction, volunteer tourism, policy instruments, and indigenous tourism. Here, the role of universities is expected to contribute.

5. Involvement of Civil Society or NGOs

Today the existence and role of civil society in development, including tourism, is essential. This includes non-governmental organizations that act as a liaison between the community, government, and outside agencies concerned with sustainable tourism development. Several non-governmental organizations have emerged in the research area, including Forest Farmers Groups, Karang Taruna (Youth Organization), Tourism Awareness

Community Groups (Pokdarwis), and others. From the results of this study, it was found that the Forest Farmers Group (KTH) in the research area plays a reasonably active role in developing tourism. KTH already has a management structure and is quite active in the field, especially in providing security for the parked vehicles of visiting tourists.

According to several researchers [59,60], the role of civil society or non-governmental organizations is very strategic in developing sustainable tourism. The role of these NGOs is not limited to the planning and development process; it also extends to integrating tourism development with rural development and society in general.

6. Media Engagement

Finally, media involvement has a strategic role, especially in marketing or promoting sustainable tourism. With this media involvement, the wider community will quickly recognize a new tourist destination area. Furthermore, the media can also function in the context of the education process for the public and tourists. As explained earlier, one of the principles of sustainable tourism is continuous education, both for the community and visitors, regarding the importance of preserving existing natural and cultural resources. Thus, through the media, various educational processes can be carried out.

Chatterjee and Dsilva [61] examined the critical role of the media in sustainable tourism development. It was concluded from their research that there is a very close relationship between media and sustainable tourism, especially in the context of developing relatively underdeveloped tourist areas. The study also concluded that the media have a role in marketing sustainable tourism areas targeting those who like to travel, including groups of parents who are already literate on the internet or social media.

4. Discussion

In relation to the level of readiness of the community in the context of implementing sustainable tourism, it can be concluded that the community is in the “very ready” category. This conclusion means the community was prepared in terms of the various forms of capital examined in this study.

First is economic capital. Tourism development requires heavy investment. Many things must be addressed in the context of preparing for tourism development. One of the most important factors is the preparation of the infrastructure needed by tourism actors, starting from arranging destinations. These facilities will include tourist attractions, culinary centers, trash bins, and adequate toilets. As a sustainable tourist destination, under the principles of sustainable tourism, which requires an educational process for visitors, one of the necessary elements of infrastructure will be an environmental education room. It will be a vehicle for education, for both local community members and visitors, on the importance of preserving the environment and maintaining the existing cultural heritage. Besides that, it should also be ensured that the local community enjoys the economic benefits of sustainable tourism. Therefore, preparing local communities to engage and play an active role in sustainable tourism development needs special attention. Training and social engineering should be carried out measurably so that people do not become “spectators” in their tourist areas. To ensure sufficient economic capital, sustainable tourism actors can invite outside investors to finance various infrastructure needs. However, the invited investors should understand well the principles of sustainable tourism development [57]. Apart from investors, tourism actors can also ask the government, in this case as a facilitator, to assist in procuring various elements of necessary tourism infrastructure [1]. As with the private sector, the government should also remain guided by the principles of sustainable tourism.

Second, in terms of cultural capital, every area where tourism develops must have artistic potential that can be used as an attraction. Culturally based tourism is included in sustainable tourism. In this study, what is meant by cultural capital is related to educational issues for the local community. The assumption is that if the awareness and education level of the local community are high, then it is certain that the implementation of the principles of tourism development will work well. In this case, the aspect of human resources is

a crucial issue. Therefore, in any action to develop sustainable tourist destinations, this human resource issue should be a significant concern. The social engineering process in preparing each new destination must be carried out as effectively as possible. It is essential not to repeat the past mistakes of other regions or countries [19].

In this study, the role of education in sustainable tourism development was specifically reviewed. Education, both in the context of formal and informal education, has a vital role in developing sustainable tourism. According to Idajati et al. [54], the intended education is education for visitors and education for the local community. Education, in this case, is related to efforts to increase public awareness of the importance of preserving natural resources, which is one of the attractions in the world of tourism that must be maintained.

Third, social capital plays a very strategic role in sustainable tourism development. This role is based on the principles of sustainable tourism, where participation and ownership by the local community are the main factors. By assuming ownership of the existing social capital, members of the local community will be able to actively participate in developing tourism in their area. By exploiting cultural values that grow and develop in their area, as one example, they can make these traditional cultural values a unique attraction in sustainable tourism. Likewise, according to Zach and Racherla, utilizing social networks owned by the community will enable tourist destinations to develop quickly [29]. Through its networks, the community can also build cooperation with fellow tourism actors in other areas with the principle of mutual benefit. Moreover, the issue of sustainable tourism is a global issue, so communication with actors in other countries is also very open.

Fourth is symbolic capital. In the context of this study, symbolic capital relates to leadership, honor, and fame. In implementing sustainable tourism, symbolic capital plays a significant role. The leadership factor in society has a strategic position. Effective leadership will be the key to successfully implementing programs, including those in the field of tourism. In relation to the level of community readiness in implementing sustainable tourism, this aspect of symbolic capital is in the “high” category. The implication is that various processes in the field will be significantly influenced by the presence of a leader who can mobilize the community [6]. This leader presence is also based on the principles of sustainable tourism, where leadership issues are included.

Furthermore, several conclusions can be drawn regarding factors influencing community readiness to develop sustainable tourism. First, from in-depth interviews conducted with several key figures in the research area, it could be seen that from the economic and socio-cultural aspects, the community was ready to organize sustainable tourism. Secondly, from the observations, the community had begun to implement tourism activities at a certain level. Such activity can indicate community readiness to carry out highly sustainable tourism activities. Implementation of the principles of sustainable tourism has also begun, such as entrepreneurial activities that can encourage job creation. With the start of tourism activities in the research area, Pink Beach, as one of Lombok Island’s leading tourism destinations, can be an initial capital with great potential for development.

For this reason, government intervention and private sector involvement are factors that will significantly determine the direction of tourism development in the research area [1]. The penta-helix approach, in which elements of government, the private sector, universities, NGOs, and media are actively involved, is expected to be effective in accelerating tourism development in this area. In tourism development in the third world, including Indonesia, the government’s role is still very much needed. The role of the government is not only that of a regulator but also as a facilitator. In various tourist areas, the government assists in the development of much-needed infrastructure and transportation facilities.

One model developed entirely within the world of tourism includes a role for private investors in developing and managing tourist destinations. The management of tourism by the private sector tends to be commercial because the character of the private sector is profit-oriented [15]. However, through understanding and applying the principles of sustainable tourism, aspects of tourism commercialization that tend to damage the environment can be averted so that concerns about environmental damage and the non-empowerment of

local communities can be prevented. In this context, the presence of higher education institutions as part of the penta-helix approach becomes essential. The role of higher education in the development of sustainable tourism is to produce the various technologies and innovations needed for the preservation of natural resources and the development of human resources [5]. The role of higher education becomes more effective when side-by-side with the presence of civil society or non-governmental organizations and the world of media. The presence of non-governmental organizations and the media can act as a counterweight or a kind of control agency over the activities of other penta-helix elements. They can function as strategic partners that can make the penta-helix model effective in implementing sustainable tourism. They can also act as a bridge of interest between the community and other tourism actors. The synergy between sustainable tourism actors will guarantee the presence of sustainable tourism, which can improve the welfare of the surrounding community.

5. Conclusions

From the discussion above, the following conclusions can be drawn. First, the people in the research area are ready to develop sustainable tourism. Their level of readiness can be described from various aspects of capital, namely economic capital, whereas the level of community readiness is included in the "very high" category. In addition, the availability of adequate facilities and infrastructure indicates this category. Regarding cultural capital, the level of community readiness is in the "high" category. This category means that the community's knowledge is high but still relatively low regarding skills. The community's level of readiness in terms of the social capital is also very high, as indicated by several indicators such as social values/norms, social relations, and the trust held by the community. In terms of symbolic capital, the community's readiness level is also high, which means that the leadership factor in the research area is quite effective in moving the community toward sustainable tourism development.

Second, it can be concluded that the aspects that influence sustainable tourism development are economic, social, and cultural. From an economic perspective, sustainable tourism can add jobs for the community and simultaneously increase residents' incomes. Regarding the social aspect, formal and informal education both play a very strategic role. From the cultural aspect, implementing sustainable tourism also positively impacts maintaining the cultural values embraced by the community. Furthermore, the implementation of the principles of sustainable tourism is likely to increase public awareness of the importance of preserving natural resources.

Third, the stakeholders who play a role in developing sustainable tourism in the research area are the government, the private sector, universities, non-governmental organizations, and the media. The government plays a role in preparing regulations and providing various necessary tourism facilities and infrastructure. The private sector parties act as investors and, together with the community, manage tourist destinations while still applying the principles of sustainable tourism. Universities play a role in the study, preparation, and development of tourist destinations so that the possibility of negative impacts can be avoided. NGOs play a role in the process of educating the public and providing assistance to managers in implementing good tourism destination management. Finally, the media help inform the public and visitors and assist in marketing existing tourist destinations. The five elements of stakeholders are described as a penta helix.

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Article

Development of the Extremely Poor Students Selection Process for Receiving the Teacher Production Project Scholarship for Protected Schools in Thailand

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Abstract: This study aimed to develop a systematic process for selecting scholarship recipients to participate in the Krurakthin project at Kalasin University. To gather insights into the selection process, stakeholders from five distinct groups, including the director of the educational service area, the director of the destination school, community leaders, lecturers, and scholarship recipients, were interviewed. This study represents the preliminary stage of analysis and process development. The research instruments consisted of (1) an opinion interview form on the scholarship recipient selection process and (2) a form for evaluating the appropriateness of the selection procedure for scholarship recipients. The data were analyzed statistically by comparing the means and standard deviations. The research findings prompted the development of a procedure for selecting scholarship recipients. Regarding the appropriateness of the scholarship recipient selection process, it was found that the appropriateness of the advertisement process was scored at 4.55 ± 0.50 points, which was at the highest level. The appropriateness of the finding process was scored at 4.73 ± 0.45 points, which was at the highest level. The appropriateness of the screening process was scored at 4.58 ± 0.50 points, which was at the highest level. Additionally, the appropriateness of the selection process was 4.54 ± 0.64 points, which was at the highest level. Each process had a total appropriateness score of 4.61 ± 0.32 points, which is considered to be at the highest level. These results led to the production of a manual for choosing scholarship candidates to enroll in the Krurakthin project at Kalasin University and to prepare for the field test of the selection process of 4th-year Krurakthin students.

Keywords: Krurakthin; selection process; SDGs; Equitable Education Fund; scholarship



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1. Introduction

The United Nations (UN) has 17 Sustainable Development Goals (SDGs) [1] to lead development that serves the requirements of the present generation without hampering the ability to meet the demands of the next generation [2]. To accomplish sustainable development, three main factors must be incorporated: economic expansion, social inclusion, and environmental protection. At the 70th Session of the United Nations General Assembly, held at the United Nations Headquarters on 25 September 2015, Thailand and 193 other UN member states signed the 2030 Agenda for Sustainable Development, a global framework for tackling mutual social, economic, and environmental sustainable development without leaving anyone behind by the year 2030. The Sustainable Development Goals (SDGs), officially known as Transforming Our World, require action from all nations, both developed and developing, as part of a global collaboration. Ending poverty and other forms of deprivation must be combined with strategies that enhance health and education, lessen inequality, and promote economic growth, while still working to protect the environment and promote peace.

Thailand has endorsed the 17 Sustainable Development Goals as guiding principles at the national, municipal, and local levels. The cabinet resolution of 25 October 2016 assigned the Ministry of Interior to drive forward the SDGs at the local level. Moreover, the cabinet resolutions of 24 March 2020 acknowledged the results of the Sustainable Development Committee Meeting No. 1/2019 on 19 December 2019, which agreed the principles of the plan to drive the SDGs for Thailand [3] and included it in the plan of the National Strategy [4] government agencies and organizations of foreign countries to use the aforementioned goals to formulate an action plan in line with the country's development plan.

The Equitable Education Fund (EEF), following the government's policy, is an organization that applies the SDGs as a strategic plan by focusing on solving poverty, SDG 1, and improving the quality of education. This organization was established according to the recommendation of the Independent Education Reform Commission, which appears in the Constitution of the Kingdom of Thailand, 2017, Section 54 of the Equitable Education Fund Act B.E. 2018 [5], promulgated on 14 May 2018. This organization strives to achieve equality in education, alleviate poverty, reduce educational inequality, and improve the quality and effectiveness of teachers by allowing the state to allocate funding. Furthermore, this organization can operate independently [6].

The EEF manages various sub-projects, one of which is the Krurakthin project. The original basis of the Krurakthin project is based on the need to solve the educational disparity of schools in remote areas. In Thailand, there are about 2000 schools that are remote and cannot be merged (protected schools or standalone), according to a study by the World Bank Research Team in collaboration with the Office of the Basic Education Commission (OBEC) database [7]. These schools must be administered in order to provide educational opportunities for the children in the area [8]. However, it was discovered that the issue with rural schools is that teachers frequently ask to relocate because they are not locals and there are no substitute teachers in the schools. Therefore, there are not enough teachers for these schools [7–10], especially primary school teachers. This corresponds with an EEF survey on the situation of special needs students, which revealed that the number of exceptionally poor students in compulsory education has steadily increased since the school years 2020–2022. In semester 1 of the academic year 2020, there were 994,428 students in special poverty. This number increased to 1,174,444 in semester 2 of the 2020–2021 academic year, 1,244,591 in semester 2 of the academic year 2021, and 1,301,366 in semester 2 of the same academic year. In the first semester of the academic year 2022, the number further increased to 1,307,152.

Previous research conducted has calculated that, if every child in Thailand achieves international standards, the country's GDP will grow by 5.5% throughout the 21st century. Encouraging exceptionally poor students (corresponding to SDG 1) to continue their education and return to teachers in schools close to home will eliminate poverty and promote education (corresponding to SDG 4). Thus, it is crucial to address the issue of exceptionally poor students in order to achieve these sustainable development goals [11].

The Krurakthin project aims (1) to provide opportunities for students in remote areas who have a passion for the teaching profession and have the potential to complete their studies until graduating with a bachelor's degree; (2) to create the spiritual teacher, a teacher who has the dedication and the basic competence of the teaching profession; (3) to engage learning of 21st century skills; and (4) to promote the ability to be a community developer. After graduation, these students will return to their hometown to work as teachers in remote schools, helping to build their local community [12].

The goals of the EEF correspond with SDGs 1. "End poverty in all its forms everywhere" and 4. "ensures inclusive and equitable quality education and supports lifelong learning opportunities for all" [1]. If the project is successful, it will reduce inequality in schools in remote areas. Through these efforts, more students from the most impoverished families will have access to quality, affordable education (learning access and learning

outcome). Shortly after graduating, they can strive to support local students in efforts to end the cycle of inequity in rural areas.

Over the past three years, the Krurakthin project has been underway, but the previous selection processes have been deemed inadequate in identifying students from underprivileged backgrounds. This may have resulted in less effective public relations, searches, screening, and student qualification processes. In addition, this project is intended to create opportunities for students with strong academic performance and a feeling of being a spiritual teacher—a person who expresses themselves as a good teacher. They should possess a framework of morality, ethics, customs, and culture, which consists of having responsibilities in duties, love and faith in the profession, treating students with goodwill, giving love and kindness, helping, sacrificing, patience, perseverance, collective care, being a good role model, and knowing how to always improve yourself. Within ten years, this project aims to create 300 graduates annually for five generations and to ensure there are new teachers working in rural locations in about 2000 small schools at the sub-district level to meet the demand for the teaching profession [13]. In selecting students to obtain such scholarships, it is crucial to possess the necessary instruments to meet the initial goal of seeking, screening, and selecting applicants who possess the fundamental credentials to enter the teacher education system at the higher education level.

The objective of this research is to develop the selection process for Krurakthin scholarship recipients to be role models in the process of public relations, search, screening, and student qualification.

2. Background

The selection of scholarship recipients is the first stage in preparing them to be role models as teachers in accordance with the project's goals. Therefore, to achieve the goal, the process must be effective and efficient so that it may be used as a significant instrument in selecting scholarship candidates who meet the nine conditions for scholarship recipients [14]: (1) having Thai nationality; (2) studying at Mattayom 6 level or equivalent and will graduate; (3) living in a family with an average income of less than THB 3000/person/month or less than THB 36,000/person/year; (4) regarding domicile, the applicant and their parent(s) or legal guardian(s) must have resided in the school's subdistrict for at least three years prior to the application date; (5) having a grade point average of five semesters at the upper secondary level or a cumulative GPA before the last semester not lower than 2.50; (6) having a positive attitude about the teaching profession and a desire to teach in a rural area where they live; (7) having experience in performing creative activities for the public, (8) not demonstrating behavior that is implied to be an obstacle to study during the scholarship period; and (9) showing neither dishonorable behavior nor lack morality during the selection process. The process for finding candidates to receive the scholarship in the project is divided into five main activities, including searching, screening, selecting, and preparing activities [15]. The objective of public relations activities is to generate awareness and comprehension about the project, and to encourage students to enroll in the courses offered by the scholarship program. Additionally, communication with the target students, schools, parents, and communities in the service areas of educational institutions is the goal of this activity. Moreover, the goal of the searching and screening processes is to find qualified students who can obtain scholarships based on the goals of the project. This is carried out with the aid of stakeholders who can show valid considerations in case of objections with regard to the process.

According to the application of the aforementioned conceptual framework, Kalasin University is one of fifteen Thai institutions that has been considered to be an institute producing students in the Krurakthin project, early childhood major, from the first to the third generation starting from the academic years 2020–2022 [14]. In the first year, a learning-by-doing approach was used in the recruitment process to identify the qualified students who would be awarded the scholarship. In that academic year, the goal was to identify 32 scholarship recipients. A total of 54 students participated in the selection

and preparation process. In the second year, the objective was to identify 26 scholarship recipients, and 43 applicants participated in the selection process. The target for the third year was 26 scholarship students, and 45 students were involved in the selection and preparation process.

While providing five activities to scholarship students from the first to the third year, the project team members consistently designed and enhanced the processes for selecting scholarship students. In the first year, field trials were conducted so that lessons could be learned, and the process could be designed for efficient application in different locations until the number of pupils achieved the desired standard. The university combined the outcomes of the performance of the five activities when being considered as a scholarship graduate production institute in the second year in order to extract lessons for process design and fix deficiencies from previous operations. Then, processes were developed so that team members could effectively apply them in the third year.

From the results of the operation in the third year, it was found that the operation process in the past was efficient and productive and can be used as a model for operations. On these grounds, the working group can apply the selection process until they search for and screen students who meet the qualifications of scholarship recipients. When entering the selection process, they can select scholarship recipients who are suitable, i.e., those with quality that reflects the results of their work arising from such a process.

However, while these three years of work have been accomplished results, it is still inconclusive whether the process can act as a model that includes public relations, search, screening, student qualification process, and preparation for other institutions operating under the Krurakthin program as there are details of the process that still require lessons to be learned, reflection, and repeated practice [15] to ensure that developed processes are reliable under any situation. An exchange of learning with other production institutes, therefore, took place to confirm that the guidelines for the implementation of the above process would receive scholarship recipients according to the project's goals.

3. Materials and Methods

3.1. Research Process

This research is classified as developmental research type I [16] as a systematic study for designing, developing, and evaluating the selection process of Krurakthin recipients. It is divided into 4 phases: the analysis phase, design phase, development phase, and try-out and evaluation phase. Thus, this research project deals with the design and development of a selection process which is implemented in stages to examine the suitability of the process as Prototype in a specific context. At the end of the initial stage, the process can be used in other universities to study its limitations in their context and adapt it for future process improvements. However, this research provides the information regarding the analysis phase, design phase, and development phase, as shown below (Figure 1).

The analysis phase is a preliminary analysis of data to identify the objectives of the EEF for the Krurakthin project. Therefore, it is necessary to analyze the qualifications of the Krurakthin scholarship students, including the duration of the process for selecting the scholarship students. After that, there must be in-depth interviews with stakeholders in the process of selecting Krurakthin, including experts from universities that have received the Krurakthin project scholarships. The experts chosen to participate in the in-depth interviews are representatives of stakeholders from various regions of Thailand. In addition, the specialists, including the Head of the Bachelor of Early Childhood Education and/or Elementary Education program, also deal with the in-depth interviews as well.

The design phase involves the utilization of the data from the analysis phase and the data collected from the discussion about the results of Krurakthin recipients from the first to third years to develop Prototype I. Prototype I was sent to experts in the Krurakthin recipient selection process from various universities and stakeholders for consideration, followed by in-depth interviews with the researcher. Finally, in the development phase, the data obtained from the in-depth interview analysis were used to improve Prototype I,

which was then reviewed and validated by experts in the selection process for Krurakthin recipients. The result was a revised and internally validated selection process [17].

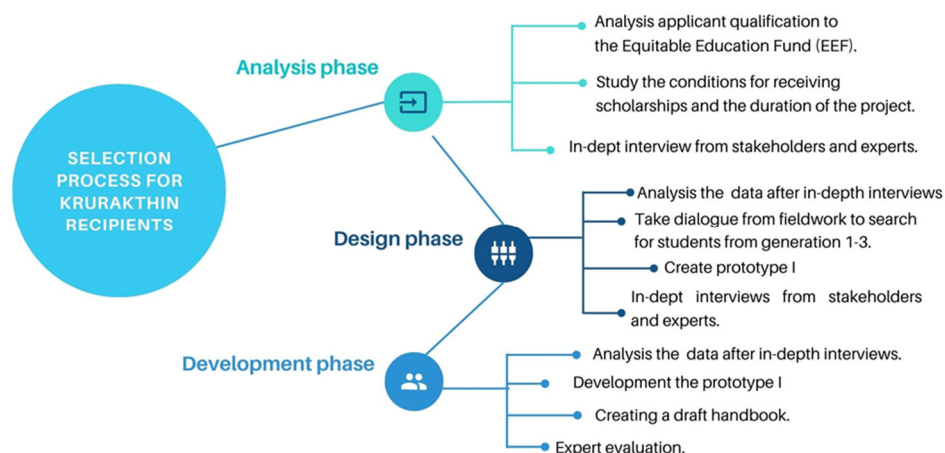


Figure 1. The diagram of research process.

3.2. Research Process

Total study populations of 107 and 136 participants were obtained using purposive sampling in the analysis phase and design phase, respectively. Both populations were divided into 2 groups. In detail, 87 and 114 samples were selected from the analysis and design phases, respectively [18]. In addition, during the analytical and development phases, the five experts were selected as representatives from the southern, northern, northeastern, and central regions of Thailand. Four of them were experts in the field of Krurakthin selection process development, while one was an expert in the field of developmental evaluation research. On the other hand, during the design phase, five specialists were involved and in charge of each step of the Krurakthin selection process, including public relations, search, screening, and student qualification processes. These specialists were obtained from other universities, and they were the Heads of the Bachelor of Early Childhood Education and/or Elementary Education programs (Table 1).

Table 1. Research participants in the developmental model of the selection process for Krurakthin recipients.

Phase	Type of Participant	No. of Participants
Analysis phase	1. Experts in the selection process of Krurakthin scholarship recipients	The group of five experts consisted of an expert in the selection process, an expert in early childhood education curriculum, an expert in primary education curriculum, a research expert, and a community expert. In detail, four of them were experts in the field of Krurakthin selection process development, while one was an expert in the field of developmental evaluation research.
	2. Stakeholders in the selection process for Krurakthin scholarship recipients	- Thirteen targeted terminal school directors; - Twenty-one high school students who participated in the selection process; - Fourteen community leaders; - Twenty-two provincial education officers and directors of primary school educational Service Areas (PESAs); - Twelve university lecturers that took part in the selection process.

Table 1. Cont.

Phase	Type of Participant	No. of Participants
Design phase	1. Specialist in the selection process for Krurakthin recipients	In detail, five specialists were involved and in charge of each step of the Krurakthin selection process.
	2. Stakeholders in the selection process for Krurakthin scholarship recipients	- Seven targeted terminal school directors; - Ten junior scholars (1st-year students); - Fifty-five senior scholars (2nd- and 3rd-year students); - Eight community leaders; - Seventeen PESA staff; - Twelve university lecturers that took part in the selection process.
Development phase	An expert in the selection process for Krurakthin recipients	The group of five qualified people consisted of four directors of early childhood departments or their representative who previously received Krurakthin scholarships from various universities. All experts used were the same group as in the analysis phase.

3.3. Research Instruments

The research tools used in each research phase comprise the following.

3.3.1. Analysis Phase and Design Process

- Five interview forms with five different stakeholder groups were used. These included the administrators of the province's educational service areas, community and local leaders, the directors of the schools where the scholars will be placed for public service, students who engaged in the process, and lecturers who participated in the process. The interview questions were divided into four categories: previous public relations, former student finding, former student screening, and former student selecting process. The participants were given the opportunity to share their experiences and express the realities that arose during the selection of the scholarship recipients by using open-ended questions [19]. Each interview format placed a strong emphasis on needs, wants, challenges, and recommendations. All interview forms were sent to five experts, including a selection process expert, an early childhood education curriculum expert, a primary education curriculum expert, a research expert, and a community expert, in order to verify and evaluate the Index of Item-Objective Congruence (IOC);
- Five IOC assessment forms of each stakeholder interview were sent to the previously mentioned experts.

3.3.2. Development Phase

- Five interview forms with five different stakeholder groups were used, which included the administrators of the province's educational service areas, community and local leaders, the directors of the schools where the scholars will be placed for public service, students who engaged in the process, and lecturers who participated in the process. The interview questions were divided into four developed categories: public relations, student searching process, student screening, and student selecting phases. Questions in each step were focused on needs, wants, and incomplete process details. Similar to the first phase, each interview format placed a strong emphasis on needs, wants, challenges, and recommendations. All interview forms were sent to five experts, including a selection process expert, an early childhood education curriculum expert, a primary education curriculum expert, a research expert, and a community expert, in order to verify and evaluate the Index of Item-Objective Congruence (IOC);
- Prototype I, which expressed the frameworks for selection processes, was established. It included an overall designed framework as well as four fraction-developed frameworks: public relations, student searching, student screening, and student selecting;

- The handbook was revised by providing details of the guidance and the information of stakeholders that needed to be contacted in each step. In addition, this handbook also offered various important online documents that were used in the field work. Users could assess the documents via scanning the QR code presented in each step.
- The IOC assessment forms of each stakeholder interviews were sent to the experts previously referred to;
- The evaluation forms assessed the effectiveness of the created framework;
- The evaluation forms assessed the suitability of the handbook.

In accordance with the above method, the IOC assessment forms were scored in a range from 1 (obviously measuring), –1 (clearly not measuring), or 0 (the content area is unknown), while suitability assessment forms were scaled as follows: 5 represented strongly suitable, 4 represented suitable, 3 represented neutral, 2 represented not suitable, and 1 represented strongly not suitable [20].

3.4. Data Analysis

The data obtained in the quantitative phase were statistically analyzed by the mean, standard deviation, and percentage. In addition, qualitative results which were collected from the interviews of stakeholders and all suggestions from experts were grouped. The repetition of qualitative results was selected and verified as an important issue using the Triangulation method. Data synthesis and summary were performed on these important issues [19].

4. Results

The results of the developmental research, which aimed to develop the Krurakthin project selection process at Kalasin University, were as follows.

4.1. Analysis Phase: Finding Problems

The data obtained from the interview with stakeholders regarding their needs in the public relation process were synthesized [21]. The interview process involved continuously gathering information from relevant individuals until sufficient data were obtained, resulting in some data redundancy. Next, the identified problems and gaps were investigated and analyzed to determine potential solutions to address them. In addition, problems and obstacles, as well as suggestions on the process of selecting grantees for the Local Teachers Program, are shown in Tables 2–5.

Table 2. The results of the project’s public relations process for entering the Krurakthin program, based on the general needs, problems, and obstacles.

Issues	Contextualization of the Needs, Problems, and Obstacles of the PR Process (The Stakeholders Who Gave the Opinions)
1. Needs	- Books or documents about the project should be sent earlier before the staff arrive (targeted terminal school directors, community leaders, and provincial education officers and directors of PESAs); - The staff from the university or EEF guidance counselors should begin the process by organizing meetings with the targeted populations (provincial education officers and directors of PESAs); - A LINE group should be created in order to organize meetings with directors of the schools where the scholars will be placed for public service, directors from schools where the target group is studying, directors of primary school educational service areas, and provincial education officers (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers).

Table 2. Cont.

Issues	Contextualization of the Needs, Problems, and Obstacles of the PR Process (The Stakeholders Who Gave the Opinions)
2. Problems and obstacles	- Some places did not receive documents/books about the project (targeted terminal school directors, high school students, community leaders, and provincial education officers and directors of PESAs); - The project's announcement was made slowly (targeted terminal school directors, high school students, community leaders, provincial education officers, and university lecturers); - School guidance counselors who had students who would qualify for the scholarship did not advertise to them (targeted terminal school directors and high school students); - The director who had just relocated did not know the community members well. Lack of familiarity with the community leaders made the collaboration less efficient than it could have been (targeted terminal school directors and community leaders); - Public service announcements were constrained due to the community members needing to go out for gardening and farming. They were not always at home (high school students and community leaders); - Sending information to other affiliations was delayed (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - The public relations campaign did not reach all target groups (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - Time for the public relations campaign was constrained (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - Some points of the information might not have been clear (high school students, community leaders, and provincial education officers and directors of PESAs); - Some points of the information were difficult to understand (high school students and community leaders); - The information about the Krurakthin project that had been issued was delayed (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - The public relations campaign did not reach all target places, so few people received information about the project (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers).
3. Suggestions	- In addition to distributing public relations materials, the EEF should host meetings to enlighten and increase project awareness among provincial education officers and directors of primary schools in the instructional service area (targeted terminal school directors, provincial education officers and directors of PESAs, and university lecturers); - Senior scholars and teachers who have previously been given scholarships should notify students who are eligible about this program (targeted terminal school directors and high school students); - The institution should initially hold meetings with local leaders for the directors who have recently relocated since they still have little interaction with the locals (community leaders and university lecturers); - The university staff should visit the schools where targeted students are studying to deliver information. The knowledge might then be spread around the neighborhood through the schools (targeted terminal school directors, high school students, and university lecturers); - Destination schools, schools where the scholars will be placed for public service, should be designated as project public relations centers (targeted terminal school directors, high school students, and university lecturers); - In order to share information and help with follow-up, destination schools should be encouraged to enhance public relations via networking at school meetings (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers); - As this group was actively engaged with students, community leaders should contact them through that channel. As a result, this could help students to receive direct messages (targeted terminal school directors, community leaders, and university lecturers); - To ensure that residents are aware of the information for at least one month prior, the advertisement should be posted as a sign in various locations, such as the boards at temples and schools (targeted terminal school directors, high school students, community leaders, and university lecturers); - Community leaders should educate staff about qualified students. Additionally, the project's goals must be clear to leaders from the beginning of the public relations process (targeted terminal school directors, high school students, community leaders, provincial education officers, and university lecturers); - Community leaders should work closely with schools to determine the number of students interested in the Krurakthin project and other information (targeted terminal school directors, community leaders, provincial education officers, and university lecturers); - Community leaders should collaborate with the directors of the schools where the scholars will be assigned for public service, as well as the schools where the target students are enrolled (targeted terminal school directors, community leaders, provincial education officers, and university lecturers); - Community leaders should inform students about the personnel who may give them additional information about the project (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - The guidelines for public relations should be clearly defined (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - In order to obtain further and relevant information, the destination school should be contacted (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - It would be better to first investigate the potential publicity locations to learn details regarding the samples and how to reach the target audience as effectively as possible (targeted terminal school directors and university lecturers); - Once the target audience is identified, stakeholder interviews with locals and directors from the school where the scholars will be assigned for public service will help to develop a model for public relations that can quickly and effectively reach the target population. Although less time was lost on seeking and screening, the necessary qualifications were not reflected (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers); - A process or contact channel should be added to contact the personnel who can provide more information (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - The materials should be delivered to the homes or schools of eligible students (high school students and community leaders).

Table 3. The results of the scholar search process for admission to the Krurakthin program, based on the general needs, problems, and obstacles.

Issues	Contextualization of Needs, Problems, and Obstacles of the Scholar Search Process (The Stakeholders Who Gave the Opinions)
1. Needs	- Stakeholders wanted to participate in the scholar search process (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers).
2. Problems and obstacles	- Cooperation did not occur in all locations since information was delayed (targeted terminal school directors, provincial education officers and directors of PESAs, and university lecturers); - The project was not met with cooperation from community leaders (targeted terminal school directors and university lecturers); - As some cases had issues with local authorities, they might have declined to support candidates or take part in the search process (targeted terminal school directors and high school students); - Some of the students who applied for scholarship did not meet the qualifications required by the EEF (targeted terminal school directors and university lecturers); - Some qualified students did not have the passion to be teachers (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers); - There were no extremely poor students who met the criteria for being teachers in the destination school (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers); - Due to the delayed information, students were unable to prepare for the application (high school students and community leaders).
3. Suggestions	- Concerning the scholar search process, the EEF should host meetings to inform and raise project awareness among provincial education officers and directors of primary school instructional service areas (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers); - The most important requirements of eligible students should be acknowledged in order to select the most suitable grantees (targeted terminal school directors, community leaders, provincial education officers and directors of PESAs, and university lecturers); - The search procedure should include participation from the directors of the destination school where the scholars will work (targeted terminal school directors, high school students, and university lecturers); - Teachers from the destination school where the scholars will work should attend in fieldwork to identify the qualified students (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - Before the trip, personnel from the schools where the students will go should check in-depth information to find out which students are eligible for scholarships (targeted terminal school directors, high school students, community leaders, and university lecturers); - The directors and teachers from the schools where the children were enrolled should take part in the fieldwork (high school students, community leaders, and university lecturers); - All parties should be involved in the search process (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - Community leaders should review the students who send in LINE applications to identify those who are not eligible for the scholarship (targeted terminal school directors, high school students, provincial education officers, and university lecturers); - Besides financial status, the search process should consider a prospective student's volunteer activities and community service (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - Other aspects such as lifestyles, family income, behavior, talent, learning, and passion for being a teacher should be taken into account (targeted terminal school directors, high school students, community leaders, and provincial education officers and directors of PESAs); - The counselors should join in the search process as they know their students' background well (targeted terminal school directors and high school students); - I would like to have a disambiguation page. The school they were studying at joined the search (targeted terminal school directors, high school students, community leaders, provincial education officers, and university lecturers).

Table 4. The results of the grantee screening process for admission to the Krurakthin program, based on the general needs, problems, and obstacles.

Issues	Contextualization of Needs, Problems, and Obstacles of the Grantee Screening Process (The Stakeholders Who Gave the Opinions)
1. Needs	- Information gained from the fieldwork should be verified (community leaders, provincial education officers, and university lecturers); - The screening procedure should take the students' behaviors and enthusiasm for the scholarship into account (targeted terminal school directors, high school students, community leaders, and provincial education officers and directors of PESAs);

Table 4. *Cont.*

Issues	Contextualization of Needs, Problems, and Obstacles of the Grantee Screening Process (The Stakeholders Who Gave the Opinions)
2. Problems and obstacles	- After sixth or ninth grade, extremely poor students frequently leave for work. Students who applied for the scholarship might not have met the requirements because they may be capable of taking care of themselves (targeted terminal school directors, community leaders, and provincial education officers and directors of PESAs); - Some documents were difficult to grasp and were confusing. Additionally, because the document's instructions were unclear, several mistakes may have been made when filling out the form (targeted terminal school directors, community leaders, provincial education officers, and university lecturers).
3. Suggestions	- The household income and attitudes towards the teaching profession should be considered (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - The outstanding activities and other volunteer activities should be added to the criteria in the screening process (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - Household debt should be taken into account (targeted terminal school directors, high school students, and community leaders).

Table 5. The results of the scholarship recipient student qualification process for admission to the Krurakthin program, based on the general needs, problems, and obstacles.

Issues	Contextualization of Needs, Problems, and Obstacles of the Scholarship Recipient Qualification Process (The Stakeholders Who Gave the Opinions)
1. Needs	- Directors from the schools where the scholars will be assigned to work would like to be involved in every part of the student qualification process (targeted terminal school directors, high school students, and university lecturers); - The camp should involve activities to develop 21st century skills, such as teamwork (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - The lesson learned should be identified once all activities for a day are completed (high school students and university lecturers); - Community leaders were not required to participate in the student qualification process since they were not involved in the previous search. Additionally, teachers should participate in identifying potential candidates because they are knowledgeable about the field (targeted terminal school directors, high school students and community leaders); - Duration of the camping should be extended to one week (high school students and university lecturers).
2. Problems and obstacles	- The duration of the interview session was constrained. Therefore, it could not observe students' behavior (targeted terminal school directors, high school students, and directors of PESAs); - The online interview provided little opportunity to observe student behavior. Additionally, in comparison to the period of the interview, the score ratio was excessive (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - There were some interview questions that were either too hard or too simple. This was inappropriate for students from diverse backgrounds. Consequently, some students were unable to respond to the interview questions (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - The interview had to be well-organized, and the committees had to be on the same page (targeted terminal school directors and provincial education officers and directors of PESAs); - Due to the COVID-19 pandemic, activities at the camp were ineffective (high school students and university lecturers); - Students felt pressured and slept less at night due to time constraints in completing their portfolios (high school students and university lecturers); - Due to insufficient materials for portfolio design, the information presented, when completed, was difficult to comprehend (high school students and university lecturers); - The preparation time for interviews was limited (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers).

Table 5. Cont.

Issues	Contextualization of Needs, Problems, and Obstacles of the Scholarship Recipient Qualification Process (The Stakeholders Who Gave the Opinions)
3. Suggestions	“I want to be an early childhood teacher camp”
	- The camp should be organized at the destination school where students will be assigned to work (targeted terminal school directors, high school students, and university lecturers); - The duration of the camp should be extended (targeted terminal school directors, high school students, and university lecturers); - Volunteer activities should be included in the camp (targeted terminal school directors and high school students); - A teaching demonstration should be included as one of the camp’s activities, and a score should be provided (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - The directors of the schools where the scholars will be working should be involved in sharing work experience at those schools (targeted terminal school directors, high school students, and university lecturers); - Students should take part in evaluating the behavior of their peers who are attending the camp (targeted terminal school directors and high school students); - The scoring criteria should be adjusted to give 20 points for camp participation, 30 points for the exam, 20 points for the portfolio, and 30 points for the interview session (high school students); - The camp should be held in a rural region near the destination schools where the scholars will be working to enable them to become familiar with the cultural context (targeted terminal school directors, high school students, and community leaders); - Storytelling should be added to be the activity at the camp (targeted terminal school directors, high school students, and university lecturers); - Basic childcare skills should be added as an activity at the camp (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - The length of the seminars should be reduced because they caused attendees to feel sleepy. Activities requiring physical mobility should be intensified (high school students); - The activities related to teamwork should be encouraged and the working time should be lengthened (targeted terminal school directors, high school students, community leaders, provincial education officers and directors of PESAs, and university lecturers); - Teachers from the school where the students will be working should attend the camp and participate in the monitoring of the candidates’ behavior (targeted terminal school directors and high school students).
	Interview
	- The duration of the interview should be extended so that committees have sufficient time to question and evaluate qualified applicants (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - The committees should be allowed to ask other questions which are not directly related to the topic (targeted terminal school directors, high school students, and provincial education officers and directors of PESAs); - The committees should be allowed to create the questions used in the interview session (targeted terminal school directors and provincial education officers and directors of PESAs); - The score ratio for the interview has to be decreased. On the other hand, the score ratio from either the portfolio or camp participation should be increased (targeted terminal school directors, high school students, and provincial education officers and directors of PESAs); - According to the online interview, the scoring ratio should be altered to 20–30%, with the remaining points based on camp attendance (targeted terminal school directors); - The directors from schools where the students will be placed for public service should take part in designing the interview questions (targeted terminal school directors); - The chosen students should demonstrate the following qualities: humility, patience, spiritual teaching, a passion for community development, a passion for assisting the underprivileged, and involvement in neighborhood activities (targeted terminal school directors, high school students, and provincial education officers and directors of PESAs); - These elements, such as attitudes about being an early childhood teacher and critical thinking, should be measured throughout the interviews. Additionally, questions about neighborhood and readiness for a career as an early childhood educator teacher should be addressed (targeted terminal school directors, high school students, and provincial education officers and directors of PESAs); - An activity question that measures volunteerism should be added (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers); - Interviews should evaluate a candidate’s capacity for problem-solving, creativity, teacher ethics, and proficiency with early childhood teaching methods (targeted terminal school directors, high school students, provincial education officers and directors of PESAs, and university lecturers).

4.2. Design Phase: Prototype Generation

The findings from phase 1’s data analysis are illustrated in Figure 2.

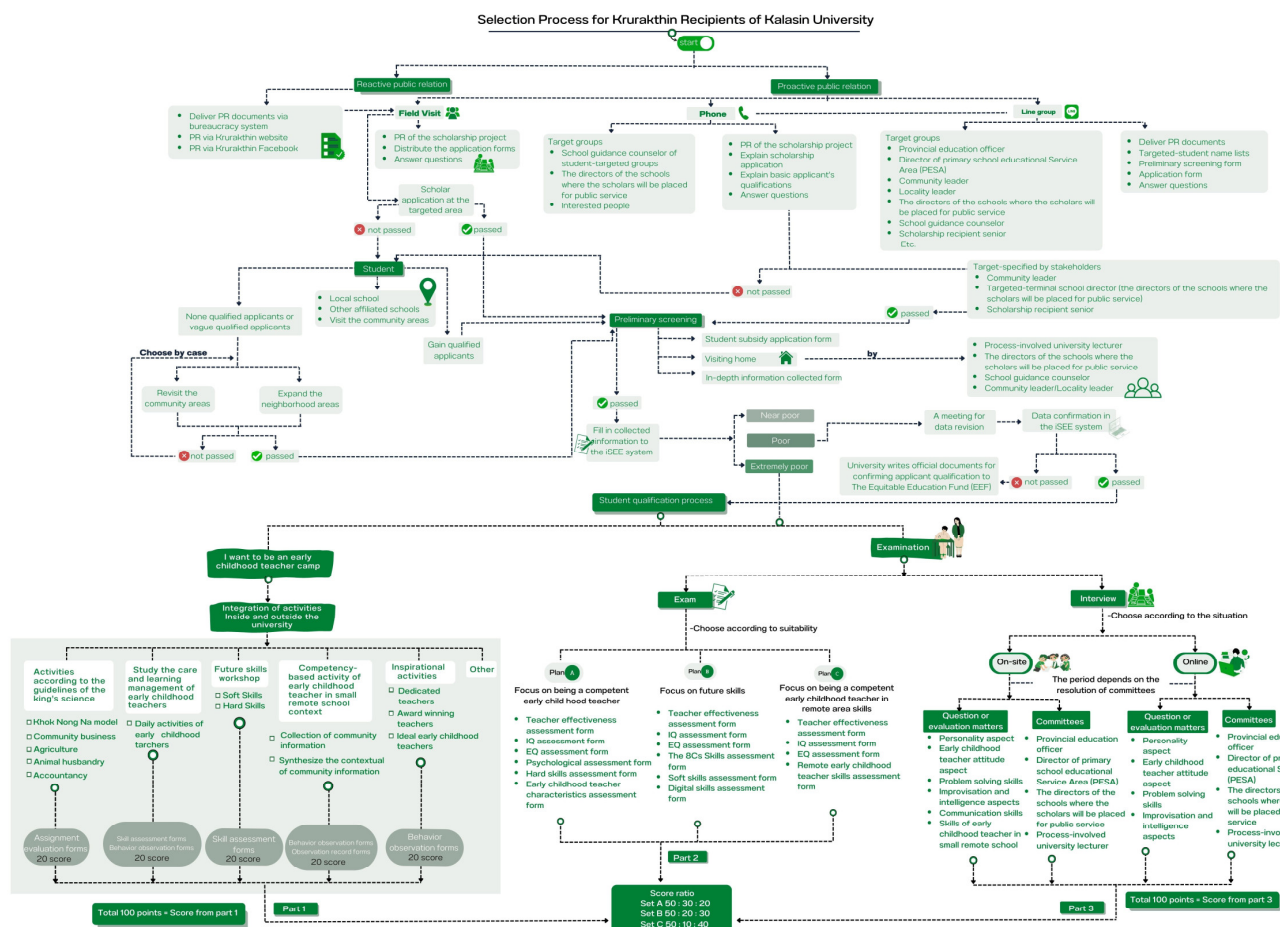


Figure 2. Diagram of Prototype I on the selection of scholars for the Krurakthin program.

4.3. Develop Phase: Prototype I Revision

As indicated in more detail in Table 6, these findings prompted the creation of the Krurakthin program's scholar selection procedure, which is illustrated in Figure 3. The prototype was developed by extracting lessons learned and verifying the information using the triangulation method. This process seeks to gather the consensus opinion of experts or individuals with experience in a specific field to assess the quality of the tool, ensuring that the obtained data are consistent, reliable, and trustworthy. These data serve as evidence for further research and data collection.

Table 6. Synthesizing the needs of the public relations process, search, screening, and student qualification process of scholarship recipients for admission to the Krurakthin program from various stakeholders.

Issues	Issues Raised by Synthesizing the Needs of Stakeholders in the Scholarship Student Selection Process (The Stakeholders Who Gave the Opinions)
Public relations	- The project's team should have contacted the government agencies to which the public relations materials were issued (targeted terminal school directors, community leaders, PESA staff, and university lecturers); - A LINE announcement was required prior to entering the location (targeted terminal school directors, community leaders, PESA staff, and university lecturers); - Before the project team arrived at the site, the government agencies required a preliminary screening form and a list of the target students (targeted terminal school directors, community leaders, PESA staff, and university lecturers); - Infographics and VDO clips were required to make public relations more understandable (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), and PESA staff).

Table 6. Cont.

Issues	Issues Raised by Synthesizing the Needs of Stakeholders in the Scholarship Student Selection Process (The Stakeholders Who Gave the Opinions)
Searching	- Neighborhoods should be investigated at the same time in order to prevent unqualified students from being accepted (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, and university lecturers); - The duration between the public relations and search processes should be indicated (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, and PESA staff); - The stakeholders wanted to discover and pre-interview the target students from the name list provided in order to become acquainted with each other first (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, and university lecturers); - The target students' names should be provided to community leaders for pre-screening (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, and university lecturers); - School guidance counselors should participate in the search process (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, PESA staff, and university lecturers).
Screening	- There should be more than one qualified student who passed the initial screening (targeted terminal school directors, community leaders, PESA staff, and university lecturers); - Class instructors and guidance counselors at the school should participate in the screening process and give behavioral data on voluntariness, morality, ethics, and talent (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, and PESA staff).
"I want to be an early childhood teacher camp"	
Student qualification	- The score ratio on participation at the camp should be emphasized, since the committees can observe the students' patience, adaptability, and cooperation with the others (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - Learning management and activity organization should be emphasized (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - Hosts and speakers may share their knowledge at the community camp (targeted terminal school directors, PESA staff, and university lecturers); - Camping should boost teachers' motivation to teach preschool students (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, PESA staff, and university lecturers); - Camping should clearly reflect the job of an early childhood teacher (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, PESA staff, and university lecturers); - As an early childhood teacher, students should be given opportunities to practice their abilities through activities such as teaching and child care. This could be accomplished by allocating students to network schools and giving a score after the activity is completed (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - Camp activities should take place off site, such as in the schools where students will be placed to work in the future (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), community leaders, PESA staff, and university lecturers); - Due to a number of activities in the camp, there was not enough time for students to practice their communication and expression skills (junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), and university lecturers); - Assertiveness and storytelling abilities should be enhanced, while computer skills should be reduced because they are currently unnecessary (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), and university lecturers).
	Examination - Instead of dividing skills into several segments, the exam should combine all skills at once (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - Testing for early childhood skills in distant locations should be maintained, since it informs students about their responsibilities as future teachers (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - Future skills should be tested (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - Teamwork and coexistence skills should be tested (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - IQ/EQ tests should be given, and the results should be incorporated into camp participation (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), and PESA staff); - A spiritual teacher exam should be taken separately from the camp participation (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), and PESA staff); - A practical exam should be added to the camp that is held continuously (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - A score ratio for creative skills should be included (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), and PESA staff); - The interview session should provide a chance for students to demonstrate their abilities (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), and PESA staff); - After the teaching demonstration, it is critical to evaluate the candidates' capacity for problem-solving in a classroom setting (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - The interview questions should not focus on true or false answers, but rather on students' capacity to respond critically (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - The interview committees should consist of early childhood teachers, lecturers teaching in that field, and community leaders (targeted terminal school directors and PESA staff); - The interviews should be held on site so that the committees may observe the interviewees' performances (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers); - The score ratio should be divided into subsets, such as Set A = 50:30:20, Set B = 50:20:30, and Set C = 50:10:40. The score received in the screening process was involved in the camp participation (50 points) (targeted terminal school directors, junior scholars (1st-year students), senior scholars (2nd- and 3rd-year students), PESA staff, and university lecturers).

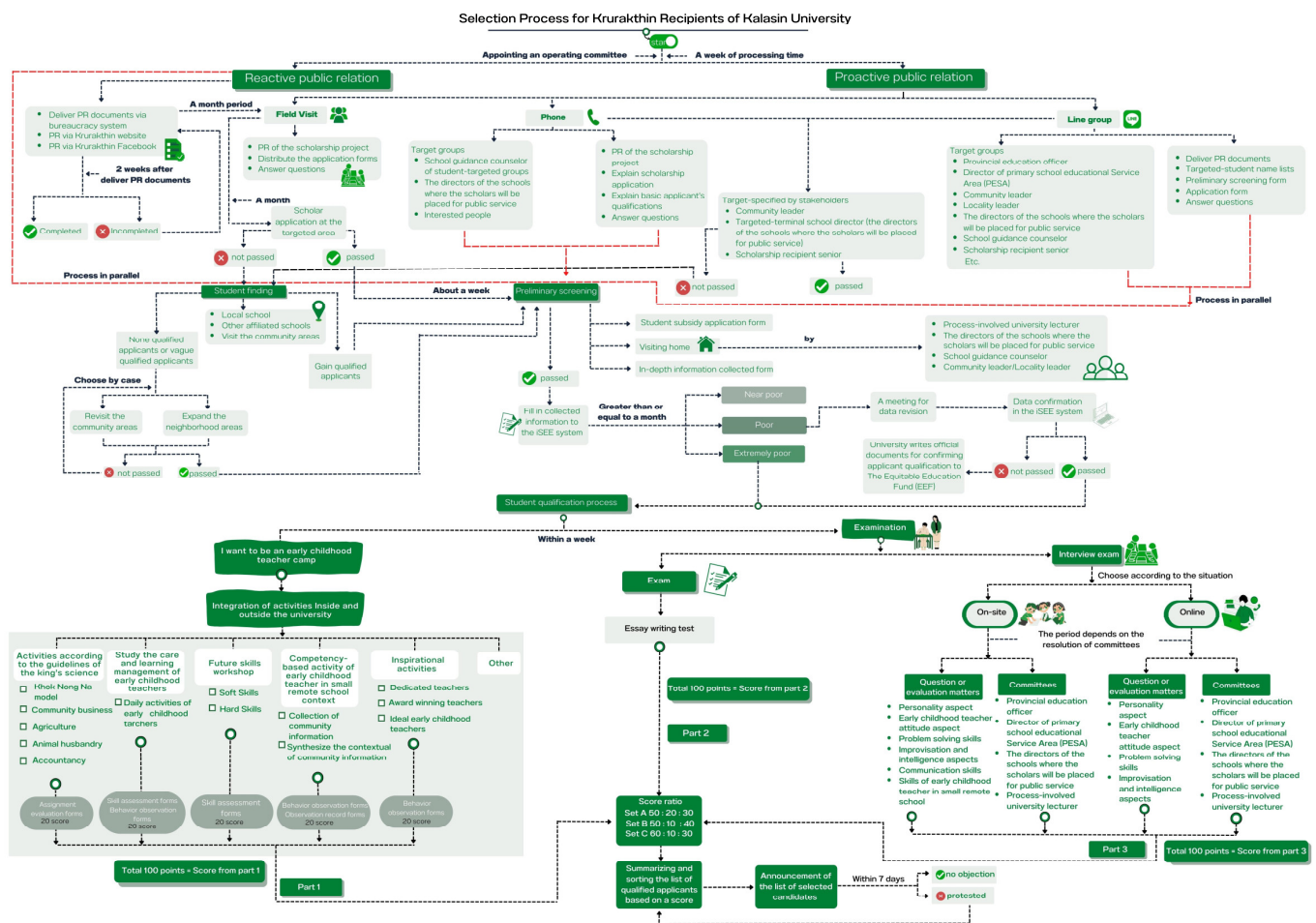


Figure 3. Diagram demonstrating the student selection process for receiving the scholarships from the Krurakthin project that has been evaluated by experts. Comparison of original and Prototype I revision of Krurakthin selection process.

The results of the stakeholders' recommendation (Table 6) led to the improvement of the scholarship selection process in Figure 3. Five experts and five specialists were assigned to provide guidance and evaluate the appropriateness of the process, respectively. It was found that the appropriateness of the public relations process was found to be at the highest level, scoring 4.55 ± 0.50 points, followed by the appropriateness of the search process, which scored 4.73 ± 0.45 points, the appropriateness of the screening process, which scored 4.58 ± 0.50 points, and the appropriateness of the selection process, which scored 4.54 ± 0.64 points. Overall, all processes received the appropriate score at 4.61 ± 0.32 , which was at the highest level.

As indicated previously, we proposed a selection process that would take place before the 1st-year Krurakthin scholarship was awarded. The original selection process comprised four steps: public relations, searching, screening, and qualification. However, the details of each step differed from those for Prototype I revision of the Krurakthin section process (Figure 3), as shown in Table 7.

Table 7. Comparison of original and Prototype I revision of the Krurakthin selection process.

Selection Process	Original Selection Process	Prototype I Revision Process
Public relations	Channel: Offline, online, active (OOA) via sending the documents and website.	Channel: Reactive and proactive public relations via using the phone and LINE group.
	Procedure: The process occurred in series.	Procedure step: The process occurred in parallel.
	Time limitation: None.	Time limitation: There was a specified processing time for each step.
	Delivered documents: Scholarship details and application form.	Delivered documents: Scholarship details, preliminary student screening form, application form, and targeted student name list.
Searching	Performed when the officer received the application forms.	PR, searching and screening of the student were performed in parallel, even if there were no applicants. Student searching and finding were performed in targeted schools and other affiliated schools, by visiting community areas, and via targeted student home visits.
Screening	Performed after the application form was obtained from the applicant if they met the verification criteria. Students who met the scholarship criteria were screened through student home visits.	Screening process: school guidance counselors were additionally involved in the screening process.
Student qualification	Committees: Targeted terminal school directors, community leaders, provincial education officers, directors of PESAs, and university lecturers who took part in the selection process.	Committees: Targeted terminal school directors, provincial education officers, directors of PESAs, and university lecturers that took part in the selection process.
	Score: The score ratio included two categories: exam and camp attendance. The scoring ratio was 85:15.	Score: The score ratio included three categories: camp attendance, exam, and interview. The scoring ratios were as follows: set A, 50:20:30; set B, 50:10:40; and set C, 60:10:30. The selection of any set was based on the committee's decision.
	Exam: Teacher effectiveness assessment test, IQ/EQ test, and evaluation of the workpiece evaluation score, which accounted for 85%.	Exam: Essay writing test score accounted for 20%, 10%, or 10% corresponding to the score ratios of set A, set B, or set C, respectively.
	Interview exam: On site.	Interview exam: Flexible (chosen according to the situation, on site and/or online).
	I want to be an early childhood teacher camp: The activities included inspirational activities, King's science, building a workpiece, and early childhood caring, which accounted for 15%. All the activities were held on site at Kalasin University.	I want to be an early childhood teacher camp: The activities included inspirational activities, King's science, building a workpiece, early childhood caring, future skills, and competency-based activities, which accounted for 50%, 50%, or 60%, corresponding to the score ratios of set A, set B, or set C, respectively. All activities were held inside and outside at Kalasin University.

5. Discussion

Kalasin University is one of the most important universities for producing early childhood teachers in the northeast of Thailand. Therefore, the university has been awarded Krurakthin scholarships from the EEF for three consecutive years and has received funding for the fourth and fifth rounds that will occur in the near future. The selection process for extremely poor students is the key factor for the receipt of this scholarship, which targets students who meet the qualification criteria set by the EEF. The process includes public relations, searching, screening, and student qualification. The original public relations process consists of three channels: offline, online, and active (OOA). The important activities include sending the scholarship information document and application form to the relevant organizations. After the public relations process is complete, the searching process is conducted. University officers verify the applicant's qualification based on the criteria, and students who meet the scholarship criteria are screened through student home visits. Only extremely poor students are invited to attend the camp, which includes inspirational

activities, King's science, building a workpiece, and early childhood caring, the score from which accounts for 15% of the final score. The examination, the score of which accounts for 85% of the final score, includes a teacher effectiveness assessment test, IQ/EQ test, and workpiece evaluation. All the activities are held on site at Kalasin University. Students who score at least 60% are announced and those who do not pass can raise any objections within seven days (Table 7).

Throughout the public relations, search, screening, and student qualification processes, some issues were discovered. Public relations is a type of applied communication that focuses on building and maintaining relationships with stakeholders [22,23]. The findings of this research indicated that the public relations process has some limitations, including the delayed delivery of public relations information, documents that were difficult to understand, and incomplete and confusing information. These results yielded a lack of understanding and commitment on communication [24]. For instance, the project did not cover technical colleges, vocational schools, and the department of non-formal education, etc. Additionally, some problems were discovered throughout the search procedure. Firstly, there was a problem with team members' understanding of their roles throughout the preparation for the search process. This result may have been affected by a lack of communication, as it is important to build trust by following through on commitments and to ensure that everyone understands decisions and their roles in implementing them [24]. Both experienced and inexperienced team members should be open to sharing knowledge. Team knowledge sharing was also found to significantly impact team performance [25]. These findings suggest that leaders who build their team's expertise and engender trust can increase knowledge sharing, which can improve team performance. By understanding the root causes of poor communication, it is possible to address and resolve underlying issues. Secondly, school guidance counselors with targeted students were suggested to participate in the search process. Thirdly, the community leaders should search for students who are eligible to apply for scholarships in advance. Lastly, the search for students to receive scholarships should emphasize volunteering and helping society. When focusing on the screening process, these issues were pointed out. For example, filling out the form in the screening process was complicated as the information was not clearly stated. Consequently, this led to discrepancies in the information. Stakeholders also suggested that in addition to collecting data on household debt, the screening process should place an emphasis on students' volunteerism and positive attitudes regarding the profession. We collected all points raised by stakeholders and discussed them with the EEF. It was found that some points could not be used to amend an application form (EEF 01 form); for example, "the scholarships should emphasize on volunteering and helping society". Thus, we decided to use those points in the student qualification process (an interview exam which was equipped with portfolio presentation).

Neeraj and Ruchi [26] suggest that better recruitment and selection strategies lead to improved organizational outcomes. With reference to the student qualification process yielded from this research, it was divided into two stages, which included attending the camp and having an interview. The first issue that was raised during the attendance phase was that the camp needed to be hosted close to the destination schools where the scholars would be assigned to work so that they could become familiar with the local contexts. The camp experience provided a sense of community and a break from the isolation. It also helped the campers develop independence and a new understanding [27]. Activities emphasizing practical skills and encouraging teamwork should be included. Candidates should also be able to grade one another or rate other group members. In addition, the duration of time for attending the camp should be lengthened. Ferrari and McNeely [28] and Garst et al. [29] found that the length and intensity of the camp experience can significantly impact the outcomes for children and adolescents. This is especially true for camps that involve a longer duration of participation compared to other youth programs. Regarding the interview problems, the majority of participants agreed that the committees should be allowed to determine and create the interview questions used

to evaluate candidates' attitudes and critical thinking abilities toward the early childhood teaching profession. In addition, questions on readiness to be early childhood teachers and questions about community volunteer activity should be included. For this reason, the duration of the interview session should be extended in order to give the committees more time to evaluate the behavior of the students.

Data gathered from the aforementioned issues led to developing the procedure for choosing scholarship recipients (Figure 2). The researchers enhanced the public relations process, which was divided into reactive and proactive public relations. Reactive public relations emphasized sending documents through the government system and advertising through the website and Facebook for Krurakthin KSU. Additionally, proactive public relations involved the process of sharing project information with the target students through the people who were involved in publicizing the project. This was carried out by following up via phone calls to see whether the students had received the public relations materials, to clarify the requirements for applicants and how to apply, and to address any concerns about the project. Such methods were used along with communicating via the LINE group channel to send missing documents, the name list of target students, the preliminary screening forms, and the application forms, etc. Moreover, the lecturers who were involved in the projects also went to the local area to advertise the project and recruit interested students along with preliminary student qualification screening. If there were no qualified students to apply, the team members visited the sub-district area in the destination schools where the scholars will be assigned for working to recruit applicants, or they would have expanded the recruitment to the neighborhood area. When the recruitment was expanded to the neighborhood, the students' qualifications also had to be preliminarily screened. This procedure solved the problems of delayed public relations, not receiving public relations documents, and not comprehending the project.

Students who met the initial criteria participated in an in-depth interview with the lecturers and then a home visit was conducted to verify the information received from their parents, family members, and neighbors. House visits included participation from the director of the destination school, the school guidance counselor working with the targeted pupils, and local leaders. After that, the team members filled out the information in the Information System for Equitable Education (iSEE) system to further analyze the results of student poverty. If the results from the iSEE indicated that students were poor, the team that took part in the search process held a meeting to update or review the students' data. Then, the information in the iSEE system was verified again. Students who passed the screening procedure were chosen to participate in the camp and assessment process. In order for students to learn from the actual setting or realistic learning resources, the camp was developed to combine several contexts both inside and outside the university. Attending the camp also provided students with the knowledge and essential skills that they would need to become teachers in rural communities through activities focused on the King's philosophy; King Rama IX's development approach was deep, well-rounded, and far-sighted, and emphasized long-lasting sustainability before the international community became alert to this. The elements of the King's approach are education and health, increasing production productivity, and researching risk management. Each of the following components contributes to the improvement of the quality of life of all people, especially the poor: a study trip to develop early childhood teachers' learning management; future skills training; early childhood teacher competency-based activities in a small school and remote community contexts; and activities to promote the inspiration of early childhood teachers.

The exam was divided into two parts: a test and an interview. With regard to the test, the researchers divided the test into three parts, focusing on early childhood teacher professional testing, future skills, and skills for being a teacher in remote areas. The committees responsible for the examination decided the circumstances related to the necessary characteristics of an early childhood teacher. For the interview session, the researchers modified the procedure based on prior information from the stakeholders that emphasized the presence of external examiners. The interviewers consisted of three lecturers from each

group that participated in the search process and served as chair, member, and secretary. Experts included provincial officers, the director of the primary school educational service area, and directors of the destination schools. The interview process could be performed both on site and online as necessary. The time of interview could be adjusted according to the resolution of the committees. The percentage of participation in the camp was used to calculate the student qualification process score. The score ratio was separated into three categories: camp attendance, exam, and interview. There were three different sets of the scoring ratio: set A was 40:30:30; set B was 40:40:20; and set C was 30:40:30. The selection of any set was based on the committee's decision.

After the researchers revised the diagram of the scholarship recipient selection procedure, the updated procedure was provided to the stakeholders for additional feedback. The issues gathered throughout the public relations, search, screening, and student qualification processes were analyzed. Firstly, those involved in the public relations process should strengthen coordination with government agencies via phone calls to confirm whether or not the materials have been sent. Furthermore, the name list of target students and preliminary screening forms should be provided to the government agencies. Secondly, the neighborhood should also be used as the search area to avoid having students who did not qualify. There should be a period of time between the public relations process and the search process. Additionally, a name list of students and the form of a preliminary checklist should be provided to the community leaders to screen students who met the requirement in advance. Thirdly, there should be more than one student per position at the destination schools. Furthermore, school guidance counselors were responsible for screening students and providing crucial behavioral information, such as volunteerism, morality, ethics, and talents. Finally, throughout the student qualification process, testing should not be divided into three parts, but every skill should be tested. During camp attendance, both IQ and EQ should be evaluated. In addition, the interview session should include questions that allow students to demonstrate their abilities and presented ideas or solutions for the problems that possibly occurred in the classroom when they become a teacher in the future. Moreover, the score ratio should be emphasized on attending the camp. Most of the stakeholders, with different ideas, suggested that the ratio of camp participation scores, test scores, and interview scores be divided into three sets: set A = 50:30:20, set B = 50:20:30, and set C = 50:10:40.

After that, the researchers used the information from the stakeholders' recommendations to improve the selection process again (Figure 3). To summarize, in the public relations process, reactive and proactive public relations should be carried out concurrently to cope with the challenges associated with the project's slow announcement. The timeline for each activity would be described in detail after submitting documents to the government agencies that were relevant to public relations. The team members would make contact via phone calls to confirm whether or not the materials had been sent to all government agencies and to address any concerns about the project. The faculty members would visit the local communities to promote the project after sending the public relations materials for one month. After that, one month later, the faculty members would return to the area to recruit the qualified students to join in the project. To improve convenience and speed in receiving data that would assist in making a decision on whether the team members should visit the neighborhood or not (if none of the students satisfied the requirement), the researchers devised an applicant pre-qualification checklist that was distributed to community leaders so that they could help to discover qualified students in advance. The faculty members who had participated in the search were required to input the important data into the iSEE system within one week of returning from the fieldwork. According to the testing method, the researchers incorporated stakeholder ideas to improve the testing process by changing the test into a writing essay on a topic related to early childhood teachers. Improving the testing method had an effect on the score ratio of camp participation: test scores: interview scores, divided into three sets which include set A = 50:20:30, set B = 50:10:40, and set C = 60:10:30. Furthermore, the researchers improved the process of summarizing scores and announcing scholarship recipients by allowing other candidates

to appeal their results within seven days after the name of the scholarship recipients were announced (Figure 3). After completing the improvement of the scholarship recipient selection process, the researchers invited experts to critique the process that had been improved from the research. Then, experts were asked to evaluate the appropriateness of the scholarship recipient selection process. It was found that the appropriateness of the overall processes had a total appropriateness score of 4.61 ± 0.32 points, showing the most appropriate level. This study highlights the process of promoting enrollment and assisting all stakeholders in selecting poor and extremely poor students [30] to receive scholarships. These targeted students often face challenges in access, attendance, and academic performance in education [31,32]. Therefore, we believe that our demonstrated selecting process might be a good practice for universities that receive the Krurakthin scholarship in the future [33].

6. Conclusions

This research is a part of the research project involved in the development of the teacher's improvement process in the Krurakthin project by implementing a new paradigm in the context of the northeastern region of Kalasin University. This research was categorized as developmental research since it was conducted to accomplish the project's objectives, i.e., to design a method for selecting scholarship winners to study in the Krurakthin project at Kalasin University. The study was divided into two phases. Regarding the analysis phase, the research was conducted to analyze the problems and limitations of the scholarship selection process in previous years from various stakeholders, which include the provincial education officers, directors of the primary school educational service area, directors of the destination schools where the scholars will be assigned to work, community leaders, lecturers, and students. The results gained from the interview session led to the conducting of research on the design and development phases of a process for selecting scholarship recipients. The researchers used a model of the process that was developed to ask the stakeholders' opinions again before improving the process on the second occasion and presenting the revised process to experts for evaluation. The evaluation results reported that the scholarship selection process was most suitable. Furthermore, the researchers prepared various documents that would facilitate the selection of additional grantees. Additionally, the handout for selecting scholarship recipients of the Krurakthin project, Kalasin University, was completed in order to prepare for evaluating the process in future fieldwork. The study will be conducted in the implementation and evaluation processes.

7. Limitations and Future Work

The choice of choosing stakeholders depended on the context and cultural differences of each area; for example, in the south of Thailand, some important religious leaders were stakeholders. In contrast, the tribal leaders had to be involved when searching for candidates in the northern area because the population in this area is made up of several tribes;

Each region had different areas. This affected the time of the selection process, as the southern search area consisted of flat areas and islands, whilst the northern search area consisted of flat and hilly areas. In addition, the northeast was a plateau region. As a result, the team members responsible for the selection process had to arrange the timeframe while taking into account the challenges of getting through the area;

The camp's activities were created to meet the requirements of each institution, which led to a range of activities with distinct characteristics. However, the main activities organized in the camp were carried out in accordance with the EEF's goals, such as engaging the inspiration of early childhood teachers in remote areas and the learning of the King's philosophy, etc. [11].

Further research into the model's application, with an emphasis on other institutions' usage of the model, may help to discover new information that will aid in improving

the quality of the selection process. Additionally, it is advised that future researchers in this field conduct developmental research, including university lecturers in charge of the Krurakthin scholarship program, in order to gain a deeper understanding of the efficiency of the Krurakthin scholarship student selection process. This will help to improve the quality of the selection process for scholarship recipients with all nine qualifications as specified by the EEF.

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Article

Examining Predictors and Outcomes of Decent Work among Chinese Female Pre-Service Primary School Teachers

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Abstract: The purpose of this study was to examine the future decent work perceptions in the Psychology of Working Theory (PWT) based on a sample of female primary pre-service teachers in higher education. A cross-sectional design was used for this research. 368 pre-service female teachers were recruited from a university in eastern China for the current study. The results of structural equation modeling indicated that the PWT model applied to Chinese pre-service female primary school teachers. In particular, subjective social status was positively related to future decent work perceptions, disadvantaged mindset was negatively related to future decent work perceptions, and future decent work perceptions were positively related to academic satisfaction. Overall, all the proposed direct pathways in this study were significant. This is the first empirical study to apply the PWT framework among Chinese pre-service female teachers in primary school. With this examination, we were able to comprehensively examine the relationship between variables such as subjective social status and disadvantaged mindset, and future decent work perceptions, helping to improve students' academic satisfaction and providing suggestions for future career development for this group.

Keywords: Psychology of Working Theory; decent work; subjective social status; disadvantaged mindset; academic satisfaction; female pre-service primary school teachers



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1. Introduction

In the past, primary school teachers in China are often considered a form of decent work as the occupation allows individuals to have sufficient time off, receive adequate compensation, and have a high social status [1]. After graduating from high school in China, there are a large number of female students who choose to enter college to study primary education so that they can have the option of becoming primary school teachers after their higher education in college [2]. However, in order to reduce the burden of homework and out-of-school training for students in compulsory education, the Chinese government proposed a “Double Reduction” policy in July 2021, aiming to facilitate students’ diversified development through after-school services by teachers [3]. The impact of the “Double Reduction” policy has increased the workload of Chinese primary school teachers by requiring them to work longer hours, which has generated a general job burnout and a low sense of professional identity, especially in the group of female teachers [4]. This current situation of female primary school teachers may adversely affect the professional outlook of female pre-service teachers who are at the college level. In addition, along with the impact

of the global epidemic on employment, the competition to work as a primary school teacher has become increasingly fierce. Therefore, the current perceptions of female pre-service primary teachers in China regarding decent work may be an interesting research topic. Are primary school teachers still decent work in the views of this group?

However, there are relatively few studies on the future perceptions of decent work among female pre-service primary school teachers. The Psychology of Working Theory (PWT) provides a pathway to our questions, which attempts to focus on the decent work of individuals in terms of social background and socioeconomic status [5,6]. Most existing papers on the PWT focus on Western cultural contexts and lack model testing around decent work in a collectivist perspective [7]. Therefore, we would like to examine the perceptions of the group of Chinese female pre-service primary school teachers about the future of decent work from this theory.

2. Literature Review

2.1. Decent Work

Decent work as the central variable of the PWT has gained the attention of a large number of scholars worldwide [8–12]. PWT is a theoretical model that can be empirically tested based on research in occupational psychology, multicultural psychology, and sociology of work [13]. As a highly inclusive career theory, it aims to explain the work experiences of all individuals, especially individuals who are poor or near poor and who face discrimination and marginalization in their lives [7,14]. PWT takes decent work as the crucial concept and places individuals in a broader social context, examining decent work and human development from the context of social class and economic status [7,15]. Within the framework of PWT, decent work is often defined as having five components: a safe work environment, health care, adequate income, free and rest time, and organizational values that are consistent with family and social values [16,17]. In other terms, decent work is high-quality work that has safe working conditions, adequate pay, adequate health insurance, sufficient time off, and is compatible with family values [18].

Previous studies on decent work have focused on predictors and outcomes [19–21]. On the one hand, several empirical studies have identified antecedent variables of decent work including career adaptability, work volition, economic constraint, marginalization, financial strain, psychological ownership, and work climate [22–26]. For example, a survey based on female workers in the United States revealed that career adaptability, work volition, and workplace climate positively predicted decent work [27]. On the other hand, research by other scholars confirmed that the outcome variables of decent work include survival needs, social contribution needs, self-determination needs, job satisfaction, life satisfaction, well-being, and meaningful work [14,17,24,28–30]. For instance, a study based on Chinese adult workers uncovered that decent work has a positive impact on employee well-being [29]. In addition, decent work can help individuals achieve physical and mental health [30]. Given that the participants in our study are Chinese pre-service primary school teachers who are part of the school population that is not yet employed, this study explores the future decent work perceptions of this group.

2.2. Subjective Social Status

Subjective social status is defined as one's perceived relative standing in a society which is derived from social status [31]. The concept of social status refers to the power and control one has over resources and denotes one's relative position in the socio-economic and cultural hierarchy [25]. More specifically, social status is the differences in people's status in social life, depending on the material wealth, income, education, and other social resources that individuals possess and their perceived position in society when compared with others [32]. As can be seen, social status is comprised of two major aspects: objective social status with income, education level and occupation as the measurement indicators; and subjective social status that includes individual self-perception [32,33]. Subjective social status is a subjective perception of oneself based on objective social status, which

refers to where individuals regard themselves in society and may manifest some parts that are more difficult to be reflected by objective indicators [25,32]. Given that our study is more concerned with people's perceived work perception and perceived status, the focus of our study is on subjective social status.

According to the PWT framework, social status is considered to be the main predictor of the process of career advancement based on economic and social resources [7]. Previous research has observed that people of lower social status are more inclined to value work as a means of survival, while people of higher social status are more probable to recognize work as a way to demonstrate their abilities and interests [34]. As research deepens, subjective social status has received increasing academic attention and is regarded as a better predictor of individual career development than objective social status [25]. It has been reported that individuals of higher subjective social status have more life satisfaction [35]. In a recent series of surveys based on the PWT framework, it became apparent that subjective social status, which is a key variable in shaping an individual's concept of work, significantly predicts an individual's work volition, work satisfaction, work meaning, and career adaptability [18,25,32,36,37]. For instance, an examination based on Chinese urban workers discovered that subjective social status positively predicted decent work, while decent work positively predicted work satisfaction [25]. In addition, a recent study denoted that the subjective social status of poor Chinese college students indirectly predicted perceptions of future decent work through work volition [18]. Based on the fact that existing studies have not explored the relationship between subjective social class and decent work among pre-service female primary school teachers, this study proposed the first hypothesis:

Hypothesis 1 (H1): *Subjective social status positively influences decent work.*

2.3. Disadvantaged Mindset

Disadvantaged mindset belongs to a kind of self-graphic, a concept somewhat similar to subjective social status [38]. This is a variable that has recently been raised by scholars that highlight an individual's perception or evaluation of the strengths and weaknesses of the self with a sociocultural influence [39]. Specifically, this concept refers to the psychological cognitive tendency of individuals who usually perceive themselves as the weaker group in society, including the tendency to feel that they have trouble resisting external risks and are at a disadvantage in social competition [38]. Individuals with a disadvantaged mindset tend to view society as full of risks and often perceive themselves as being at a disadvantage in society. It is not easy to cope with the potential risks in life even if one works hard, thus making it difficult to improve the standard of living for oneself and one's family.

As a novel variable concerned with individual subjective mindsets, relatively little research has been conducted on disadvantaged mindsets. For example, some scholars have used college students as subjects and identified that disadvantaged mindset can significantly and negatively predict systemic justice belief [39]. Since its inception, the PWT framework has paid special interest to decent work for vulnerable groups [40,41]. Although the PWT framework has specifically stressed the impact of subjective social status on variables such as decent work [32]. However, no scholar has yet investigated the possible place of the disadvantaged mindset in the PWT framework and how this variable might affect the likelihood of decent work. If scholars investigate the relationship between disadvantaged mindset and decent work, it may help to expand the model of PWT. In addition, a significant disadvantaged mindset for teacher is burnout. Teachers are often high achievers who enjoy working hard and are constantly seeking for ways to improve. These traits often cause teacher burnout. Teacher burnout is a severe kind of persistent stress that can affect any teacher, regardless of experience or enthusiasm for their profession [42]. For this reason, the present research put forward the second hypothesis:

Hypothesis 2 (H2): *Disadvantaged mindset negatively influences decent work.*

2.4. Academic Satisfaction

Academic satisfaction which can be characterized as satisfaction with the achievement of academic goals or aspirations usually refers to a student's overall satisfaction with his or her academic performance and achievement while in school [43]. College students' academic satisfaction is considered to be an important factor influencing the career preparation of this group [44]. A survey with a sample of college students revealed that academic satisfaction positively predicted career decision-making self-efficacy [45]. It has been revealed that academic satisfaction strongly predicts depression, anxiety, stress, and psychological well-being levels in college students [46]. Positive career-related outcomes such as career adaptability, calling, and work volition have been identified by scholars as predictors of higher academic satisfaction [47–49].

With the development of the PWT framework, some scholars have discussed the relationship between decent work and academically relevant variables, for example, there was evidence that future decent work perceptions of college students can significantly and positively predict academic engagement, while the relationship with academic satisfaction needs further study [50]. Given the positive impact of academic satisfaction on sustained and successful academic behavior, it is particularly crucial to further analyze the impact of future decent work perceptions on academic satisfaction [51]. Therefore, the relationship between decent work and academic satisfaction with different categories of college students as study subjects deserves further exploration. Given the earlier findings, a third hypothesis was formulated in this study:

Hypothesis 3 (H3): *Decent work positively influences academic satisfaction.*

Based on the PWT framework and the above hypotheses, we will also test the specific hypothetical model which is shown in Figure 1.

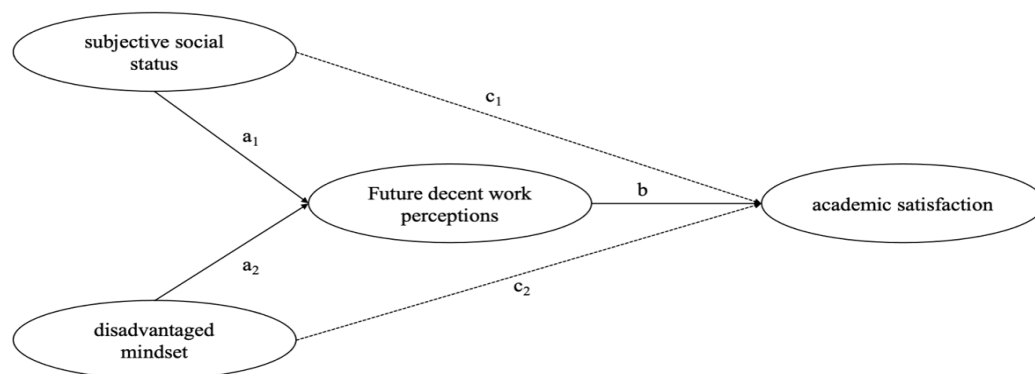


Figure 1. The hypothetical model for this study. Note: a_1 , a_2 , and b represent direct effect; c_1 and c_2 are indirect effect.

3. Materials and Methods

3.1. Participants

All data for this research came from a university in an eastern city in China. We invited the school counselors to assist us with an online questionnaire that we shared with the students. The participants in this study were all pre-service teachers who had a major in elementary education. In this study, 368 valid samples of pre-service teachers were collected. This study's data collection period was from June to August 2021. All participants were informed of the purpose of this study and the confidentiality of their personal information.

3.2. Instruments

3.2.1. Subjective Social Status

The subjective social status was evaluated by the MacArthur Subjective Scale of Subjective Social Status [18,31]. This instrument has been demonstrated to reliably predict career outcomes (e.g., career adaptability, work satisfaction, and meaningful work), and applications have been made to samples of Chinese university students [18,25,52]. Participants were presented a drawing of a ladder with 10 rungs, and read “At the top of the ladder are the people who are the best off, those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off, those who have the least money, least education, worst jobs, or no job. Please place an ‘X’ on the rung that best represents where you think you stand on the ladder”. To score this measure, we simply note the number of the rung (1–10) on which the participants placed their “X”.

3.2.2. Disadvantaged Mindset

The 8-item Disadvantaged Mindset Scale was used to evaluate disadvantaged mindset [38]. The example items include, “Even if I work hard, it is difficult to cope with the potential risks in life”, “Compared with most people, I work harder but I am not more successful”, “I have free time during the workweek”, and “I have an advantage over most people when it comes to competition [39]”. Each participant responded to questions on a 7-point Likert scale which ranged from 1 (Completely Disagree) to 7 (Completely Agree). In the current study, the internal consistency of the total table scores was 0.77. Confirmatory factor analysis results showed that the two-factor model fit the data: $\chi^2 = 46.546$, $p < 0.001$, CFI = 0.952, RMSEA = 0.084, 95% CI [0.059, 0.110], and SRMR = 0.047. Basic information about the scale can be found in Appendix A, Table A1.

3.2.3. Future Decent Work Perceptions

The 15-item Decent Work Scale was designed to assess students’ perceptions of future decent work [53]. The scale was comprised of five subscales, namely, workplace safety, health care, adequate compensation, free time and rest, and organizational values aligned with family and social values. We adopted the former research methodology and modified the project to make it more appropriate for our participants [50,54]. Participants were invited to give their answers to these questions based on the instructions below. “Please visualize your future work and respond to the questions based on this image.” Each item was reworded to accurately indicate the future direction. For example, “At my future work, I will feel safe from emotional or verbal abuse of any kind (workplace safety); “I will be rewarded adequately for my work” (sound compensation). Students were instructed to score these items from 1 (Strongly Disagree) to 7 (Strongly Agree). The internal consistency coefficient for these items was 0.88. Confirmatory factor analysis results showed that the five-factor model fit the data: $\chi^2 = 304.082$, $p < 0.001$, RMSEA = 0.084, 95%CI [0.074, 0.095], SRMR = 0.065, and CFI = 0.952. Basic information about the scale can be found in Appendix A, Table A2.

3.2.4. Academic Satisfaction

Three items from the 3-item Academic Satisfaction Scale were chosen to assess the academic satisfaction of the participants [50,55]. Participants responded to these items on a 7-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree), with examples including, “I enjoy the level of intellectual stimulation in my course”, and “I am generally satisfied with my academic life in my university [51]”. The scale showed a strong internal consistency, with $\alpha = 0.79$. This scale has only one factor. Basic information about the scale can be found in Appendix A, Table A3.

3.3. Data Analysis

To make sure that the scale has satisfactory psychometric properties, the data were analyzed using SPSS 25.0 to test the bias of the common method and to evaluate the

reliability of the scale by Cronbach's alpha coefficient. To ascertain the suitability of the sample distribution for the ensuing analysis, descriptive statistics were used to quantify the distribution. The correlation among the three variables was tested to evaluate whether the model can be established. A complete model was constructed using the lavaan package in R to examine the relationship among subjective social status, disadvantaged mindset, future decent work perceptions, and academic satisfaction. The lavaan package in R was also used to do the exploratory factor analysis (EFA) and the confirmatory factor analysis (CFA).

4. Results

4.1. Common Method Deviation Test

Several test scales were used in this study, and all tests were administered uniformly. The content of the scales, the characteristics of the participants, and the testing environment may lead to bias in the results of the study. Therefore, we tested for common method variance using Harman's one-factor test. The first unrotated factor extracted from factor analysis containing all items of interest accounted for 29% (less than 40%) of the total variance [56]. Confirmatory factor analysis results for the scales all showed that the theoretical model fit the data well. The results are shown in the *Instruments* part.

4.2. Mean, Standard Deviation, and Correlation Matrix of Variables

The descriptive statistical analysis and correlation matrix for each study variable were shown in Table 1.

Table 1. Means, standard deviations, and correlation coefficients of variables ($n = 368$).

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5
1 Future decent work perceptions	4.73	1.53					
2 Subjective social status	5.32	1.37	0.31 ***				
3 Disadvantaged mindset	3.93	1.39	−0.44 ***	−0.32 ***			
4 Academic satisfaction	4.49	1.22	0.40 ***	0.10	−0.27 ***		
5 Age	20.48	1.27	−0.10 *	−0.14 **	0.04	0.14 **	
6 Urban	1.50	0.50	−0.11 *	−0.18 ***	0.09	−0.07	0.05

Note: Urban is coded as 1 = urban, 2 = not urban. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

In the case of this study, we analyzed the data using SPSS 25.0. Correlation analysis demonstrated that subjective social status was positively correlated with future decent work perceptions ($r = 0.31$, $p < 0.001$; Hypothesis 1), and disadvantaged mindset was negatively correlated with future decent work perceptions ($r = -0.44$, $p < 0.001$; Hypothesis 2). Future decent work perceptions were positively correlated with academic satisfaction ($r = 0.40$, $p < 0.001$; Hypothesis 3). The above findings suggest that participants with low subjective social status also have lower future decent work perceptions. Similarly, the higher the individual's disadvantaged mindset score, the lower the level of future decent work perceptions. Finally, the higher the future decent work perceptions score of the participants, the higher the level of academic satisfaction. Since age was positively correlated with academic satisfaction ($r = 0.14$, $p = 0.006$), we control it when testing the hypothetical model in Figure 1 and the mediation effects.

4.3. Final Structural Model and Mediating Effect

For a good model, the criteria for fitting values to the data need to be met, for instance, χ^2/df values below 3 and RMSEA values below 0.08 [17]. The fit indices for the model in this study were $\chi^2/df = 2.547$, RMSEA = 0.065, SRMR = 0.078, and TLI = 0.881, CFI = 0.895, all of which are at or close to the critical values. Therefore, we conclude that the model proposed in the previous period has a good fit with the actual data. The final structural equation model was shown in Figure 2.

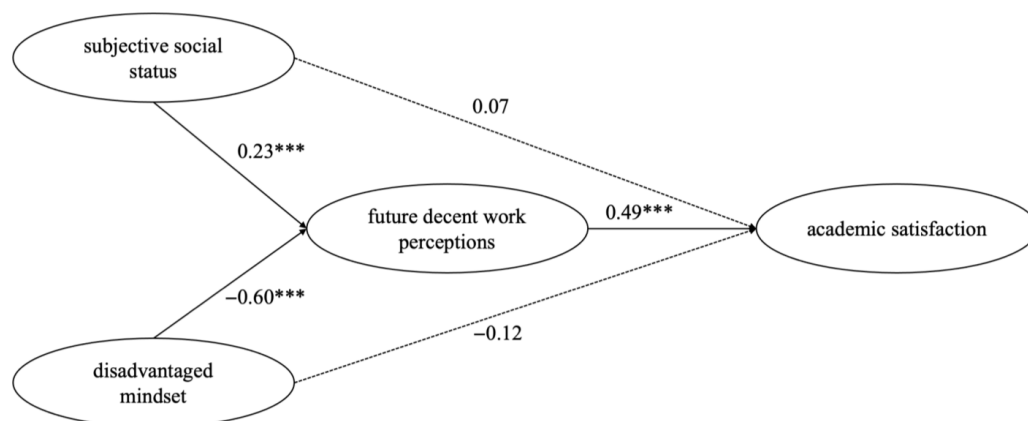


Figure 2. Final structural model. Note: *** $p < 0.001$.

A bootstrap 95% confidence interval was produced to inspect the mediation effects. It has been demonstrated in the literature that indirect effects could be confirmed if the confidence interval does not include zero [57]. The results in Table 2 demonstrated that future decent work perceptions significantly mediated the path between subjective social status and academic satisfaction ($\beta = 0.12$, $SE = 0.02$, 95%CI [0.013, 0.079]). The effect of future decent work perceptions on academic satisfaction was significantly mediated by disadvantaged mindset ($\beta = -0.29$, $SE = 0.22$, 95%CI [-0.927, -0.067]).

Table 2. Bootstrap analysis of mediating effect significance test.

Path	Standardized Indirect Effect		95% CI Bootstrap Bias Corrected	
	β	SE	Lower	Upper
subjective social status→future decent work perceptions→academic satisfaction	0.12 **	0.02	0.013	0.079
disadvantaged mindset→future decent work perceptions→academic satisfaction	-0.29 **	0.22	-0.927	-0.067

Note: ** $p < 0.01$.

5. Discussion

In response to a call to verify the PWT model with a varied sample and to investigate complex propositions in the context of PWT, we collected data from female pre-service teachers in Chinese primary schools. Overall, this study confirmed several interesting findings and added new insights to PWT.

For the predictor component of PWT, our study revealed that, as hypothesized, the subjective social status of pre-service female primary school teachers was positively associated with future decent work perceptions. This implies that the lower the subjective social status that pre-service female primary school teachers perceive themselves to be, the more likely they are to hold negative perceptions about the future of decent work. This result from the present study further supported the findings of previous scholars that lower subjective social status was associated with lower decent work scores, reflecting the cross-cultural heterogeneity of the findings [18,25,58]. In short, the data of the current paper indicated that similar to studies in the United States and Korea, individuals' perceived subjective social status was positively associated with decent work [33,58,59].

H2 indicated that disadvantaged mindset was negatively related to future decent work perceptions, which suggested that those pre-service female primary school teachers who felt they were disadvantaged in society more frequently were more likely to have negative evaluations in obtaining decent work in the future. Given that the relationship between these two variables has not been previously explored by scholars, this finding could increase the new horizon of PWT research.

In addition to exploring the antecedent variables in the PWT model, the current investigation attempted to link career-related variables with academic-related variables. A positive correlation was detected between future decent work perceptions and academic satisfaction, as H3 assumed. This was inconsistent with the previous study by Ma et al. and may be due to the different selection of the research samples for the two studies [50]. This study uncovered that the higher the future decent work perceptions, the stronger the academic satisfaction of female pre-service primary school teachers. Perhaps because primary school teachers in China have always been regarded as relatively decent, and although this group's work has become more stressful in the current context of the "Double Reduction" policy, female pre-service primary school teachers remain positive about their future careers, thus making them more probably to be satisfied with their current studies [2,3,60].

Overall, in the relationship between subjective social status and academic satisfaction, future decent work perceptions are partially mediated. That is to say, the subjective social status of female pre-service primary school teachers could be a key explanatory variable for the level of individual academic satisfaction through its influence on future decent work perceptions. Also, future decent work perceptions partially mediated the relationship between disadvantaged mindset and academic satisfaction. In other words, the disadvantaged mindset status of female pre-service primary school teachers could have an impact on academic satisfaction by influencing individuals' future decent work perceptions. However, it is important to note that these findings need to be interpreted with caution, as they were derived from cross-sectional data and lack longitudinal data over time [27].

6. Practical Implications

The results of our study have several practical implications for both practitioners and organizations. In order to help pre-service female primary school teachers better prepare for a successful future career, some practical suggestions need to be brought to the attention of the relevant authorities, as listed below.

Numerous research have revealed that women may face more discrimination in the workplace, which has a hindering effect on their career development [27,59]. Especially in the context of facing limited economic resources, many women were more likely to have difficulty obtaining decent work [61,62]. This study discovered that disadvantaged mindset was negatively related to the future decent work perceptions of female pre-service teachers in primary schools. The findings of this survey suggested that the future practice of education may require all types of educators at the university level to help female pre-service teachers to perceive society more positively, to develop a mindset that they can gradually change their current situation through hard work, and believe that they have the potential to obtain decent work.

At the same time, the government and the education sector have to focus on the significant value of future decent work perceptions for the development of female pre-service teachers in primary schools. On the one hand, the government part of it needs to promulgate educational countermeasures to assist students at this stage to establish correct work perceptions at the pre-service stage. On the other hand, the education section needs to provide various supports for the formation of decent work perceptions of elementary school pre-service teachers in all aspects of talent training.

Finally, it has been proposed that college students' academic satisfaction can be improved through interventions [63]. If career counselors, guidance counselors, and other educators at universities expect to improve the academic satisfaction of female pre-service teachers in primary schools, they need to design programs to change the future decent work perceptions of this group [18,50]. As an example, career counselors might try to incorporate disadvantaged mindset into the design of intervention programs and explore various types of interventions to change the disadvantaged mindset, based on which they

can enhance the perception of decent work for female pre-service primary school teachers and thus strengthen the academic satisfaction of this group at the university level [64].

7. Limitations and Future Directions

There are several limitations of this study that need to be addressed in the future. First, the cross-sectional design was adopted for this research, meaning that the data for all scales were collected at one point in time and therefore no causal relationships could be established regarding the variables [24,30,58]. Despite this limitation, the present examination provided support for enriching research on the predictors and outcomes of decent work and laid the groundwork for more rigorous research designs in the future. Second, there also existed the potential for single-method bias for this current study [28]. Given that the data in this report were based on participants' self-reports, in-depth information on the predictors and outcomes of decent work for pre-service female primary school teachers was still lacking [23,65]. Third, the sample was selected to represent only a portion of a certain type of female pre-service primary school teachers, which lacked attention to other types of pre-service teachers, resulting in a loss of diversity and richness in the sample. Fourth, we have explored the impact of disadvantaged mindset and subjective social class on decent work in Chinese culture, and perhaps the size and direction of research hypotheses may differ in other cultures [30].

In general, there are several possible directions for upcoming research on decent work. In the first place, there is a call for further additions of longitudinal studies or more intricate experimental designs on decent work in future studies that can assist us in making inferences about the causality of the findings of PWT [33]. As an example, future researchers might be able to select three-, six-, nine-, or even four-year intervals to conduct multiple surveys of female pre-service primary school teachers, so that the process of change in decent work for this group throughout the college years can be traced [22,65–67]. Furthermore, future research could add qualitative or mixed research, for example, using field surveys or in-depth interviews to provide more in-depth, thorough, and comprehensive explanations for the research on the predictors and outcomes of decent work among pre-service female primary school teachers. In addition, a larger and more diverse group of participants needs to be included as part of future research [25,26,30,68]. This current project was conducted with female primary school pre-service teachers, and future researchers can further analyze decent work not only confined to this group, but also need to be expanded with other types of preservice teachers such as secondary school pre-service teachers and male preservice teachers as research participants to test the theoretical model of decent work further. Ultimately, the PWT model with decent work as the central variable may need further expansion. Future research could include additional cultural context variables to assess the relevance of disadvantaged mindset, subjective social status, and decent work across cultures in other countries or regions. In addition, the PWT model can be further extended by adding antecedent variables similar to disadvantaged mindset and posterior variables such as academic satisfaction [58,69]. Therefore, we expect more exploration of the potential role of decent work in individuals' academic and career development by future researchers.

8. Conclusions

In conclusion, the current study was an exploration of the predictors and outcomes of decent work in the PWT model, which enriches research in the area of female teachers' career development, using Chinese female pre-service primary school teachers as the research object. Although the present investigation has some limitations, this study reveals the theoretical significance of decent work for Chinese female pre-service primary school teachers and has important practical implications for educators and career counselors engaged in teacher education.

Author Contributions: Y.W. was the PI for the project. X.W. and Y.W. developed the questionnaires. Y.W., H.C., K.L. and F.L. collected the data. X.W. and Y.W. developed the analytical plan and did the statistical analyses. Y.W., H.C., X.W. and X.L. interpreted the outcomes of the statistical analysis and wrote the paper. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Nanjing Xiaozhuang University (protocol code 2021 No.18 and 2021.4.2 of approval).

Informed Consent Statement: Informed consent was obtained from all participants included in the study.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the authors with the permission of Nanjing Xiaozhuang University.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Disadvantaged Mindset Scale.

No.	Items
1	Even if I work hard, it is difficult to cope with the potential risks in life.
2	Compared with most people, I work harder but I am not more successful.

Table A2. Decent Work Scale.

No.	Items
1	At my future work, I will feel safe from emotional or verbal abuse of any kind.
2	I will be rewarded adequately for my work.

Table A3. Academic Satisfaction Scale.

No.	Items
1	I enjoy the level of intellectual stimulation in my course.
2	I am generally satisfied with my academic life in my university.

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Article

How Students' Well-Being, Education for Sustainable Development, and Sustainable Development Relate: A Case of Prince Mohammad Bin Fahd University

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Abstract: This study investigates how students' well-being relates to sustainable development and education for sustainable development at Prince Mohammad Bin Fahd University, Saudi Arabia. The authors endeavor to answer the question "How Does Students' Well-Being Relate to Sustainable Development Via Education for Sustainable Development?" and four sub-questions. The authors used primary data collected by semi-structured interviews exploring the viewpoints of twenty-six female and male students ($n = 26$) aged between 18 and 25. These interviewees, who are Saudi senior business students, have played a crucial role in our study. As revealed in the content and thematic analysis results, their insights have identified additional well-being and education for sustainable development antecedents that influence sustainable education and, therefore, sustainable development. In addition to this study's new well-being and education for sustainable development factors, this study also developed a theoretical model for the relationship between antecedents for education for sustainable development factors, education for sustainable development, and sustainable development in the Saudi context. Moreover, this study's outcomes guide educational institutions to link students' education for sustainable development to their inner well-being and that on campus, which requires instructors' awareness and training to help them deliver knowledge, skills, and emotional intelligence that improve students' well-being, and therefore, education for sustainable development.

Keywords: education for sustainable development; sustainable development; students' well-being



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1. Introduction

According to the UNESCO 2030 Plan, the SDGs "Sustainable Development Goals" comprise 17 and 169 targets to eliminate poverty and acknowledge a sustainable world [1]. In November 2019, UNESCO embraced the recent global framework on ESD (i.e., ESD for 2030) for 2020–2030 [2]. It concentrates on "incorporating ESD and the 17 SDGs into learning, environment, policies, capability building of teachers, enabling and mobilization of the young generation, and regional level action" [1]. In this study, sustainability generally refers to meeting the current and upcoming generations' environmental, social, and economic requirements [3]. Education for sustainable development is usually called ESD. UNESCO defined ESD as "education that helps people to gain the skills, attitude, attitudes, learning, wisdom, and values essential to frame a sustainable future environmentally, economically, and socially". [4] Research applying the UNESCO definition has shown that education institutions, such as universities and colleges, are deemed to play an essential role in the advancement and promotion of sustainability and sustainable development (SD) in society as a whole via providing students with necessary values, knowledge, attitudes, and skills necessary to shape sustainable development. UNESCO has always emphasized the

importance of ESD, which has become necessary for researchers, educators, business leaders, and policymakers for economic, social, and environmental reasons [4]. Economically, eco-systems and sustainable practices can create a safer, healthier, more efficient, effective, and productive environment. Socially, daily sustainable practices can aid in strengthening community bonds and relationships, improve the quality of everyone's life, and provide hope and assurance of a better future for the next generations. Environmentally, sustainable development equips humans to preserve an ecological consonance in the globe's untouched atmosphere and preserve raw resources to sustain the well-being of present and forthcoming generations. Other than UNESCO in 2012, several other stakeholders, such as businesses, government organizations, and nongovernment organizations (NGOs), are part of the drive towards sustainable organizations. In this regard, universities, colleges, and research institutions are not exempt from stakeholders' legitimate expectations. However, universities, colleges, and research institutions can only achieve stakeholders' legitimate expectations when university educators and administrators overcome barriers and challenges. Responding to UNESCO's call in 2012 highlighting the importance of education for sustainability and sustainable development, this exploratory study aims to investigate how the undergraduate students of Prince Mohammad Bin Fahd University (PMU), as representatives of Saudi universities, perceive the concepts of sustainability and education for sustainable (ESD) in their institution, their well-being, the role of university education for sustainable development, and the challenges and obstacles they face throughout their education journey at PMU. In addition, this study tries to answer the question "How Does Students' Well-Being Relate to Sustainable Development Via Education for Sustainable Development?" and four sub-questions. These four sub-research questions are as follows: What other possible factors contribute to education for sustainable development? What are the other antecedents of education for sustainable development? How could university educators contribute to ESD? How do the antecedents of education for sustainable development, education for sustainable development, and sustainable development relate? Primary data were collected using semi-structured interviews. This article explores the perspectives of 13 female students ($n = 13$) and 13 male students ($n = 13$) at Prince Mohammad Bin Fahd University aged between 18 and 25. The authors used content and thematic analysis techniques to analyze the datasets.

The results showed that many students need to be fully aware of sustainability. This research highlighted the importance of conceptual and organizational change in education institutions, notably by identifying more organizational flexibility, more extensive mission statements, customized educational curricula, life-long learning, internship programs, dedication to internationalization, and strategic managing of human resources. This study contributes to the literature by deliberating on how educational institutions can promote education for sustainability and sustainable development. It also emphasizes the crucial role of educators in understanding and enhancing schooling for sustainable development in Saudi Arabian universities. The findings also point to a promising future, where the field of ESD is ripe for growth and development, fostering a sense of optimism and hope among the audience.

2. Literature Review

Based on UNESCO's definition, ESD means considering fundamental sustainable development problems in learning by students and teaching by instructors; for instance, biodiversity, sustainable consumption, climate change, poverty reduction, social responsibility, and disaster risk reduction [3]. ESD also demands participatory schooling and understanding aspects that empower and motivate students to transform their sustainability manners and take steps forward for sustainable development. Educating residents, especially young citizens, within the traditional education system is expected to enhance SD [4]. This hope guided the takeoff of the United Nations (UN) Decade of Education for Sustainable Development (DESD) initiative, supervised by UNESCO, which shows how ESD relates and links to sustainable development. During the DESD (2005 to 2014),

UNESCO established ESD as a teaching and understanding method fostering SD [5]. ESD has evolved from a notion into a transnational movement [6]. It advances competencies like envisioning forthcoming scenarios, critical thinking, and collaborative decision-making [3]. ESD stresses the necessity of incorporating all three sustainability measurements (i.e., economic, environmental, and social) and concentrate on their interaction and interrelationship in the future and globally [7]. The holistic viewpoint of sustainable development acknowledges that cultural and social factors are constantly the reason for environmental issues, and there is frequently a conflict of interest between the environmental, social, and economic goals of people and communities [8]. Hence, in teaching and learning for effective ESD, connecting economic, social, and environmental factors of sustainable development issues, integrating their present, future, and past implications, and concentrating on their global, regional, and local nature is necessary. The second paramount element of ESD is coping with learning and teaching, deemed the most challenging part. By definition, ESD concentrates on expanding skills and activity competence for sustainability [9]. However, these skills and competencies still need to be identified and applied, which hinders instructors from knowing how to teach them. Lack of identification and application has challenged instructors and academics seeking to execute ESD [10]. Hence, the interviews in this study helped the authors overcome some of these challenges by identifying several antecedents of ESD and other factors that constitute ESD [11].

Previous studies concentrated on educational agendas focusing on environmental problems, school leadership participation, understanding, attitudes, motivations, manners, and other eco-school credential programs (Refs). However, the studies did not consider the factors that contribute to education for sustainable development and the antecedents of ESD. In addition, researchers such as PILOTTI [12] focused on the benefits of imparting scientific reasoning skills to university students as a pillar of education for sustainable development. However, the researchers should have paid more attention to sustainable projects, sustainable infrastructure, research on sustainability, and raising awareness. On the other hand, [13] documented that mobile learning (M-learning) and behavioral preferences benefit ESD and long-term sustainability.

Furthermore, other researchers have examined varied factors believed to influence ESD from different points of view [9,14]. In this respect, [15] studied four factors that can equip policymakers with a marked sense of mandate when they carry on the challenge of promoting ESD, leading to a successful, ESD system. The factors are fostering teachers' and students' intrinsic motivation, engaging students and educators in the continuous advancement of learning and instruction, inspiring teamwork, and All-ness (referring to the inclusion of all students and teachers). Equal opportunity and diversity have also influenced inclusive systems [16]. Taylor et al. [17,18] discussed the influence of politics and regeneration, the alignment of the curriculum, teaching, and resources, the perceived state of education for sustainability, and how instructors' professional growth determines the state of education for sustainability performance and success. Bukhari and Khanam [18] revealed that educational performance is highly negatively correlated with depression, which jeopardizes students' well-being, and particularly positively correlated with happiness, which promotes students' well-being. Student well-being is a significant factor contributing to ESD; hence, researchers have paid more attention to it. The authors of [19] highlighted 33 investigations on student well-being in academic periodicals between 1989 and 2020. The studies identified four methods of conceptualizing learning well-being: eudaimonic, hedonic, integrative (i.e., incorporating both eudaimonic and hedonic), and others. Their results highlighted eight overarching realms of student well-being: Purpose at school, Relationships, Negative Emotion (i.e., lack of emotion), Positive emotion, Engagement, Accomplishment, Contextual/External factors, and Intrapersonal/Internal factors. Hossain, O'Neill, and Strnadová [19] called for further qualitative research on learner well-being based on learner–learner experiences and for research studies to be executed in a non-Western context. Hence, the authors argue that student well-being factors (i.e., manageable workloads, transparency, grading criteria, fairness, sense of belonging, work–life

balance, and mental health support) identified via the interviewee's responses make sense since they impact students' happiness on campus. Prior studies have neither identified all ESD factors (i.e., sustainable practices, sustainable projects, sustainable infrastructure, and research on sustainability) nor identified all antecedents for education for sustainability (i.e., manageable workloads, transparent, grading criteria, fairness, sense of belonging, work–life balance, and mental health support) and other factors that relate to ESD such as instructors' role models, institutional commitment, leadership towards sustainability, and collaboration with government. In addition, prior research has yet to develop a theoretical model for the relationship between the abovementioned factors [20,21]. Hence, this study tried to fill these gaps by proposing a comprehensive education for sustainable development model and identifying ESD factors and antecedents in the Saudi context at PMU. In doing so, this study answers the following research questions: (1) What factors contribute to education for sustainable development? (2) What are the antecedents of education for sustainable development? (3) How do university educators contribute to ESD? (4) How do the antecedents of education for sustainable development, education for sustainable development, and sustainable development relate? The antecedents include manageable workloads, transparent, grading criteria, fairness, sense of belonging, work–life balance, mental health support, missing factors of emotional intelligence, and other factors that relate to ESD such as instructors' role models, institutional commitment, leadership towards sustainability, and collaboration with the government. Other challenges that have been identified in the implementation of ESD in the context of standard education in PMU are what are believed to constitute ESD factors (i.e., sustainable practices, sustainable projects, sustainable infrastructure, and research on sustainability).

3. Theoretical Framework and the Study Propositions

Theories used to study ESD include Transformative Learning, Place-based education, Global Citizenship Education, Ecological Literacy, Social Learning, and systems theory. Transformative Learning avers that education is a potential catalyst that, through fostering critical reflection, self-awareness, and empathy, can transform individuals and societies towards being more conscious of the importance of sustainability [22]. Place-based education posits that social context must underpin education [23]. Global Citizenship Education promotes a shared global responsibility that makes learners act like informed citizens [24]. Ecological Literacy promotes decision-making based on appreciating ecological factors such as environmental stewardship [25]. Social Learning posits that sustainability awareness is fostered by collaborative and participatory learning processes that have room for solving problems collectively and shared decision-making [26]. The highlighted approaches have limitations, as they represent partial aspects of the complex nature of ESD. Systems theories present a more comprehensive perspective.

Researchers have used systems theories to understand ESD [27–29]. Chen and Stroup [30] provided a detailed description of systems theory, highlighting that its core is conceptualizing a system as a combination of intermingling parts that display behavior different from the parts that constitute it. Further, a system can be social, physical, biological, or even symbolic, and it can also be a combination. The system can, in time, transform through change but still retain its identity. In this regard, a system is intentionally organized in line with the goal. Feedback mediates the relationship between the system's behavior and the goal. Time serves as a central variable in systems theory as it serves as a reference point for dynamics in the system. The system has a boundary that separates the system from the environment and other sub-systems. The interaction between the system and the environment is the input and output of information, matter, and energy. Furthermore, the system's relationship with the environment can be open, closed, or semi-permeable.

A systems approach to exploring, analyzing, and seeking to understand sustainable development has been used in various studies, including in higher education settings [31]. Underpinned by a systems approach, Pappas [31] posited that sustainability has five contexts: social/cultural, economic, environmental, technical, and individual. Understand-

ing the contexts is complicated because the contexts interact and influence each other in complex ways. Pappas [31] argues that of the five contexts, individual sustainability has the most significant influence on the success of sustainability activities. This emphasis on the role of individual sustainability empowers us to realize our potential impact on sustainability. Individuals can transfer their understanding of the complexities of sustainability contexts to the rest of the systems. In the context of the current study, Pappas' [31] conceptualization of giving due regard to individual factors suggests that focusing on student-related aspects can influence ESD within the university education sector.

Further, at the university level, Pappas [31] advocates for methods of instruction that integrate thinking from across the five sustainability contexts as part of a multi-faceted approach. Several studies support a multi-faceted and multi-disciplinary systemic approach to understanding sustainability and facilitate an appreciation of the interconnectivity of the economic, political, social, and ecological issues central to developing sustainability [32]. Further, the approach lends itself to a more holistic appreciation of sustainability.

Based on systems theory, Porter and Córdoba [33] developed functionalist, complex adaptive systems, and interpretive perspectives as three broad approaches to systems thinking. According to the functionalist perspective, systems have a hierarchical and decomposable macrostructure so that the whole is equal to the sum of its pieces, neither more nor less [34]. Any system may be comprehended by analyzing the individual characteristics of each constituent, and the system's behavior is explained by the interaction of all the elements [35].

From the perspective of complex adaptive systems, systems are densely connected networks of agents, self-organization, and emergence where there is continual learning and evolution from the bottom up. Complexity theory, non-linear systems, and complex adaptive systems are the main applicable theories to analyzing complex systems. The rationale for complexity theory is that for a system to survive in its dynamic environment, it must maintain its wholeness and be part of the environment in which it subsists, contributes, and competes for resources [36]. A system is considered sustainable if it survives, as shown by its ability to maintain its totality as a fundamental part of the more extensive system. Education goals and skills applied to the complex adaptive systems perspective can separate each system perspective, identify areas of leverage, empower learning, design incentives, win trust, and build consensus [33]. Such practices lend themselves to accepting various perspectives and an interpretive approach.

Given that there is no universal formula for sustainability, ESD has various interpretations in different parts of the world [31] and, given Porter and Córdoba's [33] three broad approaches to systems thinking, an interpretive perspective is satisfactory. The choice is influenced by the fact that one of the aims of interpretive inquiry is understanding the mental models and meaning-making processes of embedded actors and how they interact to create a shared reality [37]. According to the interpretive perspective, meaning is subjective, socially constructed, and not self-evident; in this regard, systems require critical inquiry as they cannot be understood by just analyzing the individual characteristics. Theories that apply to the interpretivist approach include symbolic interactionism, Soft systems theory, and critical systems thinking. Sustainability issues can be handled through awareness raising, self-reflection and appreciation of systems, collaborative stakeholder decision-making, and coordinated action. Educational goals and requisite skills enhance self-understanding, understanding one's worldview, identifying stakeholders, and facilitating revisiting functional plans to align them with collaboratively reached decisions.

An interpretive approach uses symbolic interactionism and critical social theory. In sociology, symbolic interactionism is a micro-level theoretical framework and worldview that examines how people repeatedly engage with one another to form and preserve society [38]. It deals with how people create meaning and identity in their social contexts and how their goals, actions, and social relationships are affected by their socially enacted meanings. Symbolic interactionism presupposes multiple or conflicting interpretations of a phenomenon [33]. Symbolic interactionism enables the integration of different perspectives,

providing a more comprehensive and nuanced explanation of factors contributing to ESD, its antecedents, and how university educators could contribute to it. Critical systems thinking, as seen through critical social theory, on the other hand, investigates contradictions, structures, practices, ideologies, relations, and political praxis in order to understand the role of power, domination, and exploitation in society [39]. In this regard, a critical theory of sustainability proposes that unsustainability in society emanates from a combination of the dominative, exclusionary, destructive, and exploitative nature of global capitalism, together with dominating forces such as racism, nationalism, patriarchy, and dysfunctional industrialism [39].

From a systems perspective, antecedents of ESD are multi-dimensional, including, but not limited to, environmental, economic, and social. For students, the antecedents are a combination of environmental, economic, and social aspects relating to students' well-being, instructors as role models, the commitment of the educational institutions, leadership towards sustainability, and collaboration with the government. Combining these antecedent factors results in ESD through knowledge, skills, attitudes, and values, adoption of sustainable practices, projects, and infrastructure, research on sustainability, and increased awareness. A combination of the antecedents and the associated ESD leads to sustainable development. Given the preceding discussion, the authors developed the following propositions regarding education for sustainable development and attaining sustainable development:

Proposition 1: Students' well-being is an antecedent of ESD.

Proposition 2: Instructors' role models, institutional commitment, leadership towards sustainability, and collaboration with government institutions affect ESD.

Proposition 3: ESD influences future environmental, economic, and social sustainable development.

Proposition 4: Education for sustainable development (ESD) mediates the relationship between the antecedents for ESD and sustainable development (SD).

Proposition 5: ESD is crucial in mediating the relationship between its antecedents and sustainable development (SD).

Proposition 6: Many university and college students in Saudi Arabia need to acquire ESD. Hence, their awareness will improve ESD and, therefore, SD.

Proposition 7: University instructors' awareness and implementation of ESD and SD will improve ESD and, therefore, SD.

4. Methods of Data Collection

This study aimed to investigate how PMU undergraduate students, as representatives of other Saudi universities, perceived the concepts of sustainability and ESD in their institution, the role of education in universities in sustainable development, and the challenges and obstacles to implementing sustainability initiatives in Saudi Arabian education institutions. The sampling method is convenience sampling, which involves using students who are "convenient" and willing to answer our research questions. There is no pattern whatsoever, but we asked senior students who were available for the interviews. The relationship between the authors and the respondents is a teacher to a student. There are no potential validity issues since the respondents were voluntarily chosen to answer the questions with security and confidentiality for their answers. Through a qualitative approach, the authors used semi-structured interviews to collect primary data. The study sample comprised male ($n = 13$) and female ($n = 13$) PMU College of Business students of diverse majors (i.e., business administration, human resource management, accounting, and management information systems) aged between 18 and 25 years in January 2024. All these interviewed students were Saudi students who were fluent in English. PMU students are fluent in English, and English is the language of instruction at PMU. All PMU students spend one year studying English and or improving their languish skills. In addition, students are required to pass the ILET with a certain level to be accepted at PMU. Hence, there is no need for translation. Data authenticity can be extracted from students'

answers, gestures, tone, etc. When students know that their interview information will be kept confidential, they will be open to talking frankly. The selection was based on students' time on campus and their experiences with different instructors over three to four years.

Data collection was in four stages: First, the authors prepared fourteen questions that covered the topic. The questions were reviewed and agreed upon by the second author. These fourteen questions are available in Appendix A (Part 1: Ethical ESD (University Level) interview questions for interviewees) and Appendix B (Part 2: Analysis of the Determinants of Student Well-being: Focusing on the causal effects of a Stress-free and comfortable study environment). Second, the authors informed the students about the interviews and explained the purpose of the research and why students needed to participate in the interviews, emphasizing the extreme confidentiality of the information given. The authors also requested the consent of the interviewees, which was obtained through completing an informed consent form before commencing the interviews. Third, interviews were conducted. The interviews were audio recorded after the interviewees' agreement. Fourth, the interviews were transcribed within a week of completion and kept confidential for further analysis, ensuring the students' privacy and comfort. The purpose of this research is to understand and improve the sustainability and ESD perceptions in Saudi Arabian universities, and your participation is crucial for its success.

4.1. Data Analysis

Data captured in interview transcripts was meticulously analyzed using content analysis and thematic analysis techniques, which systematically classify data using coding to identify their key categories and themes. The analysis was a comprehensive four-step process. In the first step, the authors carefully read the 26 interviewees' responses twice, immersing themselves in the interviewees' answers to understand what has been said and implied in the content. The second step involved grouping the interviewee's answers based on the identified themes and subthemes. In the third step, coding was used to identify the critical categories of issues. In the fourth step, the authors linked the themes and subthemes to develop six propositions. Finally, the authors refined the originally proposed framework (Figure 1) of the relationship among the antecedents of ESD, ESD, and SD.

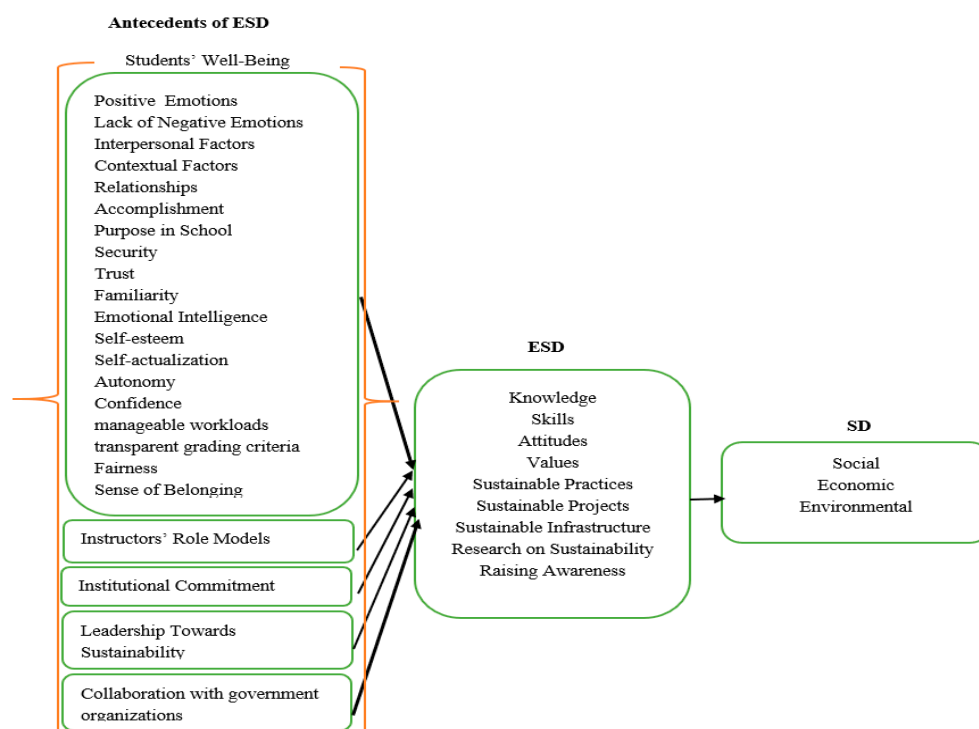


Figure 1. The study theoretical model.

Below is an example of coding extracted from the interviewee's answers. The extracted codes are italicized.

Question: "How could university educators contribute to ESD?"

Interviewee 1

"University educators contribute significantly to ESD by fostering a culture of critical thinking, ethical responsibility, and environmental awareness among students. One key way they do this is by incorporating sustainability themes into their teaching materials and discussions, providing students with the knowledge and tools to analyze complex issues through a sustainability lens". "For instance, a history professor might explore the historical roots of environmental challenges, helping students understand the long-term impact of human actions on the planet. Likewise, an engineering instructor might incorporate sustainable design principles into their coursework, guiding students to develop solutions that minimize environmental impact".

"Moreover, educators contribute to ESD by encouraging student involvement in sustainability initiatives on campus. They may facilitate student-led projects, such as community gardens, waste reduction campaigns, or renewable energy projects. By involving students in hands-on sustainability efforts, educators empower them to apply theoretical knowledge to real-world challenges, fostering a sense of responsibility and agency". "University educators could contribute to ESD by instilling a sense of environmental consciousness, ethical responsibility, and critical thinking skills that prepare students to address the complexities of a rapidly changing world".

Question: "How can university students actively contribute to sustainability?"

Interviewee 2

"Universities play a critical role in ESD by incorporating environmental and social responsibility into their curricula. This role entails interrelated courses on sustainability, environmental science, and ethical practices. Additionally, interdisciplinary cooperation is one way that universities can improve ESD. This role entails promoting collaboration amongst departments so students may explore the relationship between sustainability and their field of study. For instance, a business and environmental science student might work together on a project investigating sustainable company practices".

Interviewee 3

"I agree [with Interviewee 3]. Additionally, universities can promote eco-friendly activities such as recycling programs, energy-efficient infrastructure, and lowering carbon footprints through responsible resource management on their campuses". "Universities should participate in community outreach initiatives to help advance ESD. This participation entails collaborating with neighborhood organizations and carrying out initiatives dealing with neighborhood environmental issues. This collaboration reinforces the value of sustainability outside of campuses by giving students real-world experience and positively affecting the community".

Question: "What factors facilitate the implementation of sustainable initiatives in PMU or Saudi Arabian Education Institutions?"

Interviewee 4

"Strong leadership commitment is one of the important variables supporting implementing sustainable initiatives in our institution. Leaders who value sustainability set the tone for the entire organization. This dedication cascades down, ensuring that policies, resources, and support are in place to propel long-term efforts ahead. Collaboration between departments and stakeholders is also es-

sential. We can pool skills and resources by developing a teamwork culture and implementing sustainable initiatives that are more successful and complete. Our institution has discovered that involving students in decision-making is critical. Engaging students in sustainability efforts gives them new insights and instills a sense of ownership. This involvement cultivates a strong mindset among the student body, leaving an impression that lasts beyond their academic years. Establishing clear communication channels guarantees everyone is aware and motivated to contribute to long-term goals”.

Interviewee 5

“Collaboration with government organizations and the corporate sector is critical for obtaining support and resources for long-term projects. Furthermore, implementing sustainable concepts into national education regulations might help institutions accept and implement green initiatives. Cultural understanding and compatibility with local values are important in Saudi Arabian educational institutions. Adapting long-term activities to conform to cultural norms and values aids in gaining support and acceptability. Furthermore, financial incentives and government assistance are required. Institutions are more inclined to invest in environmentally friendly practices when some clear incentives and regulations favor sustainability. Government support, whether in the form of financing or legislation, offers a solid platform for the successful execution of long-term initiatives in the education sector”.

Question: “What do you know about sustainability and ESD institutions?”

Interviewee 6

“Sustainability encompasses meeting present needs while ensuring the ability of future generations to meet their own needs. ESD institutions embrace sustainability as a foundational principle and integrate it into their operations. They recognize the interconnections between social, environmental, and economic dimensions of sustainability. Such institutions adopt sustainable practices within their physical infrastructure, such as energy-efficient buildings, waste reduction strategies, and responsible resource management. Their policies and practices also prioritize social equity, diversity, and inclusion. ESD institutions promote education for sustainable development as a core component of their curriculum, research, and community engagement efforts. They offer interdisciplinary programs that address sustainability challenges and equip students with the knowledge, skills, and values necessary for sustainable development. These institutions foster a culture of sustainability, engaging students, faculty, staff, and the broader community in sustainable initiatives and dialogue. By modeling sustainable practices and values, they inspire and empower individuals to become responsible global citizens committed to creating a more sustainable future”.

Question: “What factors facilitate the implementation of sustainable initiatives in PMU or Saudi Arabian Education Institutions?”

Interviewee 7

“Elements that tend to contribute to the success rate of implementing sustainability-focused initiatives within educational systems, particularly in the Kingdom of Saudi Arabia, are:

- a. A strong foundation established through the commitment and ongoing leadership skills displayed by positions within the system, such as a management team(s) that are keen on creating an environment based on given sustainability objectives, which in turn provides purpose for those within an educational environment which can be done through the usage of regulations and resource allocation. In addition, it promotes a culture of obligation toward sustainability.

b. To encourage diversity, inclusion, and sustainability, it is crucial to dynamically involve the community, faculty and staff, and students in sustainability activities; therefore, strong connections built with stakeholders (like partnerships, government-funded establishments, and non-profit organizations) are vital to educational systems both within the Kingdom and worldwide to promote sustainability efforts”.

Interviewee 8

“The strong institutional commitment and leadership toward sustainability play a key role in supporting long-term objectives, illustrating sustainability, and implementing the provided resources and guidance. For instance, institutions encourage growth and awareness of sustainability and invest in certain eco-friendly behaviors promoted and enhanced by encouragement inside the institution. This commitment reflects, inspires, and encourages the support of sustainability and students to participate in certain activities that promote what is beneficial for us and the environment”.

Question: “What are some of the conditions that help create a stress-free and comfortable studying environment that can increase subjective well-being and suppress depressive symptoms for students in university?”

Interviewee 9

“Promoting a stress-free and comfortable studying environment that enhances subjective well-being and reduces depressive symptoms in university students requires certain conditions. These conditions include having a supportive social network where students can seek guidance and emotional support from friends, classmates, professors, and university staff. The physical environment should be well-designed with ergonomic furniture, good lighting, and minimal distractions to enhance comfort and concentration. Also, a well-structured academic system with clear expectations, transparent grading criteria, and manageable workloads helps students effectively manage their time and reduce anxiety. Furthermore, access to comprehensive support services, including counseling and mental health resources, is crucial. Encouraging a healthy work-life balance through participation in extracurricular activities and providing recreational facilities promotes relaxation and social connections. Lastly, fostering a culture of inclusivity and respect ensures that all students feel valued and supported”.

Interviewee 10

“Creating a positive social environment among students is essential for promoting a sense of belonging and lowering feelings of loneliness. Furthermore, providing ideally constructed study areas and physical comfort, in conjunction with adaptable learning environments, is crucial for improving focus and lowering stress levels. Good time management instruction helps students manage their academic responsibilities without going overboard. A calmer learning atmosphere is facilitated by accessing mental health support resources, communicating expectations clearly, and allocating the workload and assessments fairly. Moreover, the promotion of an inclusive and diverse culture, the encouragement of healthy habits, and the cultivation of a positive learning culture all work together to create a nurturing environment that actively supports university students’ success and mental health in addition to preventing harm to their subjective well-being caused by academic demand”

Note: ESD denotes education for sustainable development; SD denotes sustainable development.

Results

The study results from the content and thematic analysis technique show additional identified ESD (Table 1 and Figure 1) factors that influence ESD and, therefore, future SD. The results also identified more ESD factors that need to be considered to provide learners with ESD and SD. In addition, the study results reveal three different themes and four subthemes that helped in coming up with the following six propositions:

Proposition 1: The antecedents for ESD, including manageable workloads, transparency, grading criteria, fairness, sense of belonging, work–life balance, and mental health support, are not only crucial for learners’ well-being but also influence ESD. These factors, often overlooked, can significantly enhance the effectiveness of ESD.

Proposition 2: Other factors that relate to education for sustainable development (ESD), including instructors’ role models, institutional commitment, leadership towards sustainability, and collaboration with government institutions, affect ESD.

Proposition 3: Education for sustainable development (ESD) influences future sustainable development environmentally, economically, and socially.

Proposition 4: Education for sustainable development (ESD) mediates the relationship between the antecedents for ESD and sustainable development (SD).

Proposition 5: The potential impact of education for sustainable development (ESD) on university and college students in Saudi Arabia is immense. By raising their awareness, we can significantly improve ESD and, consequently, SD. This proposition holds the promise of a more sustainable future.

Proposition 6: Some universities and college instructors must be aware of the factors and implementation of education for sustainable development (ESD). Their awareness will improve ESD and, therefore, SD.

Table 1. Themes and subthemes extracted from the interviewees’ responses.

Theme 1: Antecedents for ESD Factors	Theme 2: ESD Factors	Theme 3: SD Factors
Theme 1: Well-being		
Positive Emotions		
Lack of Negative Emotions		
Interpersonal Factors		
Contextual Factors		
Relationships		
Accomplishment	Knowledge	
Purpose in School	Skills	
Security	Attitudes	
Trust	Values	
Familiarity	Sustainable Practices	Social
Emotional Intelligence	Sustainable Projects	Economic
Self-esteem	Sustainable	Environmental
Self-actualization	Infrastructure	
Autonomy	Research on Sustainability	
Confidence	Raising Awareness	
Manageable workloads		
Transparent grading criteria		
Fairness		
Sense of Belonging		
work_life balance		
Mental health support		
Sub-Theme 1:		
Instructors’ Role Models		
Sub-Theme 2:		
Institutional Commitment		

Table 1. Cont.

Theme 1: Antecedents for ESD Factors	Theme 2: ESD Factors	Theme 3: SD Factors
Sub-Theme 3: Leadership Towards Sustainability		
Sub-Theme 4: Collaboration with government organizations		

Note: ESD denotes education for sustainable development; SD denotes sustainable development.

5. Conclusions

This study's advanced propositions are consistent with previous research in one way or another. These previous studies include UNESCO in 2015, which relates ESD to SD; Mogensen's [40] concentration on the expansion of skills and activity competence for sustainability; and Hossain, O'Neill, and Strnadová's [19] claim that student well-being is one of the significant factors that contributes to the antecedents of education for sustainable development. In this study, the results show that student well-being influences ESD and, therefore, SD. Hossain, O'Neill, and Strnadová's [19] study results recognized eight overarching realms of student well-being: Purpose at school, Relationships, Negative Emotion (lack of emotion), Positive emotion, Engagement, Accomplishment, Contextual/External factors, and Intrapersonal/Internal factors. All these factors were also found to influence ESD in this study's results.

Moreover, the results are consistent with Semin's [14] competencies of principals in assuring ESD. The competencies, identified as manageable workloads, transparent grading criteria, fairness, a sense of belonging, work–life balance, and mental health support, are the positive and negative behaviors affecting education for sustainability. Furthermore, this study's results are consistent with Wanda et al. [9] and Fullan's [15] studies, which claimed four factors that lead to a successful ESD system that can equip policymakers with a marked sense of mandate when they carry on the challenge of promoting ESD. Finally, the study results of Bukhari and Khanam [18] revealed that educational performance is highly negatively correlated with depression, which jeopardizes students' well-being; this study's results confirm that in the Middle Eastern context, learners' well-being influences ESD. Hence, the authors argue that the student well-being factors identified through interviews, incorporating manageable workloads, transparency, grading criteria, fairness, sense of belonging, work–life balance, and mental health support, make sense since they impact students' happiness on campus.

5.1. Theoretical Implications

At a theoretical level, this study confirms the need for a holistic or integrated approach to ESD that incorporates not just economic, environmental, and social factors but also acknowledges the complexities of the Saudi context where such factors are underpinned by religion. According to Borg et al. [8], a holistic viewpoint of sustainable development acknowledges socio-cultural factors, the influence on environmental factors, and the associated conflict of interest in a society with a high level of religious homogeneity, as is the case in Saudi Arabia; there may be either less conflict of interest among the factors, or the conflict may take different forms. The differences imply that Western-based theories of ESD and their associated learning and teaching processes may present fit challenges in the Saudi context, demonstrating a need for theories that guide instructors' and academics' contextualization of methods of implementing sustainable ESD.

5.1.1. Practical Implications

A practical implication of this study is the guidance it provides, first to educational institutions and then to policymakers, on the apparent need to link student well-being

inside and outside the classroom, institutional and leadership commitment, and ESD as part of achieving a non-fragmented approach towards national-level SD.

5.1.2. Research Limitations

This study has limitations mainly related to its exploratory nature using a semi-structured interviewee approach. In addition, it was conducted in one Saudi university, which might limit its realizability. Other researchers could explore the many other universities in Saudi Arabia to help generalize this study's findings. While this study revealed student well-being as a factor that influences education for sustainable development and, by implication, sustainable development, the extent of the influence could not be ascertained because of the qualitative nature of this study. Future research may explore the relationship between the identified well-being factors and education for sustainable development.

5.1.3. Future Research

The propositions advanced by this study present opportunities for future research using both qualitative and quantitative designs. For a start, a quantitative study could establish the relationship between manageable workloads, transparency, grading criteria, fairness, a sense of belonging, work–life balance, mental health support, the absence of emotional intelligence, and the establishment or practice of ESD.

The proposition that instructors' role models, institutional commitment, leadership towards sustainability, and collaboration with government institutions influence ESD needs further investigation for a nuanced understanding and, therefore, a clear way forward for both educational institutions and the country.

The proposition that ESD influences future sustainable development environmentally, economically, and socially has implications for the curriculum in learning institutions. It opens the need to qualitatively interrogate the meaning of economic, social, and environmental aspects in Saudi Arabia and how they can be integrated into the education system.

Finally, Proposition 4's suggestion that ESD mediates the relationship between the antecedents for ESD and sustainable development needs to be tested through a quantitative study.

6. Discussion

This study's advanced propositions are consistent with previous research in one way or another. These previous studies include UNESCO in 2015, which relates ESD to SD; Mogensen's [40] concentration on the expansion of skills and activity competence for sustainability; and Hossain, O'Neill, and Strnadová's [19] claim that student well-being is one of the significant factors that contribute to the antecedents of education for sustainable development. In this study, the results show that student well-being influences ESD and, therefore, SD. Hossain, O'Neill, and Strnadová's [19] study results recognized eight overarching realms of student well-being: Purpose at school, Relationships, Negative Emotion (lack of emotion), Positive emotion, Engagement, Accomplishment, Contextual/External factors, and Intrapersonal/Internal factors. All these factors were also found to influence ESD in this study's results.

Moreover, the results are consistent with Semin's [14] competencies of principals in assuring ESD. The competencies, identified as a manageable workload, transparent grading criteria, fairness, a sense of belonging, work–life balance, and mental health support, are the positive and negative behaviors affecting education for sustainability. Furthermore, this study's results are consistent with Wanda et. al. [9] and Fullan's [15] studies, which claimed four factors that lead to a successful ESD system that can equip policymakers with a marked sense of mandate when they carry on the challenge of promoting ESD. Finally, the study results of Bukhari and Khanam [18] revealed that educational performance is highly negatively correlated with depression, which jeopardizes students' well-being; this study's results confirm that in the Middle Eastern context, learners' well-being influences ESD. Hence, the authors argue that the student well-being factors identified through interviews, incorporating manageable workloads, transparency, grading criteria, fairness, a sense of

belonging, work–life balance, and mental health support, make sense since they impact students’ happiness on campus.

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Informed Consent Statement: The authors obtained informed consent from all study subjects, ensuring their confidentiality and demonstrating our commitment to ethical research practices.

Data Availability Statement: Data are unavailable due to privacy or ethical restrictions. The authors informed the interviewees that their data would not be revealed or accessed by anyone other than the researchers, which gave them assurance and protection from any current or future potential harm due to their honest answers on a sensitive topic. The authors agreed with this assurance because they looked to make the interviewees feel secure and comfortable and provide honest answers without fear from anyone. The authors tried hard to know what the interviewees said and did not say. However, their language, tone, and body gestures or reactions can tell us. The authors understand the cultural norms of the conservative society. We study the topics of well-being, ESD, and sustainable development.

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Appendix A

Part 1: Ethical Education for Sustainable Development (University Level) Interview Questions for the interviewees:

- (1) What is the meaning of Education for sustainable Development?
- (2) Why would you think Education for Sustainable Development is critical nowadays?
- (3) How can universities contribute to Education for Sustainable Development?
- (4) How could university educators contribute to Education for Sustainable Development?
- (5) How can university students contribute to sustainability?
- (6) What do you know about the concepts of sustainability and Education for Sustainable Development institutions?
- (7) What do you think is the role of education in university in contributing to sustainable development?
- (8) What are the factors that facilitate the implementation of sustainable initiatives in your institution or Saudi Arabian Education Institutions?

- (9) What are some of the conditions that help to create a stress-free and comfortable studying environment that causally increases subjective well-being and suppresses depressive symptoms for students in university?
- (10) How comfortable studying setting prevent harm to their subjective well-being normally caused by increased studying obligations, assignments, projects, and commitment to multiple assessment tasks?

Appendix B

Part 2: Analysis of the determinants of student well-being: Focusing on the causal effects of a Stress-free and comfortable studying environment:

- (1) What are some of the conditions that help to create a stress-free and comfortable studying environment that causally increases subjective well-being and suppresses depressive symptoms for students in University?
- (2) How a comfortable studying setting acts as a shield, preventing harm to students' subjective well-being that is often caused by increased studying obligations, assignments, projects, and commitment to multiple assessment tasks?

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Article

The Importance of Studying Abroad for a Sustainable Education: Research on Mongolian Student Opinions

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Abstract: Student mobility and internationalization of universities have become an important issue for empowering young people and cultural exchange, in line with the quest for implementing a sustainable education. The young generation of Mongolia has a strong desire to study in foreign universities. The aim of this paper is to analyze the opinions of Mongolian learners on studying abroad as displaying the characteristics of sustainable education. According to our quantitative research, a large percentage of university students are very interested in participating in the ERASMUS mobility program of the European Union. However, there are certain challenges to getting into the program, especially for scholars studying in isolated areas who have limited opportunities to obtain scholarship information. As for the graduates from Mongolia who have already participated in the program, their satisfaction with the program is high. The research found that quality education was the most appraised benefit, while the language barrier posed the main challenge during studying abroad, followed by adaptation to the teaching methods of the host university. Findings show that mobile students developed their academic knowledge and enjoyed experiencing new places and cultures. They also acknowledged improving their professional skills for their future careers and adopting a more sustainable lifestyle.

Keywords: studying abroad; ERASMUS program; Mongolian students; European Union; sustainable higher education



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1. Introduction

Currently, the primary driver of economic advancement lies in a proficient workforce. The capacity to produce an educated workforce is a key factor in the growth of the knowledge economy. Whereas the economy provides knowledge-based goods, higher education supplies and disseminates knowledge. The key role of knowledge for growth makes it imperative to develop higher education [1]. In the Lisbon meeting (2000) of the European Union (EU), it was declared that the aim is to make the EU the most “dynamic knowledge-based economy in the world” by 2010 [2]. In the educational environment, studying abroad was encouraged to incorporate more dynamism, not only for economic reasons, but for its various benefits, such as to develop cultural understanding, to enhance knowledge, and to acquire valuable career skills.

In this context, internationalization of higher education became a major aspect in Europe [3]. The main objectives of exchange programs such as ERASMUS were to foster student mobility within Europe or at international level, and ERASMUS has been very successful in doing so [4]. The first student exchange program between higher education institutions in Europe took place in 1987, and in its first year it already involved 3244 students from all over Europe [5]. The ERASMUS program now comprises several education and

training initiatives alongside the student exchange program, previously called SOCRATES. For over 30 years, students have enjoyed spending semesters in universities abroad under the ERASMUS program [6]. The mobility element encourages students and teachers to gain international experience and leads to deeper collaboration and common projects between universities.

This study analyzes the international mobility of Mongolian higher education students by means of quantitative research from an academic, economic, and social point of view. The paper focuses, in particular, on willingness to study abroad, awareness of scholarship programs, and the benefits and challenges associated with such international mobility with a view to determining the linkage between studying abroad and the development of a sustainable education. The novel character of the research is related to the fact that to the authors' knowledge and according to the literature search performed, there have been no other comprehensive studies conducted on the topic of Mongolian scholars studying abroad and the consequences for the participants.

2. Literature Review

The concept of sustainable education combines economic, social, and environmental aspects, the three pillars of sustainability, into a long-term vision related to education [7,8]. Obviously, it is derived from the two terms of 'sustainability' and 'education', underlining the current necessary shift in thought and behavior to reach a sustainable way of living [9]. According to Sterling (2008), sustainable education means a change in educational culture, which embodies the theory and practice of sustainability in a critically aware manner [10]. Sustainable education challenges society to develop programs that improve quality of life and increase empowerment [11]. As stated by Hays and Reinders (2020), sustainable education is meant to create curricula and methods that instill in people the necessary skills to face challenging environments [12]. Sustainability needs to be embraced in the future as a core paradigm for a quality education [13].

As such, in this paper we uphold the idea of sustainable education as a vehicle for a well-performing, merit-based educational system which is able to sustain itself consistently in the long-term, institutionally and financially, by delivering quality outputs for better and sustainable living.

When judging it from a national framework perspective, sustainable education has been defined in the literature as knowledge delivery that ensures a balanced national development, encompassing both economic and social issues and contributing to fulfilling human needs [14]. The role of quality improvements in education for national economic growth cannot be questioned [15]. If public policy is designed accurately, sustainable education should contribute to higher welfare in social and economic terms for the respective country. The risk is that in an era of globalized relationships, where international education dominates the planet, the primary focus to which education contributes is international development, while national growth remains a by-product, as asserted by Alam et al. [16]. There is a need to increase awareness of a sustainable education, with all its components, with a view to changing attitudes [17] and adopting knowledge and skills for a sustainable future that will change the daily behavior of students [18]. In higher education, the sustainability approach is usually promoted via institutional initiatives and campus activities [19]. A recent survey on Italian students [20] showed that they perceive sustainable education and youth confidence as the major future building blocks for society.

Higher education institutions (HEIs) have a key role in sustainability through equipping future leaders with adequate policy measures to reach the established Sustainable Development Goals (SDGs) [21]. The internationalization of universities, as well as dedicated financial resources for education and research by local and regional authorities, is considered a crucial and integral part of the efforts to achieve the SDGs [22,23].

Nowadays, people in academia have realized the added value of expanding classes away from the solely home university ambiance to fruitful cross-cultural interaction and cooperative project-based learning [24]. The extension of universities' international activi-

ties has increased rapidly in recent years [25,26]. Universities have recognized the benefits of internationalization in the form of enhanced reputation, benchmarking against best practices, and dynamics from diversity [27], and, as such, they have actively encouraged this move, transforming it into a strategic priority [28].

The issue of internationalization in the field of higher education has been extensively commented on in the literature [29–31]. Internationalization has been deemed one of the new types of engagement for ensuring a sustainable higher education [32]. From the Asian continent, China, evidently, has received a lot of attention, with authors showing that internationalizing its higher education has been a government-led effort to enhance the country's position and influence worldwide [33,34]. In a comprehensive review, Tight (2022) has shown that this quest for internationalization has its supporters and critics [35]. It is well known that countries such as Singapore, Taiwan, Korea, and China have registered significant numbers of scholars throughout the years studying abroad, especially in the United States, Australia, or Western Europe. Quality education was pursued by students from developing countries to enhance their prospects [36]. Seeking to boost competitiveness in various fields, these students were expected to apply the advanced knowledge accumulated upon returning to their home countries.

The current paper delves into the possibility of studying abroad using scholarship funding. This encourages a merit-based and wider participation of students from all backgrounds (privileged and underprivileged). Also, it avoids the pitfall of talent migration from East to West, where students use funds from their country of origin to access international education, as Alam (2023) suggests [37]. International mobility of students can be considered an investment for enhancing cultural understanding and sustainability in the present intercultural framework. Moreover, encouraging student mobility is an appropriate policy to increase employability in labor markets impacted by globalization. Indeed, there is more research that demonstrates the positive influence of studying abroad on the students' subsequent work life [38].

ERASMUS is the flagship program financed by the European Union and the most popular international mobility framework for higher education in Europe. Over 4000 HEIs in more than 30 countries participate in the program [39]. The initiative started in 1987 and since then has enabled more than 10 million students from across Europe to pursue valuable learning experiences in other countries [40]. The program's participation rate is on a rising annual trend, with a few exceptions due to external factors such as the recent COVID-19 pandemic. In 2022, the program reached a staggering total of 13.7 million individuals engaged in foreign mobility, as indicated in Figure 1.

Concerning the direction of university student migration, there are 'incoming/inbound mobilities', where foreign students enroll in universities in a specific country, and 'outgoing/outbound mobilities', where students depart from their home country to pursue studies in foreign universities. Within the ERASMUS program, the term 'study mobility' encompasses the movement of various individuals, such as university students and trainees, with the objective of facilitating their academic fulfillment.

Figures 2 and 3 delineate the numbers of student mobilities abroad during the academic year 2022–2023 within the ERASMUS program. The countries with the most significant outbound flows comprise Spain, France, Italy, Germany, and Poland. Conversely, Spain, Italy, Germany, and France have prominent inbound flows. Spain, Italy, Germany, and France emerged as the countries with the highest mobility overall.

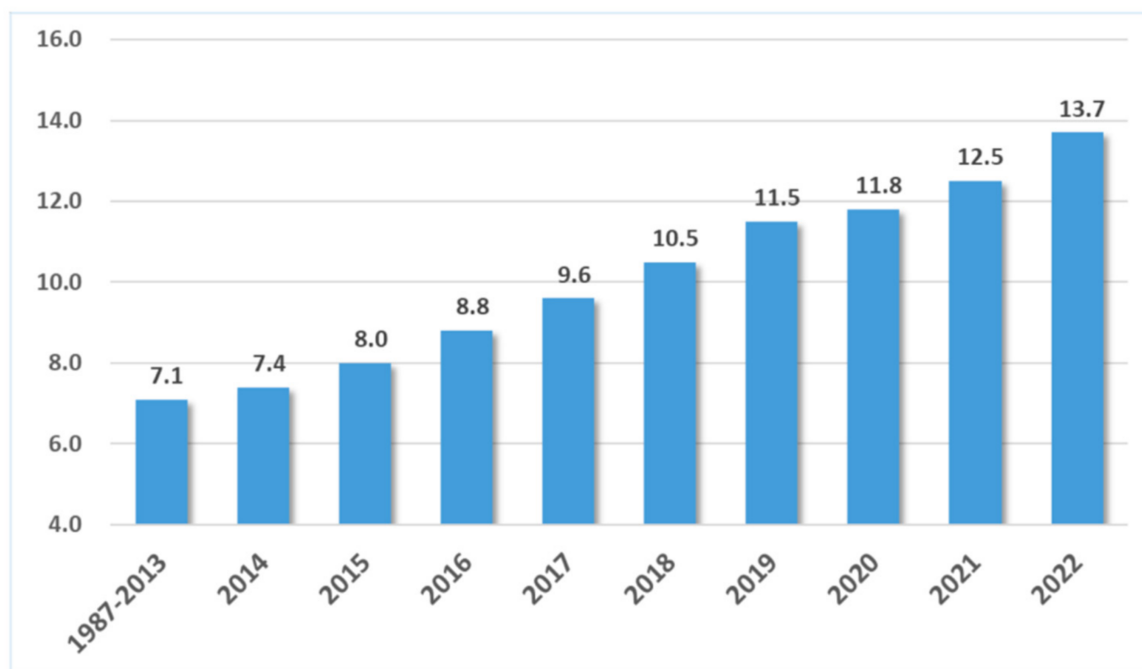


Figure 1. Cumulative ERASMUS mobilities for students and staff (total per year, in millions). Source: ERASMUS Annual Report 2022, European Commission [41].

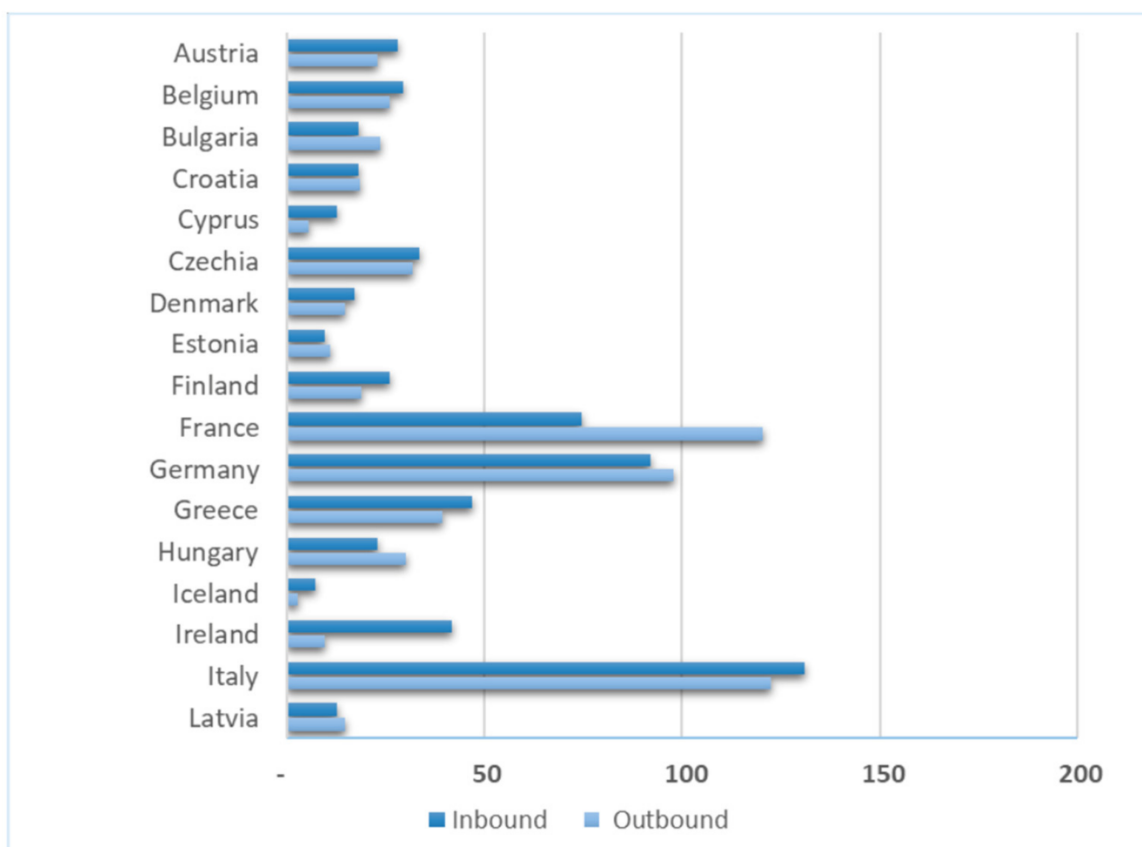


Figure 2. Study abroad mobilities under ERASMUS in 2022, part 1 (thousands). Source: ERASMUS Annual Report 2022, European Commission [41].

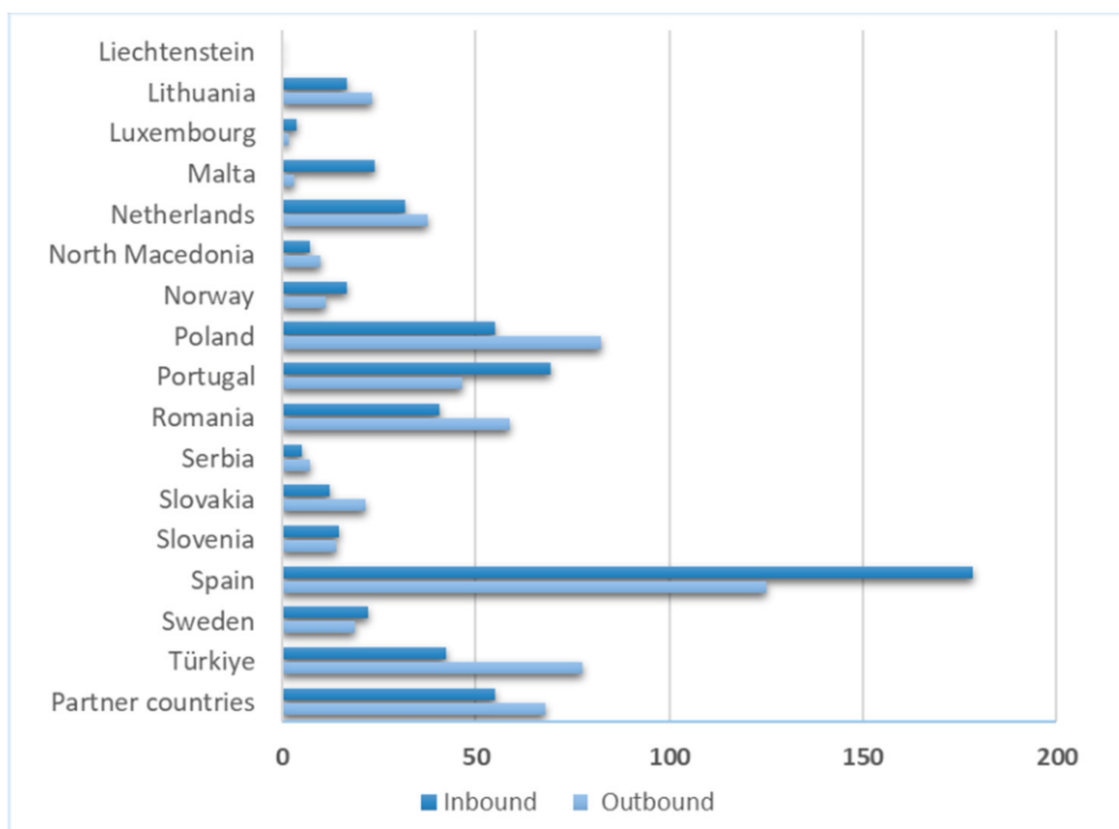


Figure 3. Study abroad mobilities under ERASMUS in 2022, part 2 (thousands). Source: ERASMUS Annual Report 2022, European Commission [41].

After gaining popularity for student mobility inside the European Union, the ERASMUS program expanded internationally when the European Commission launched the KA107 initiative (now called KA171) in 2015. Under this initiative, HEIs from Europe could initiate partnerships with universities around the world for student and staff mobility [42]. Thus, ERASMUS became a true tool of internationalization, and universities in countries such as Mongolia could benefit from incoming and outgoing mobilities financed by the EU in both directions.

In Mongolia, annual scholarship announcements foster bilateral educational cooperation with more than 20 countries through their respective diplomatic missions. Notably, the offer comprises scholarships from 10 European countries. The year 1999 witnessed 5107 students pursuing overseas education, a figure that surged to 27,980 by 2023 [43]. In 2022, some 2345 students were enrolled in European higher education institutions, out of which 10 participants were in the popular ERASMUS program.

Since 1993, the number of government scholarship programs that have been offered every year (see Table 1) has been augmented, and a large number of students have received scholarships in foreign countries. More than 2500 students from Mongolia have been awarded Chinese government scholarships, marking the highest number among countries receiving foreign scholarships. Apart from the scholarships outlined in Table 1, government scholarships from both European and Asian countries maintain their effectiveness. Examples include the Swiss Government Excellence Scholarships, Swedish Institute Study Scholarships, Danish, Italian, Czech, Malaysian, and Korean Government Scholarships, and others.

Table 1. Announced scholarships in Mongolia every year.

	Country	Type of Scholarship	Starting Year	Number of Scholarships Received
1	British government scholarships	British Chevening Scholarships	1993	200
2	United States of America government scholarships	Fulbright Foreign Student Program	1994	1500
3	European government scholarships	DAAD Scholarships for Development-Related Postgraduate Courses	1992	321
		Eiffel Scholarships in France	2013	10
		Hungary Scholarship Program	2013	200
4	Australian government scholarships	Australia Awards Scholarships	1993	700
5	Asian government scholarships	Japanese Government Scholarships	2001	384
		Chinese Government Scholarships–Bilateral Program	2012	>2500
		Taiwan Scholarships	2018	1600
		Türkiye Scholarships	1992	1200

Source: Authors' own compilation from official data.

3. Materials and Methods

3.1. Research Matter

For universities, an elevated percentage of mobile students represents a mark of good reputation and quality education [44].

A large number of European HEIs consider ERASMUS to be a valuable advantage offered to students enrolled in various programs. Of the different ERASMUS components, study mobility is deemed highly relevant for internationalization by 83% of HEIs [45].

Upon closer examination of European preferences among Mongolian students, it was discerned that Germany, France, Austria, and Italy emerged as primary destinations of interest among prospective international scholars. As of 2023, 903 people went to study in Germany, 745 in Ireland, 245 in Hungary, 149 in Italy, and 96 in France [43]. As shown in Table 2, the flow of scholars studying in the latter European countries has been on the rise since the pandemic. Germany, Ireland, and Hungary receive the highest number of students from Mongolia.

Even though there is no centralized official record of how many persons from Mongolia have participated in the ERASMUS mobility program, the EU Delegation to Mongolia has registered the information of around 100 individuals who benefitted from such mobility. Therefore, the research team undertook a questionnaire survey among the experts of the departments responsible for foreign relations and cooperation of the major universities in Mongolia to enquire about the number of participants in the program from those universities.

The major Mongolian universities joined the ERASMUS program at different stages (see Table 3), after signing inter-institutional agreements with universities from the EU. Students from the Mongolian University of Life Sciences were the first to participate in the program in 2009. Thus, it may come as no surprise that this university records the highest cumulative number of students that enjoyed an ERASMUS exchange abroad (37 persons).

Table 2. Number of Mongolian students in selected European countries in the last 5 years.

	2019	2020	2021	2022	2023
Austria	94	16	14	51	68
Belgium	13	3	3	13	8
Bulgaria	23	3	10	6	6
Croatia	4	0	0	7	3
Cyprus	8	2	4	1	5
Czechia	53	14	11	36	56
Denmark	2	0	1	2	5
Finland	7	1	1	5	22
France	69	20	24	67	96
Germany	550	191	278	796	903
Hungary	304	157	269	231	245
Ireland	186	23	112	880	745
Italy	97	34	58	124	149
Latvia	6	0	1	1	0
Netherlands	9	2	1	13	24
Poland	53	6	42	73	30
Portugal	4	0	0	1	1
Romania	14	3	4	5	7
Spain	9	3	4	19	10
Sweden	16	4	8	10	25
Total	1521	482	845	2341	2408

Source: Compiled by the authors from Mongolia National Statistics Office data [43].

Table 3. Participation of Mongolian universities in the ERASMUS mobility program.

	University	Year of Joining the ERASMUS Program	Students Participating in ERASMUS	Students Participating in ERASMUS 2018–2023	Main Study Area of Participant Students
1.	National University of Mongolia	2009	30	20	Mongolian Studies, History and Archeology
2.	Mongolian University of Science and Technology	2016	10	3	Engineering, Architecture and Management
3.	University of Finance and Economics	2016	6	0	Business Administration
4.	Mongolian University of Life Sciences	2009	37	19	Ecology and Economy
5.	Otgontenger University	2017	2	2	Business Administration
6.	CITI University	2014	25	3	Business Administration

Source: Compiled by the authors from Mongolian universities' own data.

In the same year, 2009, the National University of Mongolia joined the program, boasting now a total of 30 participating students. The Mongolian University of Science and Technology and the University of Finance and Economics joined the ERASMUS program later, in 2016. Furthermore, other universities enrolled in the program. Comparing the number of students who participated in study abroad with the total number of students

since joining the program, it can be concluded that the program has increased rapidly in popularity since 2018.

Two distinct categories are delineated based on the duration spent abroad: ‘degree mobilities’, which persist until the attainment of a university degree, and ‘credit mobilities’, which entail continued studies earning credits but lead to the attainment of a degree in the student’s home country. As shown in Table 4, the majority of project proposals submitted by Mongolia were eventually selected. A total of 328 university students, teachers and staff went to European countries between 2015 and 2020. The number of teachers and students moving from European countries to Mongolia was 191.

Table 4. International credit mobilities from Mongolia, 2015–2020.

	2015	2016	2017	2018	2019	2020	Total
Project proposals submitted by Mongolia under ERASMUS	19	25	24	32	38	46	184
Selected projects from Mongolia under ERASMUS	9	15	16	19	36	42	137
Students and staff moving to Europe	30	63	44	60	64	67	328
Students and staff moving to Mongolia	20	29	19	35	43	45	191

Source: ERASMUS for higher education in Mongolia Report, 2020, European Commission [6].

3.2. Marketing Research

The study consists of two main parts. First, the research team investigated the willingness of Mongolian university students to pursue studies abroad, particularly by means of the ERASMUS mobility program. The study also examined whether the information about the program is different in urban and rural universities, and what difficulties students face in participating in the program. In the second part, graduates from Mongolian universities who qualified and participated in the ERASMUS program were asked about their satisfaction with the program and the benefits and challenges they encountered at the host universities. Both parts of the study investigated various traits of sustainable education, such as quality academic activities and outcomes as well as important economic and social aspects, through the lens of Mongolian students.

The research conducted is a quantitative study. The research aims to elucidate the perspective of Mongolian students toward studying abroad. More specifically, the first major aim of the research is to investigate the willingness of Mongolian students to study abroad, their aspirations linked to such an endeavor in line with creating a sustainable education, as well as their understanding of the ERASMUS mobility program, and the challenges associated with taking part in it.

As of 2023, the Mongolian Statistics Office reported a total of 113,322 undergraduate and postgraduate level students enrolled in educational programs [43]. Among them, a sample of 817 students from the top eight universities in Mongolia was surveyed using a quantitative methodology of the opinion poll type, following the directives established by the Ministry of Education. Given these circumstances, it is reasonably justifiable to infer that the selected sample fairly represents Mongolian students at a national level.

The research was structured around the following set of specific objectives in line with its first aim and the paper’s theme:

- Determining willingness to pursue studies abroad;
- Identifying expectations regarding participation in a mobility program abroad;
- Assessing students’ familiarity with the ERASMUS mobility program;
- Determining the common problems of qualifying and participating in the mobility program.

The study was based on the technique of opinion polling, using an online computer-managed questionnaire as the primary instrument for data collection facilitated by Computer-Assisted Web Interviewing (CAWI), a method preferred by the youth [46,47]. To follow the empirical manner of this study, a non-probabilistic method known as the ‘snowball’ ap-

proach was applied for sampling. Specifically, the research focused on full-time university students registered in Mongolian universities.

The research involved 817 undergraduate and postgraduate students who were enrolled in diverse educational programs across eight esteemed higher education institutions in Mongolia. When resorting to sampling, the level of representativeness is typically reflected by the standard error. In this context, the calculated standard error stands at 5%, whereas the confidence level is 95%. Following the collection of data by means of the questionnaire, the information was processed using a dedicated software program (Statistical Package for Social Sciences, Version 16.0).

As to the university students, 10.5% of the cohort originated from the University of Humanities (UH), while 14% were affiliated with the Mongolian University of Science and Technology (MUST), and 10.2% were from the National University of Mongolia (NUM). Additionally, 14.5% represented the University of Finance and Economics (UFE), with 11.8% affiliated with Otgontenger University (OTU), 27.7% coming from the Mongolian University of Life Sciences (MULS), and 11.4% from the isolated areas located on the eastern and western side of Mongolia, namely Khovd and Dornod universities. The gender distribution revealed that 48.5% were male and 51.5% were female participants. Notably, 92.7% of respondents were pursuing undergraduate studies, while the remaining 7.3% were enrolled in postgraduate studies.

A second major aim of the research was to obtain opinions from Mongolian students who had engaged in international ERASMUS mobilities so as to investigate the positive and negative points of such an experience from an academic, economic, and social point of view and to identify the motivations behind students' decisions for choosing particular destination countries for study abroad.

For the second aim, the research questions were grouped around the following specific objectives:

- Determining the primary elements behind the choice of Mongolian students for a specific country;
- Identifying the preferred destinations of Mongolian students for their ERASMUS mobility;
- Establishing the key benefits associated with involvement in the ERASMUS program;
- Identifying the major difficulties experienced by Mongolian students participating in the ERASMUS program.

Specifically, the focus was on university students meeting the research criteria, namely those who undertook outbound ERASMUS mobility from Mongolia. The eventual sample consisted of 43 outgoing students. In this scenario, the computed standard error stands at 10%, with a confidence level of 90%. Considering the statistical population was approximately 100 individuals, the sample size ideally should have been larger. However, this study is preliminary in nature. Participants in the ERASMUS mobility program who were included in the research studied in the 13 countries listed in Table 5. Among them, the highest number of scholars studied in Italy, Poland, Spain, Austria and the Czech Republic.

Due to the exploratory nature of the study, the goal was to gather a large number of filled-in questionnaires from Mongolian students who participated in ERASMUS mobility abroad. The sample encompassed 74.4% female and 25.6% male participants. Among them, 23.3% pursued mobility during their bachelor's cycle, 44.2% during their master's degree, and 32.6% during their doctorate. The age distribution of the respondents is presented in Table 6. Notably, the largest portion (41.9%) falls within the age range of 26 to 35 years, followed by those aged between 36 and 45, constituting 30.2% of the total respondents (see Table 6). According to related research, for most of the countries involved in the ERASMUS program, female students outnumber male students [48].

Table 5. Countries where ERASMUS students from Mongolia undertook mobility.

Country	Female	Male	Frequency	Percent	Valid Percent	Cumulative Percent
Austria	1	3	4	9.3	9.3	9.3
Bulgaria	1	2	3	7.0	7.0	16.3
Czechia	3	1	4	9.3	9.3	25.6
France	3	0	3	7.0	7.0	32.6
Finland	2	0	2	4.7	4.7	37.3
Germany	2	0	2	4.7	4.7	42.0
Italy	8	1	9	20.8	20.8	62.8
Poland	2	3	5	11.6	11.6	74.4
Portugal	1	1	2	4.7	4.7	79.1
Romania	1	0	1	2.3	2.3	81.4
Türkiye	2	0	2	4.7	4.7	86.1
Spain	5	0	5	11.6	11.6	97.7
Netherlands	1	0	1	2.3	2.3	100
Total	32	11	43	100	100	

Source: Authors' own research.

Table 6. Age of the surveyed respondents.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18–25 years	5	11.6	11.6
	26–35 years	18	41.9	53.5
	36–45 years	13	30.2	83.7
	46 years and above	7	16.3	100
	Total	43	100	100

Source: Authors' own research.

4. Results

The first part of the study analyzes the aspirations and motivations of Mongolian students to pursue studies abroad in order to enhance their education and improve their career prospects. Elements that impact the motivation of students toward mobility abroad vary on a country basis, depending on economic, social, and cultural features [49]. In recent years, the desire of students and young people to study in foreign universities has grown rapidly.

The majority of undergraduate and graduate students in our survey expressed their willingness to study in a foreign university. A notable observation from the research is the substantial interest expressed by a majority of 82.7% of participants in pursuing academic opportunities abroad within their respective fields, a high-quality education being the major driver (Table 7).

When asked about their preferred study destinations, a total of 32.4% of all respondents expressed a desire to study in European countries. Meanwhile, 27.7% of students indicated an interest in studying in Asian countries, 27.1% in America, and 11.3% in Australia. Only 1.5% of respondents selected other options. There is no essential difference in educational level concerning the regions where students are interested in studying abroad (Table 8).

Table 7. Willingness to study in foreign countries.

		Do You Want to Study in a Foreign Country?			Total
		Yes	No	Don't Know	
Education level	Bachelor	78.2%	8.1%	6.4%	92.7%
	Master	4.5%	0.2%	2.6%	7.3%
Total		82.7%	8.3%	9.0%	100%

Source: Authors' own research.

Table 8. Preferred region for study abroad.

		Which Region Are You Interested in Studying in?					Total
		America	Europe	Asia	Australia	Other	
Education level	Bachelor	25.2%	30.1%	25.6%	10.4%	1.3%	92.7%
	Master	1.8%	2.3%	2.1%	0.9%	0.2%	7.3%
Total		27.1%	32.4%	27.7%	11.3%	1.5%	100%

Source: Authors' own research.

When students evaluated their knowledge and information about the ERASMUS mobility program, 3.1% answered “very good”, 5.8% “good”, 14.3% “acceptable”, 18.2% “poor”, and 58.6% “very poor”. In other words, 76.8% of the students do not know the program. Although students want to study in European countries, it is common that they do not have information about ERASMUS mobility, a major program for studying abroad. Looking at this by grade, knowledge of the program increases as the grade progresses, with students in grades 1 and 2 having the least knowledge of the program (Table 9).

Table 9. Knowledge about the ERASMUS mobility program.

		Very Good	Good	Acceptable	Poor	Very Poor	Total
Grade	Freshman	1.1%	2.0%	5.6%	8.0%	26.8%	43.5%
	Sophomore	1.2%	1.6%	4.2%	5.8%	15.8%	28.5%
	Junior	0.6%	1.7%	3.4%	3.5%	11.1%	20.4%
	Senior	0.1%	0.5%	1.1%	1.0%	4.9%	7.6%
Total		3.1%	5.8%	14.3%	18.2%	58.6%	100%

Source: Authors' own research.

A significant majority of students (76.5%) expressed support for the ERASMUS mobility program (see Table 10). There is notably high anticipation among them for their university to offer opportunities to participate in the program.

Table 10. Willingness to participate in the ERASMUS mobility program.

		If the School You Are Studying in Offered a Long-Term Exchange Program to Study in European Countries, Would You Choose to Study Abroad?			Total
		Yes	No	Don't Know	
Education level	Bachelor	70.0%	6.6%	16.0%	92.7%
	Master	6.5%	0.4%	0.5%	7.3%
Total		76.5%	7.0%	16.5%	100%

Source: Authors' own research.

Table 11 highlights the top 10 countries in which the students surveyed would like to study. Germany (17.7%), France (11.4%), Austria (6.9%), Italy (5.9%), and Ireland (4.0%) received the most votes as the European countries where students would like to study. No major differences toward the preferred countries were found according to the educational level of students. However, the majority of engineering students were interested in studying in Germany.

Table 11. Ranking of countries as the preferred destination for study.

	Countries	Number	Percent
1.	Germany	145	17.7%
2.	France	93	11.4%
3.	Austria	56	6.9%
4.	Italy	48	5.9%
5.	Finland	33	4.0%
6.	Ireland	33	4.0%
7.	Sweden	32	3.9%
8.	Switzerland	28	3.4%
9.	Belgium	26	3.2%
10.	Hungary	25	3.1%
11.	Other	298	36.5%

Source: Authors' own research.

More than 51% of participants pointed out that foreign language skills will improve while studying in foreign universities. Also, 40.3% of respondents recognized the importance of getting to know a new culture and studying in a new place, while 36.4% emphasized improving academic knowledge and successful learning (Table 12). This perspective encompasses the expected social and economic development of individuals, and is closely associated with the holistic benefits of a desired sustainable education in the home country.

Table 12. The importance of studying abroad.

		Education Level		Percent of Cases
		Bachelor	Master	
Importance of studying abroad	Increasing knowledge of foreign languages	48.3%	3.1%	51.4%
	Making new friends	26.5%	1.6%	28.1%
	Better learning	33.5%	2.8%	36.4%
	Getting to know new cultures and places	36.7%	3.6%	40.3%
	Other	11.2%	0.7%	11.9%
Total		92.6%	7.4%	168.1%

Source: Authors' own research.

The study conducted among university students from isolated regions in Mongolia, specifically Khovd University in the west and Dornod University in the east, revealed significant challenges stemming from their remote location. Limited access to the internet and occasional lack of information regarding study opportunities abroad were identified as major hindrances.

Despite these obstacles, an overwhelming majority of participants, comprising 89.2% of the total sample, expressed a strong desire to pursue studies abroad within their respective

fields of study. However, a significant issue emerged as their majors did not align with available scholarship programs (Table 13).

Table 13. Challenges to study abroad for participants in a mobility program.

	The Universities						Universities in Isolated Areas	Percent	Percent of Cases
	UH	NUM	MUST	UFE	MULS	OTU			
Language difficulties	2.3%	2.0%	2.3%	3.0%	9.5%	3.1%	6.5%	28.7%	44.0%
Financial difficulties	2.4%	3.2%	5.0%	3.7%	6.3%	3.2%	6.2%	30.0%	46.0%
Lack of information	2.1%	1.3%	1.0%	3.1%	5.7%	1.3%	3.7%	18.2%	27.9%
Scholarship criteria	2.1%	0.7%	1.7%	2.2%	3.5%	0.6%	3.0%	13.8%	21.2%
University requirements	1.2%	0.5%	0.7%	1.2%	2.8%	0.6%	2.3%	9.0%	14.3%
Total	10.1%	7.7%	10.7%	13.2%	27.8%	8.8%	21.7%	100%	153.4%

Source: Authors' own research.

Financial constraints were cited by 46% of participants as an important hurdle. Furthermore, language barriers emerged as a notable challenge for 44% of participants, while 27.9% encountered obstacles associated with information accessibility when considering educational pursuits abroad. Fairly similar results on the challenges encountered can be found in the study of Tuvshingerel (2012). The financial outlay of Mongolian students abroad reveals expenditures ranging from 0.8 to 16.8 thousand dollars for tuition fees and 3.0 to 12.0 thousand dollars for personal expenses, resulting in an aggregate expenditure between 4.6 and 27.5 thousand dollars [50]. According to the results of our research, students ranked financial difficulties in the same position, which sheds light on the fact that to establish sustainable education, policy makers definitely need to ensure a solid financial background as a starting base for academic performance.

The second part of the study investigates the attitudes and expectations of Mongolian students concerning their decision to pursue studies abroad. These factors encompass various elements, including the prestige of the HEI based on its teaching and research endeavors, the appeal of the host country, associated expenses, employment prospects, as well as the presence of relatives and friends in the destination country. The benefits and challenges to studying abroad are associated with the economic and social aspects included in sustainable education. To investigate these factors, the authors employed the analysis of dichotomous responses. No missing data were found regarding the variable pertaining to the attitude toward participating in ERASMUS, and no discernible gender disparities were observed in the motivations for participation.

Recognizing the pivotal emotional drivers influencing university students' decisions to opt for studying abroad, alongside improving the conditions for mobility, is crucial for formulating educational policies, regulations and guidelines aimed at attracting a wider participation in such programs. Such experiences yield societal, economic, and professional development benefits, enhancing academic performance and refining students' skills, while also fostering the cultivation of empathetic international attitudes conducive to cooperation.

When delving into the realm of international scholarships, some essential aspects to examine are the emotional motivations guiding university students toward pursuing a period of studying abroad. Upon examining the motivations behind students' decisions to engage in academic mobility abroad, besides the appeal of the chosen country and the prestige of the host university, a significant majority of respondents (32.6%) opted for the academic offering and the scholarship itself. The second most prevalent rationale was the willingness to study abroad, with master's and bachelor's students particularly expressing a desire to study in foreign country.

An intriguing discovery was that the prestige of the host university was perceived twice as significant by doctoral candidates compared to bachelor's students, a trend likely

attributed to the greater maturity in their educational journey. Master's students did not consider university reputation to be a decisive factor. Another factor is the country chosen for study. Master's students, especially, considered specific countries in which to pursue their academic endeavors. Only a small fraction of individual respondents, constituting 7%, cited proximity to family and relatives in the destination country as a motivating factor for studying abroad (Table 14).

Table 14. Reasons for the choice of studying abroad.

	Study Cycle			Total Responses	Cumulative Percent
	Bachelor	Master	PhD		
A particular country	0.0%	14.0%	2.3%	16.3%	16.3%
University reputation	4.7%	0.0%	7.0%	11.7%	28.0%
Scholarships and invitations to study in certain universities	7.0%	14.0%	11.6%	32.6%	60.6%
Acquaintances in the host country	2.3%	4.7%	0.0%	7.0%	67.6%
Willingness to study abroad	9.1%	11.6%	7.0%	27.7%	95.3%
Other	0.0%	0.0%	4.7%	4.7%	100%
Total	23.1%	44.3%	32.6%	100%	

Source: Authors' own research.

The predominant desires expressed by respondents in connection with studying abroad were to acquire valuable information and enhance academic performance for future career prospects, alongside the desire to explore new locations and immerse oneself in a different culture. These motivations, central to the idea of building a sustainable education in the home society, were equally distributed between genders. A majority of 95.3% of respondents opted for gathering precious knowledge and improving their academic record, which would be useful for their professional career, as the main expectation, with a slightly higher frequency for males. Another major expectation revolved around exploring novel destinations and becoming acquainted with a diverse culture, as indicated by 53.5% of participants in the ERASMUS mobility program. Additionally, 37.2% of respondents anticipated forming new friendships, while 25.6% were drawn to the opportunity to learn a new language while studying abroad (Table 15).

Table 15. Expectations related to the period of studying abroad.

	Gender		Total Responses	Percent of Cases
	Male	Female		
Accumulate knowledge and enhance academic profile	10.9%	33.7%	44.6%	95.3%
Learn a new language	2.2%	9.8%	12.0%	25.6%
Make new friends	6.5%	10.9%	17.4%	37.2%
Experience new places and cultures	6.5%	18.5%	25.0%	53.5%
Other	0.0%	1.1%	1.1%	2.3%
Total	26.1%	73.9%	100%	214%

Source: Authors' own research.

During their adjustment to studying abroad, students encounter a variety of emotional and behavioral obstacles throughout their time in the host country. Various studies have acknowledged such adjustment difficulties [51]. When questioned about the primary challenges they encountered, participants expressed significant difficulties with insufficient

proficiency in the language (35%), adjustment to educational methods and assessment techniques (17.5%), and assimilating into the university setting and academic approach (15%).

Interacting and collaborating with instructors and peers (15%) and adjusting to a different cultural environment (12.5%), including hurdles in forming social connections and exploring unfamiliar locales, were also cited (see Table 16). However, some of the participants answered that they did not experience any difficulties while participating in the mobility program (20% of cases).

Table 16. Challenges during the period of studying abroad.

	Study Cycle			Total Responses	Percent of Cases
	Bachelor	Master	PhD		
Lack of proper language skills	5.9%	11.8%	9.8%	27.5%	35.0%
Adapting to a new culture	2.0%	3.9%	3.9%	9.8%	12.5%
Adapting to the university environment and learning style	2.0%	5.9%	3.9%	11.8%	15.0%
Adapting to school procedures and assessment methods	5.9%	2.0%	5.9%	13.7%	17.5%
Communicating and cooperation with teachers and students	0.0%	3.9%	7.8%	11.8%	15.0%
Other	0.0%	5.9%	3.9%	9.8%	12.5%
None	3.9%	5.9%	5.9%	15.7%	20.0%
Total	19.6%	39.2%	41.2%	100%	127.5%

Source: Authors' own research.

Finally, 12.5% of graduates faced various other challenges, citing issues such as difficulties in finding accommodation, socializing and exploring new places in the host country, all exacerbated by the COVID-19 pandemic and associated curfews, which had strong negative effects on mobility programs, including ERASMUS. Once campuses were locked down, international scholars studying abroad experienced a shocking revelation far from their familiar home environment. Even if they were in need of assistance, most HEIs were unprepared for a serious health situation and had to improvise to keep the ERASMUS program going for both incoming and outgoing students [52]. In COVID-19 times, 60% of universities switched to online mobilities instead of physical mobilities [53]. During the COVID-19 confinement, students found themselves in a new situation, one they had never faced before [54]. In such a period of crisis, many students experienced more than the usual emotional, social, financial and legal obstacles that influence their decision on studying abroad [55].

For a study mobility to be considered successful by participants, certain factors pertaining to the host university must be effectively implemented and addressed. A significant majority of respondents regarded the educational aspect, encompassing overall quality of methodology, learning infrastructure and the student–teacher dynamic, as the most gratifying facet of studying abroad (56.1% of cases). Additionally, over a quarter of the participants perceived the school environment and dormitory services favorably (26.8% of cases), with positive evaluations also extended to the relation between teachers and administrators (14.6% of cases). Along with the arrangement of excursions for students (9.8% of cases), the existence of shows and events on the campus (7.3% of cases), and the canteen services (4.9% of cases) were also valued. There were no significant discrepancies between responses from university students at the three levels (Table 17).

Table 17. Appreciated services at the university where studying abroad.

	Study Cycle			Total Responses	Percent of Cases
	Bachelor	Master	PhD		
Education (quality)	12.2%	18.4%	16.3%	46.9%	56.1%
Accommodation conditions	6.1%	10.2%	6.1%	22.4%	26.8%
Canteen/Food	4.1%	0.0%	0.0%	4.1%	4.9%
Communication with administrative services	2.0%	8.2%	2.0%	12.2%	14.6%
Organized shows and events	4.1%	2.0%	0.0%	6.1%	7.3%
Other extracurricular activities	2.0%	4.1%	2.0%	8.2%	9.8%
Total	30.6%	42.9%	26.5%	100%	119.5%

Source: Authors' own research.

When asked about the stressful aspects related to studying abroad, two primary issues emerged in students' responses. Several students expressed dissatisfaction with educational services (39.4% of cases), especially concerning the difficulty of exams, organization of information, and diverging teaching methods, with a consistently high rate reported across all three academic levels. Master's and doctoral students rated high their dissatisfaction with extracurricular activities (27.9% of all cases). Unlike the other two academic levels, over 10% of master's level students were negatively impressed by the communication with the management staff (Table 18).

Table 18. Non-appreciated services at the university where studying abroad.

	Study Cycle			Total Responses	Cumulative Percent
	Bachelor	Master	PhD		
Education (difficulty)	7.0%	18.6%	13.8%	39.4%	39.4%
Accommodation conditions	4.7%	4.7%	0.0%	9.4%	48.8%
Canteen/Food	2.3%	2.3%	4.7%	9.3%	58.1%
Communication with administrative services	2.3%	4.7%	0.0%	7.0%	65.1%
Organized shows and events	4.7%	2.3%	0.0%	7.0%	72.1%
Other extracurricular activities	2.3%	11.6%	14.0%	27.9%	100%
Total	23.3%	44.2%	32.5%	100%	

Source: Authors' own research.

Asked about their satisfaction with the ERASMUS mobility program, a majority of 81.4% of participants reported being completely satisfied, 16.3% expressed satisfaction exceeding 75%, and 2.3% indicated satisfaction levels ranging from 51% to 75% (see Table 19). No answers were recorded for satisfaction levels under 50%, meaning that none of the respondents had strong reasons to dislike the study abroad experience.

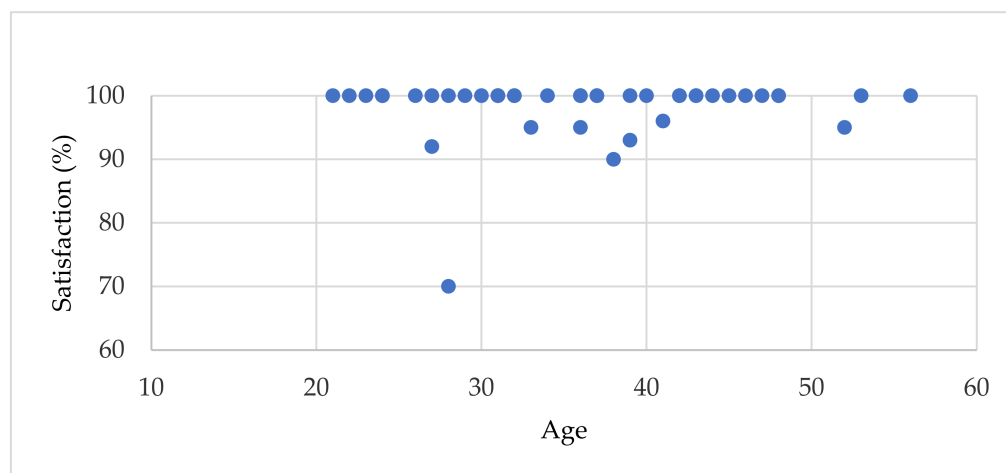
The interrelationship between satisfaction with study abroad and age of participants was investigated and illustrated by means of a scattergram (Figure 4).

Interestingly, the level of satisfaction increases with age: youngsters between 26 and 35 reported some cases of moderate satisfaction, more mature students at master's level (36–45) showed a higher level of general satisfaction, while senior doctoral students (over 46) were the most satisfied with the experience of studying abroad.

Table 19. Satisfaction resulting from participating in the ERASMUS mobility program.

	Number of Students	Percent of Cases
100%	35	81.4%
76–99%	7	16.3%
51–75%	1	2.3%
26–50%	0	0
Under 25%	0	0
Total	43	100%

Source: Authors' own research.

**Figure 4.** Scattergram of the relationship between satisfaction rating and age of respondents. Source: Authors' own research.

When relating satisfaction level with the host country of the mobility by means of clustering the respondents for the countries with higher representation, more in-depth conclusions emerged. Students who undertook mobility in France expressed 100% satisfaction. Very close, Italy and Austria displayed almost total satisfaction, with a few exceptions, related to the assessment methods used in the host university. In the case of Poland, a notable outlier appeared due to communication problems with fellow colleagues and teachers, while Spain showed a lower satisfaction level compared to other countries, typically because accommodation conditions were considered not entirely suitable by the students who pursued a mobility there (Figure 5).

The research infers that students from Mongolia who participated in the ERASMUS program were highly satisfied and felt that it had a positive impact on their careers. A last query was concerned with the influence of the period of study abroad on adopting a sustainable way of living, from an economic, social, and environmental point of view. Consistent with the main traits of sustainable education, the majority of respondents (93%) were in favor of this outcome, while only 7% rejected it. The scholars viewed their period of study abroad as a valuable investment to enhance the quality of their education, perform better in their future career, including employment prospects, and adopt a more environmentally friendly lifestyle in their personal life.

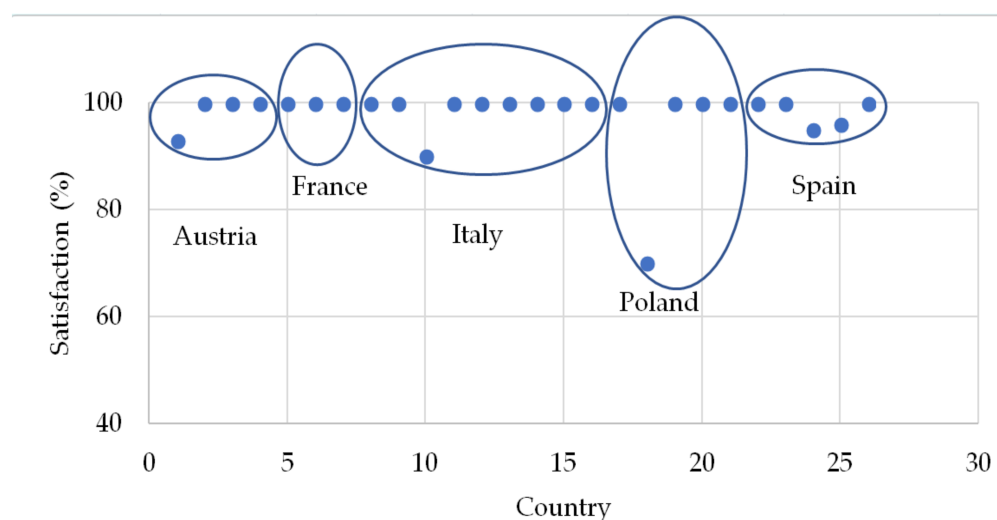


Figure 5. Scattergram of the relationship between satisfaction rating and destination country. Source: Authors' own research.

5. Discussion

Studying abroad is expected to have a valuable impact on the economic and social development of participants and their respective communities. The experience and good practice gathered while studying in a foreign country and environment is a key component of a sustainable education, leading subsequently to a sustainable way of living in the home society. Naturally, ERASMUS-supported temporary study in a European country should have a positive influence on the students' life and career after graduation, notably on their employment and work, but also on their social activities as citizens, on their family life, and in other areas [56].

In our research, the most positive outcomes among participants in ERASMUS mobilities were related to personal and professional development, cultural enhancement, and foreign language skills. Accumulating knowledge in the form of quality education was cited by Mongolian students both as a perceived benefit by those desiring to study abroad as well as a real-time experienced benefit by those who had already undertaken ERASMUS mobilities. This is consistent with findings from a study on Turkish students who stressed academic, professional, and individual development as the salient benefits of studying abroad [40]. The competitive side of the academic career was perceived as a main asset by Singapore and Malaysian students as well [35]. In contrast, Australian students appreciated the practical experience most [27]. The sharing of cultural ideas and values, appreciated by Mongolian students, was highlighted as a key benefit of studying abroad in the seminal paper by Teichler (2004), alongside international communication and discourse [56].

An international mobility to the EU has, moreover, a Europeanization effect in as much as it influences the social profile of students [57]. It is also reasonable to assume that participants in the mobility program will enjoy an increased knowledge of the EU [58] and its values, such as inclusion and diversity, active participation in democratic life, and the fight against climate change. The findings also revealed that Mongolian students achieved a better environmental awareness after their study period abroad. These characteristics form a solid ground for establishing a sustainable education in the students' home countries.

However, as the present research revealed, there are many obstacles to studying abroad, with financial and linguistic the most prominent ones, followed by lack of information and difficulty in adapting to academic methods in the host university. The link between student attitudes and their reasons to study in a foreign country were analyzed extensively by Sanchez, Fornerino, and Zhang (2006) using expectancy theory. The results included four categories of obstacles, familial, financial, psychological, and social, irrespective of the nationality of students. The motivations were also similar, albeit the particular combination of stimuli for studying abroad varied on a country basis [59]. Using a large database

of students from seven European countries, Souto-Otero et al. (2022) also captured the financial barriers as an overall challenge when pursuing study abroad, followed closely by personal barriers, such as comfort factors, anxiety, and lack of proper information [39].

In contrast, Chinese students raised concerns about the dominance of the English language as a challenge related to studying abroad, fearing also that internationalization will lead to 'Westernization' [35]. In a broader context, several authors stressed the difficulty of recognition of qualifications as a challenge following study abroad and the more subtle consequences of a possible 'brain drain', with affluent and well-prepared students being lured by recruitment offices of fee-based top universities [28,37].

Regarding long-term exchange programs offered by their respective institutions to study in European countries, an impressive 84.9% of respondents indicated their willingness to participate. The findings emphasize the keen interest among students of isolated universities in seizing international academic experiences, despite the challenges posed by geographical constraints. Expanding opportunities for young students not only secures their brighter future but also profoundly influences national development by means of a sustainable education. Specifically, revitalizing rural areas necessitates ensuring equal access to information for young individuals residing, learning, and working in underprivileged regions. The escalating urban–rural gap stemming from rural depopulation demands focused attention. Interestingly, students exhibited a great interest for the ERASMUS mobility program. This finding highlights the students' proactive engagement with international opportunities via scholarships.

An ERASMUS impact study [45] shows that 92% of companies are looking for personality characteristics such as confidence, communication skills, problem-solving, tolerance, and decisiveness when making a recruitment decision. Various tests demonstrate that ERASMUS students display a better mastery of these characteristics. After their study period abroad, the difference in values obtained in tests rises by 42% compared with the student average. ERASMUS students are half as likely to experience unemployment compared to their home peers, and a reasonable time after graduating, their unemployment rate is significantly lower. This is consistent with the economic component of sustainable education, demonstrating the proof of a better financial outcome for the graduates who have undertaken a period of study abroad within the mobility program.

Given the limitations of the present research, which was centered only on the Mongolian case and had a relatively small sample size, the authors intend to build on the findings by conducting a more extensive, grounded study in the future, incorporating a broader sample that includes students from other Asian countries involved in exchange programs for studying abroad with the European Union. Such a study will also enable valuable cross-cultural comparisons for future directions in this research area.

6. Conclusions

Studying abroad is an enriching learning experience because of the active engagement of students with other people in the new environment [60]. This research contributes to the literature of internationalization of higher education by means of a quantitative study conducted among Mongolian students in the broader context of advancing the sustainable character of education. By adopting and applying the best practices of host countries in terms of economic, social, and environmental aspects, such students form the backbone of a sustainable education meant to increase the development of their careers in the home country.

In recent years, a significant proportion of high school graduates in Mongolia have desired to study at foreign universities. The results of the present research show that the majority of Mongolian students want to study in European countries. Despite the students' interest in studying in EU member states, they commonly lack awareness of the ERASMUS mobility program, even if this constitutes a significant opportunity in this direction. When compared to other scholarship programs in Mongolia, enrollment of students in the ERASMUS program appears disproportionately low, especially in underprivileged areas,

highlighting the need for heightened awareness and better preparation among students in the future to diminish their potential fears stemming from an information gap. This calls for a stronger nationwide information campaign on behalf of European institutions as well as Mongolian universities and the Ministry of Education, to promote the significance and the benefits of the program, including in the isolated areas. Policy makers in education should also consider complementing the various scholarship schemes from abroad with national funds to increase affordability and to overcome the financial barrier, which emerged from the study as the main deterrent for enrolling in a study program abroad. As a positive sign, investigating the major Mongolian universities which were represented in the research, there is an obvious rising trend of students who have participated in the program during the last five years.

As part of the research, the opinions of graduates who undertook an ERASMUS mobility were surveyed. Overall, the majority of graduates who participated in the study were female. This is a fact not limited to this program; other scholarship programs also have a majority of women. Another academic paper [48] highlighted the same gender disparity, noting that female students were better represented in the ERASMUS mobility program. Graduates were expected to develop their academic skills, improve their professional skills, and experience new places and new cultures. The language barrier was the most pressing problem for the graduates during their period of study abroad, and the second was adaptation to the teaching methods of the host country. Some alumni, especially scholars who were studying abroad during the year 2020, pointed out that due to the COVID-19 pandemic, it was very difficult for them to learn online, find a place to stay, get to know new places, and communicate with people. However, the vast majority of graduates from Mongolia who have participated in the mobility program abroad declared themselves highly satisfied, with satisfaction rating increasing with the age of respondents.

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Article

Teaching Sustainability through Traditional Sporting Games

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Abstract: Traditional sports games (TSGs), deeply rooted in local culture, serve as valuable resources for educating in sustainable development, aligning with guidelines set forth by international resolutions such as the Agenda 2030. This study investigated how ethnomotor variables in the educational use of TSGs with objects influenced emotional well-being and the acquisition of significant and contextualised physical and social sustainability learning involving various educational agents. The study adopted a qualitative and inductive approach centred on an ethnomotor intervention to promote sustainable learning within and beyond the educational setting. A total of 226 primary school students aged between 11 and 12 from seven primary education centres in the Canary Islands, Spain participated. Seven intervention sessions were conducted, including out-of-school activities involving family members and in-school activities with the collaboration of teaching staff and a specialised researcher. Various data collection instruments were employed (field notes, questionnaires, and interviews). A content analysis of qualitative data was conducted and subsequently transformed into quantitative data. For statistical analyses of these data, multidimensional frequency areas, crosstab (Pearson's chi-square), associated effect size (Cramer's V), and decision trees were utilised. This research discusses the relevance of TSGs as tools for promoting physically and socially sustainable learning. Furthermore, the role of various educational agents, including family members, teachers, and teacher-researchers, in developing these experiences is highlighted. The findings also highlight emotional well-being (psychosocial and socio-emotional affectivity) as a key aspect in the process of meaningful and contextualised sustainable learning.

Keywords: sustainable development; ethnomotricity; cultural heritage; Agenda 2030; quality education



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1. Introduction

1.1. Traditional Games, Resources to Educate Physical and Social Sustainability in a Contextualised Way

Traditional games (TGs) stand as extraordinary resources for fostering sustainable development goals in support of quality physical education [1–4]. TGs are motor practices deeply rooted in local culture [5], passed down following traditional customs and practices. In the Canary Islands, where this study was conducted, TGs involving objects represent a significant facet of traditional recreational culture. These TGs have fostered sustainability from a dual perspective, both environmental and physical or social [6].

Through TGs, children learn to maintain a respectful relationship with the physical environment. Prior to playing, TGs activate two processes linked to physical sustainability: (a) sourcing objects from the natural (e.g., stones, bones, branches, herbs, fruits, or reeds) or domestic environment (e.g., ropes, wheels, sacks, brooms, needles, shoes, or handkerchiefs), and (b) crafting those hand-made materials in an artisanal manner (for example, making stilts using rope and paint cans). Retrieving, recycling, and reusing are three key verbs in sustainable learning.

TGs trigger bodily techniques that educate players' subjectification [7]; through positive interaction with the material environment, young individuals undergo an affective bodily experience, enabling them to understand and construct their social and cultural identity. Through material subjectification, game objects acquire a cultural significance that contributes to individual formation. A spinning top, a marble, or a ball are not merely physical artefacts, but also carriers of meanings, signs, and messages about local culture [8].

Traditionally, these actions are performed with other individuals, family members (siblings, parents) or friends, activating the second dimension corresponding to socially sustainable learning [9,10]. Thanks to social interaction with others, each participant learns to identify the best places and materials for carrying out the artisanal construction process of game objects. In this interpersonal perspective, bodily techniques foster social subjectification, the process by which individuals internalise the signs and values inherent in interpersonal relationships in their society [8].

Interaction with others provides a safe social environment for individuals to subsequently personalise their game objects uniquely (with unique shapes, sizes, and colours). This aims to enrich the process of physical subjectification in an emotional approach.

Once the object is completed, it is customary to showcase the game object to the rest of the community, thus culminating the entire process and utilising it in a wide variety of motor situations shared with the rest of the class group. In this case, these actions have a direct relationship with social subjectification.

This journey through material culture leads individuals to share a sustainable relationship with the environment and themselves (environmental subjectification or sustainability) and to foster a sustainable relationship with others (social subjectification or social sustainability).

This inseparable pairing that accompanies the process of subjectification of sustainable learning makes it possible for individuals to acquire learning with a sense and meaning within the context of the local culture where they occur [2]. It involves contextualised sustainable learning [11].

1.2. Educating Sustainable Learning through an Ethnomotor Approach

The theory of motor action or motor praxeology coins the concept of ethnomotricity to refer to the "field and nature of motor practices, considered from the standpoint of their relationship with the culture and social environment in which they have developed" [12].

The contextualised study, i.e., from an ethnomotor perspective, of the effect of TGs on the education [13] of physical and social sustainability requires combining the concepts of the internal and external logic of TGs [12,14–17]. Each TG has an internal organisation pattern or identity card corresponding to a unique way of establishing internal relationships with other participants, with space, with time, and with objects. Players participating in any TGs must adapt their interventions to their internal logic. In the case of TGs involving objects, adaptation requires performing motor actions uniquely using objects when interacting with others (e.g., passing the ball to a teammate or hitting an opponent with a handkerchief), with space (e.g., moving an object across the squares of a hopscotch game), and with time (e.g., having three attempts to throw clubs at six pins, or flying a kite in the sky for as long as desired).

Each of the motor actions that activate the internal logic of a TG are contextualised in external conditions to the rules of that TG, i.e., a unique external logic. The internal logic (IL) corresponds to the sociocultural conditions in which TGs are carried out, referring to the students (according to age, gender, or social condition), to the areas or places where it is performed (specific installation or space in a locality or nature), to practice moments (time of year, week, and day, and the presence or absence of a festive calendar), and to the materials used (origin and method of elaboration of objects).

The ethnomotor vision intertwines the internal and external features of TGs, i.e., their internal logic with external logic, and the text with the context. This pairing is an essential requirement for educating physical and social sustainability.

The usual context of TGs is the street, the square, or the place where people coincide in their daily activities. Values and learning occur outside of school; these are contexts of non-formal or informal education. The master of TGs is the game itself, taking shape thanks to agents responsible for transmitting traditional knowledge (family members or friends).

From this perspective, the major challenge for any educator or researcher wishing to introduce TGs in school and use them coherently is to promote sustainable learning and education that is meaningful for students. How can the introduction of TGs in school or formal education be compatible with the fundamental knowledge that occurs outside and in non-formal or informal contexts?

This study addresses this challenge by investigating the impact exerted by an ethnomotor educational experience. The involvement of several educational agents is essential to this process.

1.3. Educational Agents to Promote Sustainable Learning: Multidimensional Approach

To ensure that the intervention is coherent, the UN guidelines [18,19] must be followed. The UN established 17 sustainable development objectives in its 2030 agenda. One of these objectives is promoting quality education.

From the ethnomotor perspective [20], all groups of people who actively participate in building sustainable learning are considered educational agents. In this study, we have selected four agents that intervene outside and inside the school:

- (a) The students are the main participants and recipients of this educational process. Students actively intervene in the different phases.
- (b) The familiars are people close to the student (grandparents, fathers, and mothers) who intervene as the main agents in actions outside the school. Familiars guide, advise, and transmit fundamental knowledge in the immediate environment (house, square, nature).
- (c) The teachers. They are the official agents at schools, in charge of pedagogical actions with the students.
- (d) The teacher-researcher. This agent, a specialist in the use of TGs with objects, introduces TGs in schools, advises teachers and students, and is responsible for using a variety of instruments and procedures to obtain data from the educational process, perform analysis, and generate scientific evidence.

1.4. Emotional Well-Being to Foster Sustainable Learning

In previous sections, two types of physical sustainability (referring to actions performed on objects or the physical environment) and social sustainability (corresponding to actions where interaction with others or the social environment is necessary) have been described. Motor praxeology also distinguishes two significant families of motor experiences: (a) psychomotricity, represented by psychomotor games, where individuals do not interact with other players (involving action in a physical or material environment); and (b) sociomotricity, constituted by sociomotor games where individuals interact with peers, opponents, or both (involving intervention in a social environment).

It seems reasonable to assume that participation in experiences related to psychomotricity, sociomotricity, and physical or social sustainability learning activates unique emotional states. Evidence shows that TSGs generate unique emotional well-being experiences, whether they are psychomotor or sociomotor games [1–3,6,21]. In all of these cases, it has been observed that when TSGs are employed, there is a predominance of intense positive and low negative emotions. In the educational context, these findings are crucial, as disciplines such as psychology or neuroscience indicate that when a learning process is associated with the experience of positive emotions, the outcome of that experience facilitates the acquisition of significant learning for students [22–26].

Following this approach, in this study, we distinguish two types of affective experiences based on the type of social relationship that originates:

Psychoemotional affectivity corresponds to experiences of emotional well-being or discomfort resulting from educational actions directed towards game objects (e.g., obtaining

an object, preparing it, elaborating it with unique nuances, or using it alone). States of psychoemotional well-being occur when the experience meets the actors' expectations. Conversely, the experience is one of psychoemotional discomfort when individuals deviate from the objectives they had set.

Socioemotional affectivity is associated with experiences of emotional well-being or discomfort arising from educational actions that require interaction with any educational agents involved (family members, other students, or the educator) when participating in the search, construction, or collective use of game objects.

This dual perspective of affectivity facilitates the interpretation of the effects of an educational program on the process of physical and social subjectification, through which students learn to attribute meanings of signs and messages to objects obtained from their domestic or local natural environment and to the interpersonal relationships they share [8].

1.5. Reflection in Action to Foster Meaningful Learning

Awareness of the learning process in which educational agents participate is a strategy that promotes the acquisition of contextualised physical and social sustainability learning. This strategy, involving both students and educational agents, invites them to reflect on their actions and delve into their educational value [27,28]. Additionally, by using game objects [29], experiences acquire significant affective content, enriching the reflection process from the action itself. *"The physical education teacher should allow students to discover the meaning of their motor experiences. Using reflection on action as a strategy is a possible path to continue exploring"* [30] (p. 174).

Various pedagogical tools, such as writing, journals, or field notes, make these resources mirrors, reflecting the internalisation of sustainable learning [2,31].

From an ethnomotor perspective, this reflective approach strengthens the understanding of educational objectives [32] and fosters a greater appreciation of educational contributions both within and outside the school.

Integrating procedures implemented inside and outside the school, with the collaboration of participating agents and using a methodology based on action reflection, fosters students' holistic development. This approach aims to cultivate an education dedicated to meaningful, contextualised, and well-being-oriented physical and social sustainability learning for students.

In light of the theoretical framework, this research set three objectives:

- (a) Unveil the presence of comments corresponding to ethnomotor variables (referring to external logic, educational agents, and internal logic) in the elaboration of game materials conducted outside and inside educational centres in the Canary Islands.
- (b) Examine the effects of emotional well-being and discomfort arising from ethnomotor actions carried out outside and inside educational centres in the Canary Islands.
- (c) Identify the ethnomotor variables with the greatest predictive strength of the testimonies that originated the educational actions carried out outside and inside school centres in the Canary Islands.

2. Materials and Methods

2.1. Design

The design of this educational experience followed a qualitative approach [33,34] from an inductive and humanistic perspective [35–39]. Furthermore, it corresponded to an ethnomotor intervention aimed at developing sustainable learning outside and inside of schools, involving different educational agents (formal and informal).

The research employed a mixed methods approach, allowing for examining all the information from this educational intervention by combining qualitative and quantitative analysis. This approach involved different steps in the QUAL-QUAN-QUAL data transformation, illustrating how the "connecting" method was used [40–42]. This methodological framework ensured a comprehensive understanding by integrating diverse data sources and analytical techniques.

2.2. Participants

A total of 226 students (108 boys and 118 girls) aged between 11 and 12 years old, from seven primary education centres in the municipality of Telde, located in the Canary Islands (Spain), participated. Seven teachers from these institutions and a researcher who combined the roles of investigator and teacher for the student groups during the training were also involved. All of the participants provided feedback (comments) highlighting the positive impact of this experience on student education. The participants took part voluntarily. All ethical considerations required for the successful development of the research were met, respecting the Declaration of Helsinki of the World Medical Association [43], as well as obtaining approval (06/2019/CEICEGC) from the Clinical Research Ethics Committee of the Sports Administration of Catalonia, Generalitat de Catalunya (CEICEGC).

2.3. Procedure

Any educational experience that aims to use ethnomotor skills [44–46] should propose pedagogical actions as close as possible to the traditional context in which the fundamental knowledge of TSGs related to sustainability is forged [44–46]. The active methodology used in this study allowed students, educators, and families to have an active role in the actions carried out outside of school and inside the school. They all acted as educational agents whose complementary actions fostered sustainable and meaningful learning.

In this study, different ethnomotor actions were developed related to recreational activities practised in the Canary Islands with materials close to their immediate and domestic environment (stones, wood, leaves, buttons, and cans), with cultural and social areas identifying the context. The activities were close to educational centres (musical folklore, natural spaces, gastronomy, and work uses). This illustrates why it was important to have educational interventions that could occur both inside and outside of school.

The pedagogical experience was divided into different phases, during which the students were able to discover game objects practised playfully in the Canary Islands and the materials used for their creation. The students were also able to experience and learn meaningfully, searching for the materials necessary to make a toy at school and home with the help of a family member. Later, recreational objects were created with those materials. Another interesting phase was the possibility of showing those made objects to their classmates and later demonstrating the importance of practising them by playing with the objects created outside and inside the educational centre.

Finally, the students were able to carry out reflective writing about the pedagogical experience they had. The students interacted with other agents, such as family members, teachers, and the researcher, to learn about the possibilities of creating and implementing an object made with materials from its closest environment. Below, each of the phases produced by the students during the seven sessions of this experience are explained in more detail.

- (a) Outside the school, students and families were involved. They identified areas and searched for game objects, following the characteristics shown in other studies [44–47].
- (b) Outside the school, with student and family intervention, the elaboration of game objects occurred, using different tools to personalize the objects (in terms of, for example, shape, size, and colours). This action was supported by previous studies that have employed the same strategy [48–51]. These actions fostered direct and profound interaction between students and their family environment, which was associated with states of emotional well-being among the participants [52–54]. Playful objects such as rag dolls, cars, aeroplanes, spinning tops, or skateboards were examples of the objects created by the students with the help of a family member.
- (c) Inside the school, student intervention and a presentation to the educational community (students and teachers) of the objects made at home with their families
- (d) Inside the school, students and a researcher-teacher intervened. The researcher-teacher, a specialist in the construction of game elements, helped the students elaborate on selected game objects. These objects were searched for at home and brought to the

educational centre. Materials such as buttons, ropes, plastic boats, cans, and fabrics were used to create stilts, tops, yo-yos, or cars.

- (e) Inside the school, student intervention and a variety of TSGs using objects built by the students were carried out. All of these actions carried out outside and inside the school fostered a holistic understanding of the values and knowledge related to social and physical sustainability promoted by TSGs with objects [52–54].
- (f) Given the limitations of this text, the study presented focused on analysing the elaboration phases of game objects outside the school (with family members) and inside the school (with teachers).

2.4. Instruments

This research utilised data collection instruments tailored to the characteristics of the participants. The students composed an essay, which included some drawings, and they also completed an emotion questionnaire adapted to their age. The teaching staff participated in semi-structured interviews, providing information on the teaching-learning process in this educational experience. The researcher acted as a participant observer, educator, and investigator, employing field notes and audio-visual recordings registered during the development of the educational activities. The students wrote about what they experienced in the educational intervention and commented on what stood out most about this experience.

2.5. Methodological Integrity

The methodology used for this educational intervention followed the considerations of qualitative research [55] and methodological integrity.

Data adequacy: Data were obtained from the comments of 226 students enrolled in primary education who carried out the educational intervention on using objects in TGs inside and outside the school through writings elaborated by the students in phase 7.

Conclusions based on evidence: The results corresponded to the comments obtained from interviews with teachers, students' writings, and field notes made in the educational intervention in seven schools in the municipality of Telde in the Canary Islands (Spain), and whose procedure was based on evidence obtained from previous scientific studies (publications and scientific articles, as well as doctoral theses). All this led to the discovery of the formative contribution of using sustainable materials and the interaction among students when participating in an innovative pedagogical experience both inside and outside the educational environment.

Data quality control: This study, which resulted in a doctoral thesis [2], was conducted by a researcher specialised in traditional children's games from the Canary Islands, the science of motor action, and motor praxeology. This allowed for a rigorous content analysis of the qualitative data obtained, which lasted for three years of research.

The present research was conducted by reducing, separating, and grouping the comments obtained from the students. The comments were analysed using Atlas Ti version 7 into units of meaning, which were subsequently analysed using comments referring to educational contexts outside or within the school.

2.6. Data Analysis

For the development of this data analysis, a mixed methods approach was employed [56–58], allowing for the examination of all the information from this educational intervention by combining qualitative and quantitative analysis. This method facilitated the reduction and organisation of the data collected through various instruments [51]. The qualitative content analysis of the data collected in this educational intervention (including field notes, teacher interviews, and students' written work) was performed using Atlas.ti V7 software. Simultaneously, a quantitative data analysis was conducted on various semantic units, achieving Cohen's correlation coefficients exceeding 0.8 for both inter-observer and intra-observer reliability. Various statistical tests were employed, such as multidimensional

frequency area analysis, crosstabs (Pearson's chi-square and Cramer's V for effect size), and paired sample tests, in SPSS v.25 [59]. The Pearson chi-square test was conducted to assess differences in the count of instances for each variable. The following criteria were used to estimate effect sizes: 0.10 = small effect, 0.30 = moderate effect, and 0.50 = large effect [60]. A classification and regression tree [61,62] was applied to determine the discriminative power of the study variables. Specifically, a CTR model was used, which had previously been used with motor and sporting games [63]. This multivariate technique divided nodes dichotomously to establish divisions as homogeneously as possible concerning the dependent variable (within and outside the school), allowing for adequate data modelling [64]. The following statistical specifications were applied: (i) the significance level was set at $p < 0.05$; (ii) to avoid overfitting, the pruning procedure was applied; (iii) the range of iterations was 100 for parent nodes and 50 instances for son nodes; (iv) the improvement measure could not be smaller than 0.001; (v) the impurity measure (Gini Impurity) tried to maximise within-node homogeneity; (vi) the tree had a maximum of five levels in order to reduce the misclassification risk; and (vii) cross-validation was used.

Seven sessions were conducted in each centre. Participants' comments were saved and categorised using Atlas.ti and Excel. The study analysed 18 variables related to ethnomotor intervention, both inside and outside the educational institution: (a) agents: students, family, researcher, and teaching staff; (b) internal logic: rules, motor interaction, material, space, and time; (c) external logic: students, material, time, and space; (d) phases: elaboration of objects outside the educational centre (F3) and elaboration of objects inside the educational centre (F5); and (e) effects: socio-emotional well-being and discomfort.

2.7. *The Role of the Teacher-Researcher*

The role played by the teacher-researcher was that of an instructor in the phase of object elaboration, following [65], with students assisted by the supervising teaching staff and physical education teachers. This fostered greater interaction between the students carrying out the activities and the teacher-researcher overseeing them, resulting in enhanced engagement between these agents, providing a holistic view of the educational intervention [37,66]. Additionally, the researcher acted as an observer of the objects created by the students with the assistance of a family member outside the educational institution.

2.8. *Reliability and Validity Criteria*

The research methodology adhered to Levitt's guidelines on the Reporting Standards for Journal Articles in Primary Qualitative, Qualitative Meta-Analytic, and Mixed Methods Research in Psychology [55]. This framework ensured methodological integrity throughout the study.

This research rigorously addressed the fulfilment of all reliability criteria [57], as it underwent review by an external researcher who approved all the criteria of content analysis. For this purpose, the Atlas.ti V7 software was utilised. Thus, the content of semantic units of significance, extracted from the comments obtained through data collection instruments, carried out by various agents, was analysed.

The content analysis underwent a meticulous four-month procedure conducted by two researchers. Two university doctorate students specialising in physical activity and sports sciences actively participated in this process. They were experts in motor praxeology and well-versed in prior studies on the content analysis of qualitative data in different playing scenarios. To enhance their analytical process, these researchers engaged in a comprehensive 40 h training programme on content analysis, aligning with the guidelines set forth by Anguera and Blanco [47].

The quality of the interpretative research was supported by the criteria of credibility and confirmability of the results through the triangulation of methods and researchers and external verification through the critical judgement of peers in the motor action research group (GIAM) [67,68].

3. Results

The different methodological strategies (mixed methods) employed for data analysis confirmed the positive effect of this ethnomotor experience on the development of meaningful and globally contextualized sustainable learning, with variables segmented between inside and outside the school setting. The effect size was shown to be small (V. Cramer = 0.097) ($p > 0.05$), as reported in the comments of the participants.

3.1. Creating Playful Objects Outside the Educational Setting: Physical and Social Sustainability Outside of the School

The educational actions carried out outside the school generated 623 comments (Figure 1) focused on fundamental interactions and components that participated in this educational intervention.

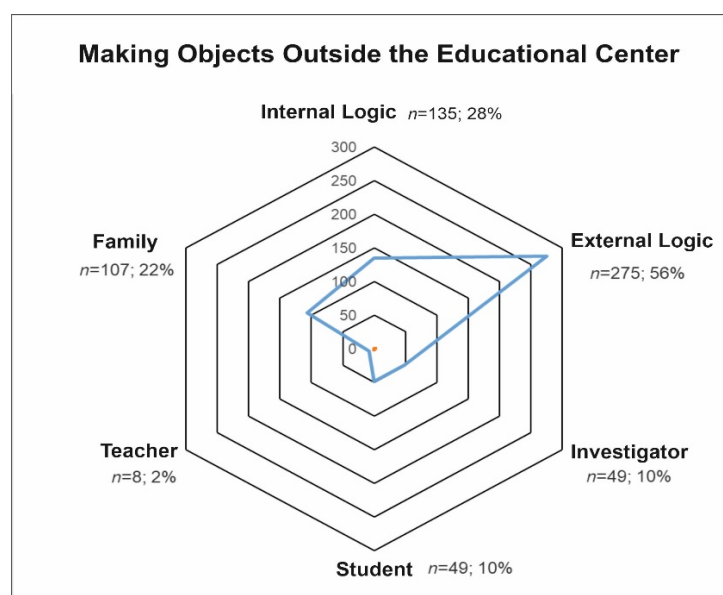


Figure 1. Comments resulting from the creation of play objects outside of the school.

The analysis of the testimonies narrated by the students, in the phase of creating objects outside the school with the help of a close relative (grandparents, parents), showed a high presence of comments referring to external logic ($n = 275$, 56%), i.e., aspects corresponding to the process of searching, obtaining, and personalizing these objects.

“What I liked the most was when we made a toy at home with our parents. I made a telephone using two cups, a string, and some paints to make a dog face”. (Student 3; comment 31)

“My toy is called a ‘zumbadera,’ and I made it with my 67-year-old grandfather. At first, I did not know how to use it, but then I learned. I enjoyed the experience”. (Student 18; comment 21)

In parallel, 205 narratives (32.9%) were identified, mentioning the participation of various educational agents (family members, teachers, researchers, and students), albeit in different proportions.

Firstly, comments describing the interaction of students with family members stood out ($n = 107$, 22%).

“My father was the one who gave me the idea to make the bottlecap toy. The first step was to get the bottlecaps, and the second step was to add weight to the candle liquid. Then we had to wait for it to dry before putting on the football player stickers”. (Student 53; comment 36)

"I made a cart at home with my mother and grandfather. I felt very good because I screwed and unscrewed. I made it with wood, wheels, ropes, paint (...), the same materials my grandfather used to play with when he was little". (Student 58; comment 14)

Testimonies corresponding to the teacher-researcher were also collected to a lesser extent ($n = 49$, 10%), recalling some details explained on the first day in class and confirmed by their family members.

"He told us that for the next day, we had to bring a traditional toy made by one of our family members when they were little". (Student 55; comment 114)

"Then he told us to make a toy at home. I made an entertainment toy (...), we learned many things, and I really liked it". (Student 57; comment 57)

Likewise, comments were recorded about the protagonism of the students in the process carried out outside the school ($n = 49$, 10%). In contrast, testimonies regarding the teacher's role barely existed ($n = 8$, 2%).

"I loved it; families were delighted, not only those who were here at the school in the joint game-making but also those who made individual games at home. Things came that I did not expect". (Teacher 2; comment 8)

"I always tell the children, they ask me my age, and I tell them I am a child because otherwise, I cannot play. That is to say, by giving the children the basic notions, they start from previous knowledge but modify it because they also have another reality". (Teacher 4; comment 52)

The search and construction of play objects outside the school with family members were accompanied by their practical use of these materials in play situations involving family members and students. Hence, testimonies referring to the internal logic of these ludomotor situations were collected ($n = 135$, 28%).

"It went from being a bottle, a few caps, and some sticks, to being a car with which we had fun racing. I was very happy to have had a time of many laughs". (Student 52; comment 33)

"We used some wooden boards, not too thick, not too thin. We used a stapler and glue. When I tried it, it did not fly, but I do not mind because my uncle and I are improving it so it can fly". (Student 49; comment 49)

3.2. Creating Play Objects with Students within the Educational Setting: Physical and Social Sustainability in School

The creation of traditional play objects within the school resulted in 650 comments (Figure 2) related to external logic, formative agents, and internal logic, but the distribution was uneven compared to the testimonies collected in actions outside the school.

The largest group of comments highlighted aspects related to external logic ($n = 302$, 46%), which was a higher percentage than that found in actions outside the educational setting. The ethnomotor nature of this experience showed testimonies external to the school both in actions carried out within and outside the educational setting. Creating objects in school encouraged students to recognize play objects with their families, some of which they had not seen until that moment. This action invited them to personalize their play object according to colours, shapes, sizes, and other unique characteristics accompanying their play artefacts.

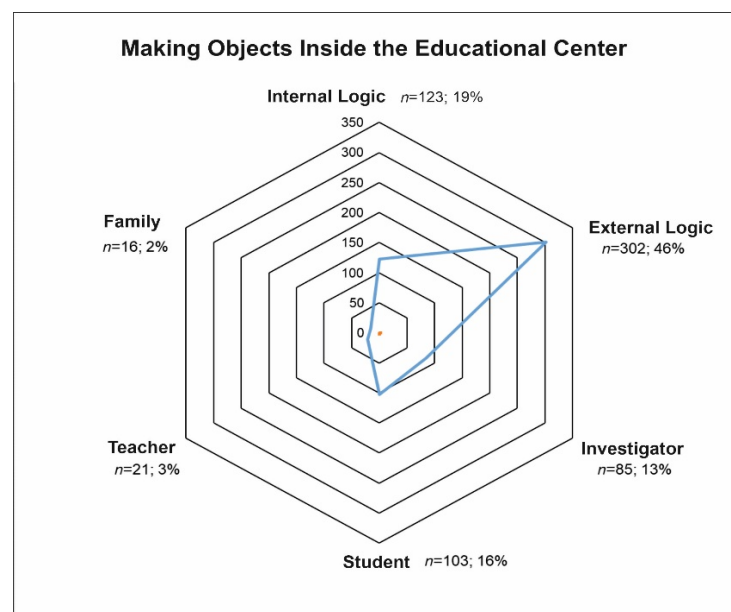


Figure 2. Comments resulting from creating play objects within the educational setting.

“That was also very good because we do not control the student’s and parent’s work at home. Parents can let us call it, get excited, and do the work themselves, and the child helps, fetches things, and brings them. Although they may be present, they may not actively participate, and there is no other option in school. In school, you do it, or you do it”. (Teacher 2; comment 19)

“When we did it as a group, I had much fun because we all contributed something, and we even decorated it in our own way”. (Student 28; comment 58)

The second-largest group of testimonies ($n = 225$, 34.6%) corresponded to the interaction or participation of different agents. One hundred and three comments (16%) evidenced the active participation of students in this process.

“We also have to say that the first, second, and third-grade students from XXX class (the tutor of that class) visited us. It was striking to see the whole school involved in elaborating and decorating the kite. It was a big family. We even took the time from the religion teacher, and she got involved in making the kite and in the social and relational work of all the students in the school”. (Researcher; field notes 3)

“In the next class, we made some stilts and a wool ball with (Fictitious name) help. Some classmates did not bring materials to make them, but we lent them some materials”. (Student 15; comment 150)

The researcher’s intervention, a specialist in traditional games, in constructing these play objects was also crucial; hence, 13% of the comments ($n = 85$, 13%) were related to the researcher.

“I felt very good and safe. I loved being with Lucho (researcher), doing workshops, and playing”. (Document 53; Student comment 3)

“I loved everything about the sock ball and kite we made. Thank you very much for coming to our school and for all the moments we laughed and had fun”. (Student 07; comment 11)

Finally, other adult agents recorded few testimonies, as they did not have a decisive role in these formative actions (teacher: $n = 21$, 3%; family member: $n = 16$, 2%).

“The Physical Education teacher came to our class to tell us that for the next day, we would have to bring two large empty cans and clothes that we do not use”. (Student 32; comment 148)

“I had a great time, and so did my classmates making the objects. The tutor also got very involved, which was a special, collaborative, and different experience for them. You truly feel they are learning and having fun simultaneously”. (Student 13; comment 8)

When contrasting the results of the frequency areas during the creation activities of play objects, both within and outside the educational environment, a similarity in the highlighted variables in both phases of the process is evident.

3.3. Emotional Well-Being Inside and Outside the School Setting

The overall results, resulting from combining all ethnomotor comments from actions carried out inside and outside the school, confirmed that this experience mainly generated states of emotional well-being ($p = 0.011$) ($M = 22.75$, $SD = 11.3$) compared to distress ($M = 8.75$, $SD = 5.56$).

“I also enjoyed crafting the ball as a group. I was surprised to see all the games and toys we could make with recycled materials during play sessions. In conclusion, I have learned that technology is unnecessary for play”. (Student 11; comment 52)

“That was also very good because, at home, we do not control the student’s or the parent’s work. Parents can let us call it, get carried away and do the work themselves, and the child only reaches out to me and brings me things. They may be present but not actively involved, and there is no other option at home. At school, you do it, or you do it”. (Teacher 2; Comment 29)

When comparing where the actions took place, inside or outside the school, there was a tendency for a greater presence of comments within the school ($n = 105$) than outside the school ($n = 79$). No significant differences were observed ($p > 0.05$) between the registered comments of emotional well-being inside and outside the school and for comments of emotional distress. However, the trend showed more records of actions inside the school.

“We are already here (school). On this day, we made stilts and balls. We had much fun. That same day, we were told that we would play with the toys made in class”. (Student 28; comment 38)

“I really liked the telephone my classmate built with two yoghurt cups”. (Student 33; comment 119)

Finally, the number of comments originating from formative actions inside and outside the school, referring to different types of emotional well-being or distress, were studied (Figure 3). The results showed that both inside and outside the school, comments of well-being (psychoemotional and socioemotional) were higher ($p < 0.001$) than those of distress (psychoemotional and socioemotional). Although the frequency of emotional well-being versus distress was equal inside and outside the school ($p > 0.05$), trends were observed: (a) more comments of psychoemotional well-being inside the school (IN = 105 vs. OUT = 79); (b) more comments of psychoemotional distress inside the school (IN = 15 vs. OUT = 11); and (c) more comments of socioemotional distress inside the school (IN = 7 vs. OUT = 2).

“When we made the ball in class, I was very surprised because I learned and did not know how to do it. I did it very carefully”. (Student 33; comment 18)

“I made a wool ball with the materials I brought from home. I was excited because I have never made a toy before”. (Student 05; comment 62)

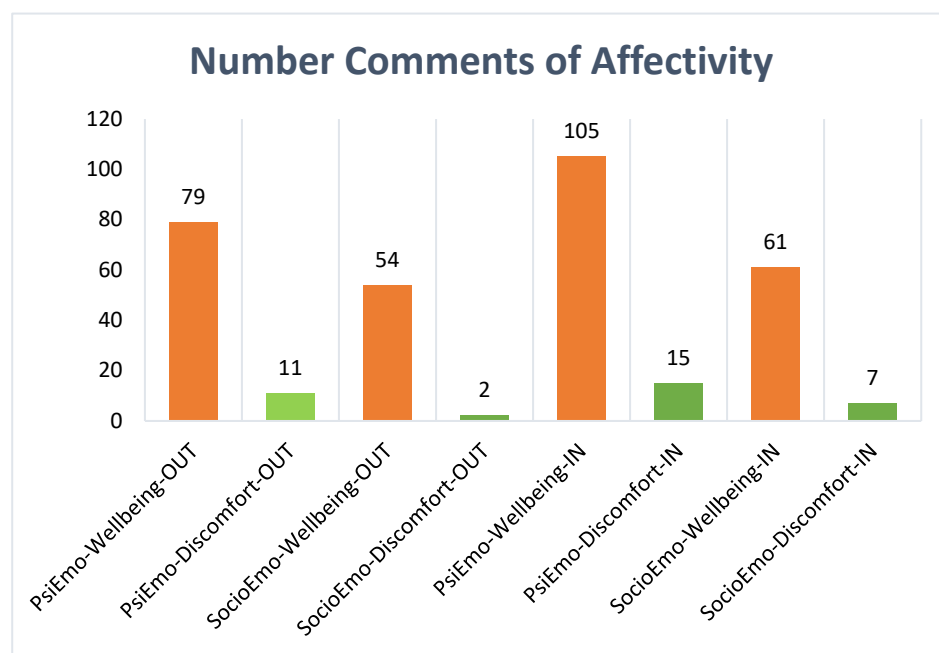


Figure 3. Emotional and relational well-being and discomfort inside and outside the school.

3.4. Classification Tree

The overall percentage correctly classified by the CRT (Figure 4) model was 81.8%. The first variable predicting the difference, like comments, corresponded to the students involved (external logic) (level 1: PT_LE) (improvement = 0.127). It was observed that when the records did not mention the students, the testimonies related to actions in the school increased their presence (node 1; $n = 591$; 88.5%). The distribution of proportions changed radically in the comments referring to the students (node 2). In this case, testimonies referring to actions performed outside the school exceeded, in double proportion ($n = 194$; 66.2%), those referring to actions in the school ($n = 99$; 33.8%).

At the second level of predictive strength (nodes 3, 4, 5, and 6), the following explanatory variable corresponded to the search for materials (improvement = 0.012). As expected, the presence of this variable (nodes 4 and 6) originated a greater number of comments on actions performed outside the school, especially when those testimonies also mentioned the family members involved in the process of sustainable learning (node 6: $n = 95$; 84.1%).

The experience of searching for objects with family members had a positive effect on the students' learning of physical and social sustainability, as evidenced by the presence of comments on these topics in the actions carried out at school without the presence of family members ($n = 18$; 15.9%).

Where the variable of material search did not exist, the most numerous comments were related to school actions (node 3) (improvement = 0.033). These comments also needed to consider the participation of educational agents ($n = 547$; 94.5%), indicating that students did not give the same prominence to the role of the teacher (formal educator agent) as to family members (informal educator agent).

At the third level of the tree (nodes 7 and 8), the variable with the most predictive strength was the elaboration of objects (improvement = 0.002). This variable only predicted the comments that did not imply the search for objects. In this case, testimonies mainly referred to actions carried out within the school (node 7: $n = 258$; 89.9%).

The fourth and final level of the tree (nodes 9 and 10) identified the last predictive variable as the procedure followed by educators (improvement = 0.002). This variable was associated with the material's variable elaboration. It was mainly present in actions within the school (node 9), where teachers used different didactic strategies ($n = 172$; 94.5%).

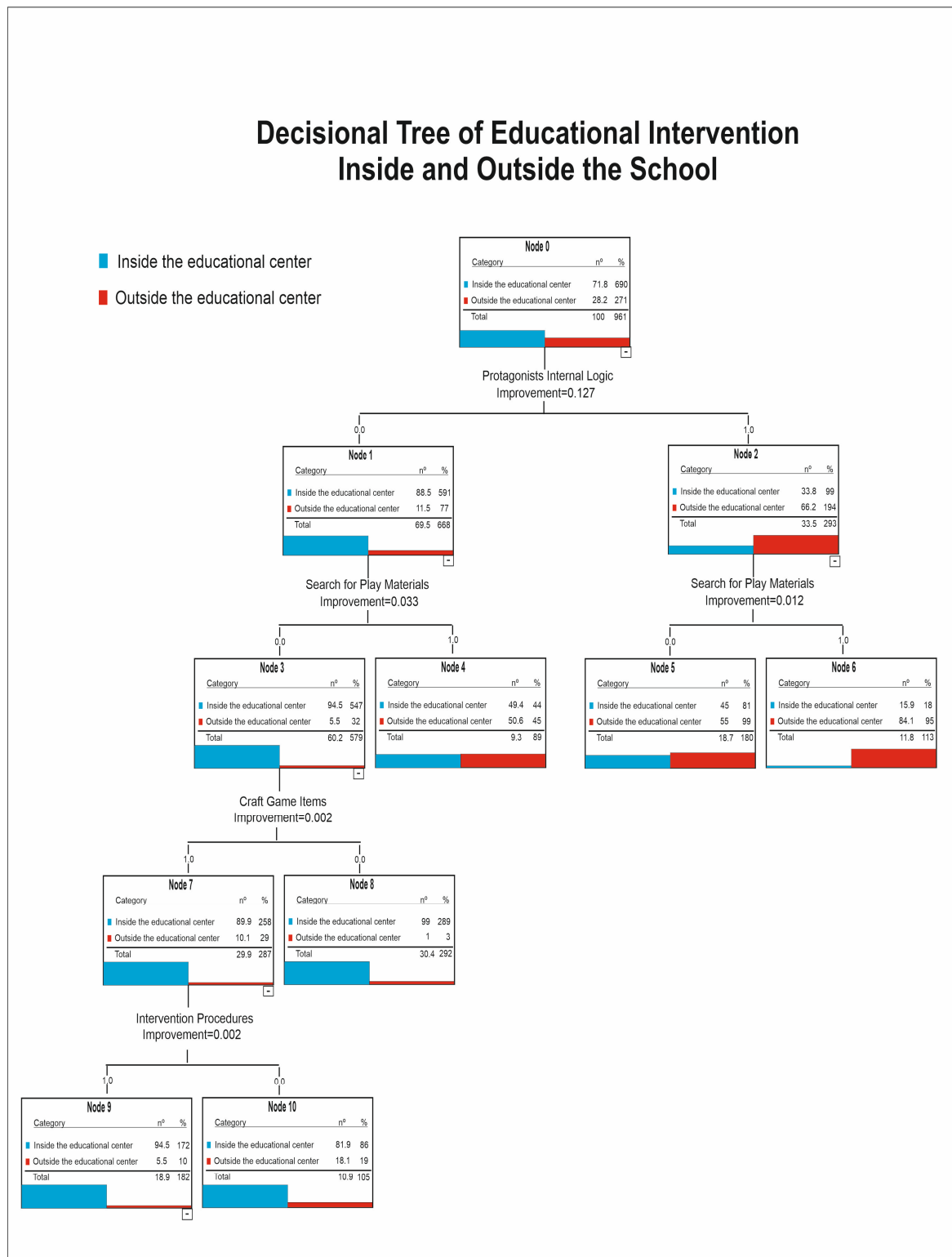


Figure 4. Decisional tree of educational intervention inside and outside the school.

Figure 5 presents the independent importance of variables in the model CRT. The variable *Búsque_B* had the highest importance score of 0.135, with a normalised importance of 100.0%. On the other hand, the *PT_LE* variable had an importance score of 0.127, with a normalised importance of 94.1%. These scores indicate that *Búsque_B* was the most influential variable in predicting inside/outside of the school, while *Elabora_El* was the least influential.

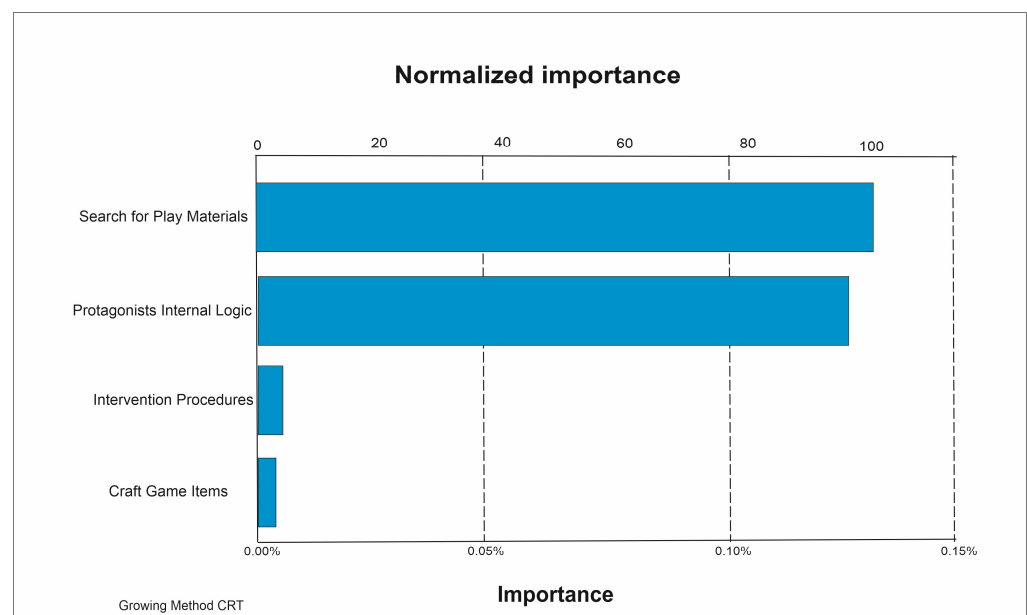


Figure 5. Normalized importance by model CTR variables.

4. Discussion

This study investigated the presence and predictive strength of ethnomotor variables in ludomotor actions with objects on physical and social sustainability education actions carried out through traditional games [69] with objects, both outside and inside schools in the Canary Islands. Likewise, the effects of this ethnomotor intervention on emotional well-being and distress were studied.

Numerous resolutions from state, regional, or international bodies, such as Agenda 2030, have established as priority objectives the development of sustainable learning and the relevant role of physical activity [18,70–72]. However, specific contributions addressing student-sustainable education through the performance of traditional games with various agents inside and outside the school environment are very scarce [2,46].

This study responds to this gap by providing scientific evidence of the effect of an original and innovative educational program aimed at fostering quality education oriented towards generating contextualized sustainable learning and psychosocial well-being.

4.1. Facilitating Sustainable Learning Contexts through Ethnomotricity: A Holistic Perspective

The findings of this study underscore the students' acquisition of fundamental knowledge regarding social and physical sustainability through the coherence of this ethnomotricity intervention unit. The integrated vision of ethnomotricity intervention demands consideration of the interaction and interdependence of the involved components: protagonists, spaces, and the use of objects provide meaning and trigger emotional well-being among students, thus fostering the appropriation of meaningful and purposeful learning.

Regarding the protagonists, the teachers, family members, and students constitute an indivisible whole, acting as active agents in the ethnomotricity formation of students.

"When we used these wooden boards, not too thick or thin. We used a stapler and silicone [physical sustainability]. When I tried it, it did not fly, but I do not mind [physical well-being] because my uncle and I [family] are improving it so it can fly [social sustainability]". (Student 17; comment 49)

Regarding the spaces employed, it is essential to emphasize that each space utilized within and outside the school serves as a laboratory for learning. Thus, the study elevates the scenarios employed within the school (classroom, gymnasium, or pavilion) and those outside the school (home, domestic, and natural environment) to the classroom level. The social actions shared with family members, teachers, and other students, along with

actions performed individually in both internal and external spaces of the school, shape students' physical and social subjectivisation process, thus facilitating the acquisition of key competencies and skills for their formation as citizens.

"My father and I [family] were the ones who came up with the idea of making the bottle cap toy. The first step was to get the bottle caps; the second step was to add weight with candle liquid [domestic objects]. Then we had to wait for it to dry to put on the football stickers [physical sustainability]". (Student 11; comment 36)

The ethnomotricity educational intervention provides coherence to the educational use of traditional games with objects from the Canary Islands. The phases comprising this experience have encouraged students to undertake actions outside the school (locating areas to obtain game materials and performing object elaboration, all with the guidance of family members) and inside the school (displaying objects, creating new materials, playing games with the constructed objects, and writing explanations about the experience, all with the guidance of educators). Thus, an attempt is made to reconcile the ethnomotricity nature of traditional sports games so that text and context, internal and external logic, teachers, students, and family members, as well as school and local environment and physical and social well-being, are intertwined as indispensable components of the process of subjectivisation of sustainable learning.

Thanks to the hierarchical segmentation technique or classification trees, the predictive strength of comments to identify actions performed within and outside the school has been identified. This statistical procedure identified three types of predictive variables: (a) the protagonists (agents: teachers, students, or family members), (b) the direct relationship with objects through two actions of object search and subsequent construction, and finally, (c) the "didactic" procedures employed by the teaching collective.

Numerous comments corresponded to testimonies that did not mention the protagonists involved in this educational process. This finding confirms the predictive strength of all subjectivisation or physical sustainability actions when comments mention the protagonists of this process; they mainly referred to actions carried out outside the school concerning family members.

The tree identifies the significant role of the variable of material search as an action specific to the external environment of the school. It also highlights the process of object elaboration as a predictive variable linked to didactic procedures. In this case, the majority of testimonies were recorded within the school, where there existed a wide variety of agents who shared their educational complicity (teachers, student classmates, and the teaching researcher specialist in TGs: (a) students experienced the phases of the activities and supported each other to carry them out. Their experiences and experiences strengthened the procedures for elaboration and implementation of the created objects; (b) the teaching staff supervised the development of the educational experience and fostered responsibility, creativity, and teamwork among students; and (c) the researcher-teacher supervised the activities of the educational intervention, energized the procedures for sustainable use of materials (physical sustainability), and energized the practical implementation of the objects created by the students, along with their classmates (social sustainability).

Simultaneously, the content analysis of comments, carried out in the phase of object elaboration both outside and inside the school, reflects this systemic view of all elements involved in the education of sustainable development learning. For example, the following testimony highlights this variety of components of ethnomotricity nature.

"I made a cart at home [space outside the school] with my mother and my grandfather [family] [social sustainability]. I felt very good [positive emotion] because I screwed and unscrewed [psychosocial well-being related to the object]. I made it with wood, wheels, ropes, paint (...), [natural and domestic objects] with which my grandfather used to play when he was little [social subjectivisation, referring to social meanings of family members]". (Student 09; comment 14)

The findings of this section confirm the consistency of the fundamentals of motor praxeology about the development of the concept of ethnomotricity and its application from a socio-cultural and educational perspective [12,15,73–76]. The findings confirm that this experience has also supported the education of Sustainable Development Goal (SDG) 3, “Good Health and Well-being”. This goal is directly related to emotional well-being, as it advocates for ensuring a healthy life and promoting well-being for people of all ages [18,70–72].

As observed in other studies, the educational potential aroused by the internal logic of the game (in this case, the use of play objects) and its relationship with local culture (in this case, through family members and educational agents at school) is confirmed [77,78]. Traditional games are a resource of utmost interest for promoting interpersonal relationships linked to the development of social sustainability [54].

4.2. Emotional Well-Being Inside and Outside School: Key Role of Sustainability

In the 1960s, Parlebas posited that affectivity was the linchpin of motor behaviours. Sixty years later, scientific advancements confirmed how sensory experiences shape the brain. Indeed, [79], in his work “Descartes’ Error”, asserts that understanding movement will lead to understanding emotion. In this study, comprehending emotions unveils the educational force of ethnomotricity educational experiences conducted through traditional games with objects.

The data obtained shed light on the impact of ethnomotricity intervention on emotional well-being.

The first finding confirms that all educational actions collectively fostered emotional well-being. Students mainly experienced positive emotions in ethnomotricity actions carried out inside and outside school. This finding aligns with previous research [4,54,80].

Secondly, it has been observed that there were no differences in the well-being generated by actions within the educational centre, focused on teachers and students, compared to those originating outside the school, led by family members. By turning external spaces and family members into educational agents, the experience allowed the restitution of the nature of non-formal learning that traditional games typically activate in everyday life environments. Young students experienced intense emotional well-being guided skilfully by family members, grandparents, or parents. In actions such as recognizing places to obtain game objects, elaborating playful objects and their conditioning, narratives referring to their relatives’ anecdotes, stories, and experiences accompanied them. Students endowed the process of social subjectivisation with meaning and significance, thanks to the socio-emotional well-being that emerged from the interpersonal relationships they shared with their family members. Objects came to life, acquiring social meaning and significance through that relational affectivity that allowed for a better understanding of the signs and values of their local ludomotor culture [8,81].

Actions carried out within the school generated trends of more intense emotions than those outside the school. A greater number of educational agents (classmates, teachers, and the specialist teacher-researcher in TSG) favoured the process of sustainable development learning with great emotional intensity.

The third finding concerns the dual orientation of emotional well-being. The educational actions that activate greater well-being invite students to maintain an affective connection with objects (psychosocial well-being). Among the possible well-being actions, we highlighted the option of touching various objects with diverse shapes, textures, and colours, personalizing play materials with unique characteristics and testing them in ludomotor situations in front of other teachers. Thus, the physical nature of bodily techniques allowed students to recognize game objects as physical and inert artefacts and as elements bearing meanings and signs of local ludic-affective culture [8,12]. The social construction of emotions derived from the affective relationship with objects activated intense states of psychosocial well-being in students, giving meaning and sense to learning linked to physical sustainability. The number of comments showed a slightly higher trend

in testimonies recorded within the school than those originating outside the school. One possible interpretation relates to the wide variety of agents, strategies, and procedures used in formal education compared to non-formal scenarios.

“After finishing the toy activity at home, we had a workshop in practical class to make a kite, a fabric ball, and some wooden toys. My classmates and I made the kite and did not enjoy it very much. What we liked the most was playing with it”.
(Student 29; comment 39)

The number of comments related to socio-emotional well-being [4] was also somewhat higher for actions carried out within the school compared to those occurring in external spaces with family members. Like psychosocial well-being, this superiority can be interpreted according to the variety of agents, strategies, and procedures used within educational centres.

This trend was also reproduced in comments directed at psychosocial and socio-emotional discomfort. A greater number of testimonies of negative emotions related to the relationship with objects were identified than those linked to interaction with others. Again, materials capture the educational force of sustainable development learning. By carrying out construction actions, displaying them to others, and using them amid a wide variety of agents, each person tests their bodily techniques [82]. In case of failure, the effects of discomfort are somewhat higher in school (due to a greater number of agents) than in the family environment, where there is a maximum affective security relationship with family members [83].

“During previous sessions, each student explained the toy they made with their family to the group. Some students need help communicating in front of the group, not just in small groups. This activity boosted self-esteem, increased confidence in group settings, and received recognition from peers for the toy they made and their oral presentation and communication with their family”.
(Teacher 4; Comment 10)

“Some of us noticed that the relationship with the grandfather or some family member was positive. With others, we observed an immense negative emotional burden. When the girl dropped the doll with disdain as if it did not matter”.
(Teacher 3; Comments 5 and 17)

These findings confirm that the experience has also supported the education of Sustainable Development Goal (SDG) 3, “Good Health and Well-being”. This goal is directly related to emotional well-being, as it advocates for ensuring a healthy life and promoting well-being for people of all ages [18,70–72].

4.3. In Pursuit of Educational Effectiveness: Towards Optimization of Interaction among Educational Agents

Analyses conducted in seven primary education centres in the Canary Islands (Spain) have revealed the interdependent relationship of the various components (variables) involved in the different phases of ethnomotricity education.

The findings emphasize the actors’ relevance, both within and outside the school environment. Furthermore, they highlight the activities of searching for and creating playful objects carried out by students with the collaboration of close family members outside of school and the activities of elaboration and application of these objects within the educational centre. *“The interactions of cultural life contribute to the generation of social cohesion, a sense of belonging, and a framework of social coexistence, all central elements in promoting a model of sustainable development”* [84].

Based on an ethnomotricity approach, this study reveals the dynamics that arise when students participate in educational activities of traditional games [5]. It has been possible to explore how these interactions unfold with various actors both within and outside the school environment and in formal and informal education contexts. All of this has contributed to educating the participants on social sustainability.

The meaningful learning that originates in students [85,86] manifests when a family member, such as a grandparent or parent, teaches the student about the search for and acquisition of materials and the transformation of these into playful objects outside the school environment. The observation of high participation and comments in the decision-making process evidences the relevance of this approach in non-formal contexts of primary education. Procedures in these comments reinforce teaching from an ethnomotricity perspective [10,12,87,88], considering the cultural and particular aspects that influence the sustainable pedagogical experience between the family member and the student.

The involvement of diverse actors in a sustainable education experience has had a positive impact on four Sustainable Development Goals (SDGs) [18,70]:

SDG 4: Quality Education: Inclusive and equitable quality education is strengthened when learners, teachers, and families collaborate. Using locally constructed playthings not only enriches learning but also makes education more accessible and relevant to learners, connecting them to their cultural and natural environment.

SDG 11: Sustainable Cities and Communities: Promoting the use of local and sustainable materials in educational activities helps students to appreciate and conserve their cultural and natural heritage. This practice can instil a sense of responsibility and pride in the community, fostering more sustainable cities and communities.

SDG 12: Responsible Production and Consumption: Students are educated about the importance of sustainability and responsible consumption by using recycled and local materials to create play items. This can lead to greater awareness and more sustainable practices in their daily lives.

SDG 15: Life on Land: Integrating elements of the immediate environment into educational activities can foster a deeper connection with nature, promoting the conservation of local ecosystems and biodiversity. This is essential for sustainable development and the preservation of biodiversity.

5. Conclusions

This study has explored an educational process of an ethnomotricity nature carried out through traditional games with objects and its impact on education for physical and social sustainability, as well as on the emotional well-being of students. It has emphasized the educational contribution of this intervention as a response to the scarcity of specific contributions addressing sustainable education through traditional games with various actors, both within and outside the school environment.

The results reveal that the students internalized fundamental social and physical sustainability knowledge through the coherent ethnomotricity intervention unit. This holistic vision requires considering the interaction and interdependence of the components involved, from the protagonists to the spaces and objects used, generating experiences of emotional well-being that favour the appropriation of meaningful and purposeful learning. It has been evidenced that actions inside and outside the school function as laboratories for sustainable development learning, where interaction with family members, teachers, and peers shapes students' physical and social subjectivisation processes. The coherence in the educational use of traditional games with objects has allowed for the reconciliation of its ethnomotricity nature, generating contextualized learning and fostering the formation of students as citizens of the 21st century.

Statistical analysis has identified the predictive strength of comments in identifying actions inside and outside the school, highlighting the importance students place in their relation with objects and the didactic procedures employed. Additionally, it has been noted that all educational actions, as a whole, favoured the emotional well-being of students, mainly through positive emotions. Interaction with objects has proven to be a key factor in activating psychosocial and socioemotional well-being inside and outside the school. However, there is a tendency towards more intense emotions within the school environment due to the greater diversity of agents and educational strategies in this context. Finally, the importance of optimizing the interaction between educational agents within and outside the

school environment to promote meaningful and sustainable learning has been highlighted. Collaboration between students, family members, and teachers has been fundamental to the success of this intervention, highlighting the relevance of considering the cultural and particular aspects that influence sustainable pedagogical experience.

Although this study has yielded promising results, future research needs to address some limitations. It is necessary to consider the generalization of findings, as the study was conducted in the specific context of the Canary Islands. Furthermore, the study needed to adequately address the issues of validity and reliability, which should be a focus of future investigations. Additionally, research with a control group could be conducted to strengthen the attribution of effects observed exclusively by an ethnomotricity intervention. For future research, longitudinal studies evaluating the long-term impact of these interventions on sustainable development and the emotional well-being of students are suggested. Furthermore, it would be beneficial to explore the implementation of this approach in different cultural and geographical contexts to better understand its effectiveness and adaptability to the education of students' physical and social subjectivisation.

In summary, this research provides scientific evidence of a significant contribution to the advancement of the Sustainable Development Goals in accordance with the 2030 Agenda [18,70].

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Conflicts of Interest: The authors declare that this educational intervention and research was conducted in the absence of any commercial or financial relationships that could give rise to the interpretation of a possible conflict of interest.

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