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# Geography Education Promoting Sustainability

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Edited by  
Eila Jeronen

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# **Geography Education Promoting Sustainability**



# Geography Education Promoting Sustainability

Special Issue Editor

**Eila Jeronen**

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## About the Special Issue Editor

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# Preface to “Geography Education Promoting Sustainability”

In the 2030 Agenda for Sustainable Development, it has been stated that all learners should acquire the knowledge and skills needed to promote sustainable development. Consequently, and also with the great proliferation of knowledge and rapid changes in technology, it is important to develop students’ understanding of the principles of sustainability.

The Special Issue “*Geography Education Promoting Sustainability*” focuses on views and experiences in geography education at schools and in teacher education, which support curricular work and school practices sharing a vision of a society that lives in balance with Earth’s carrying capacity. In addition, the special issue presents and reflects on the ideas that offer learners a context for developing active, global citizenship and participation for understanding of the interdependencies of ecological, societal, and economic systems.

I hope that you will find the Special Issue, “*Geography Education Promoting Sustainability*” enhancing understanding of sustainability and fostering initiatives and applications of sustainability based activities at schools and in teacher education.

I would like to extend my thanks to the authors of the articles contained in this book, which include a multi-sided view of sustainability and sustainable development, and many useful teaching and learning ideas for promoting them in Geography Education at different educational levels.

**Eila Jeronen**  
*Special Issue Editor*



Perspective

# An Issue of Scale: The Challenge of *Time, Space* and *Multitude* in Sustainability and Geography Education

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**Abstract:** The field of geography is important for any sustainability education. The aim of geography education is to enable students to understand the environment, its influence on human activity, and how humans influence the environment. In this article we present a study on how the interplay between the three pillars of sustainability thinking (environment, society and economy) play out on smaller and larger scales of *time, space* and *multitude* in geography education. In this paper, we argue that central issues in high quality sustainability education in geography relates to students' deeper grasp of how to shift between magnitudes of time, space and multitude patterns. We show how an appreciation of many core issues in sustainability education require students to understand and traverse different magnitudes of the scalable concepts of time, space and multitude. Furthermore, we argue and exemplify how common sustainability misconceptions arise due to an inability to make the cognitive shift between relevant magnitudes on these scalable concepts. Finally, we briefly discuss useful educational approaches to mediating this problem, including the use of digital tools in order to allow geography teachers to facilitate the students' better understanding of different magnitudes of slow, fast, small and large scale entities and processes.

**Keywords:** geography education; sustainability education; education for sustainable development (ESD), misconceptions; preconceptions; alternative conceptions; magnitude; issues of scale; mental models; digital tools; dialogic teaching

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## 1. Introduction: The Sustainability Aspects of Geography

At the time of writing this paper, over 200 bushfires are raging across large tracts of the Australian continent. An area of over 60,000 km<sup>2</sup> around the country has been burnt during the past month, and there is no real end in sight. The fires have killed 24 people so far, destroyed over 1500 homes, and estimated to have killed close to 1 billion animals (this estimate excludes non-vertebrate lifeforms such as insects and plants, for which the number of killed organisms is simply unimaginable) (e.g., [1–4]). Most people will agree that this sort of natural disaster, which will most likely have anthropogenic influences, is large in extent and effect, and perhaps unprecedented. Yet most will struggle to make sense of the extent of this natural disaster. The size of the fires, the number of animals killed and the extreme rarity of fires on this scale is far beyond the realms of everyday human experience. The purpose of the current study is to draw attention to the issue of scale in sustainability thinking within geography and how issues of scale should be taken into consideration in sustainability education.

Many contemporary researchers argue that planet Earth has reached a new geological epoch, which they call the Anthropocene (e.g., [5–7]). By distinguishing this epoch, they want to emphasise the strong human-influenced (anthropogenic) changes in Earth's physical features. These changes occur in the atmospheric, geologic, hydrologic, biospheric and other earth systems with obvious impacts on the social spheres. Simultaneously with ecologic knowledge, there is a need for human cooperation,

democracy, and social justice (e.g., [8]), and humans aware of ethics, and changed practices based on transformed political power and actions [8]. The field of geography has a significant role to play in the Anthropocene and needs to develop and reshape sustainability education that meets the needs of both the present and an unknown future.

The two main branches of geography, physical and human, provide knowledge of crucial relevance for an education towards most of the 17 UNESCO sustainable development goals [9]. With physical geography drawing mostly on the natural sciences and human geography relying more on the social sciences and humanities, together they provide a methodological and conceptually-rich and multifaceted view of human societies. These two views show how societies are organized and how they interacted/will interact with the natural environment in the past, today and in the future. Therefore, the study of geography integrates and develops our understanding of society, economy and the environment, the three traditional pillars of sustainable development thinking.

Good geography education should consequently provide a fruitful immersion of students into knowledge and understanding of how human societies and economies develop, interact with and change the natural environment in time and space. However, Rosling et al. [10] argues that humans tend to see the vast amount of information about the reality through a filter of unconscious and predictable biases. Therefore, the most dramatic information easily tramples over critical considerations and fact based on actual scales and numbers.

The issue of scale is a known challenge to science education in general (e.g., [11–13]), and in the current paper we argue that it is of particular importance with regards to students' understanding of sustainability and thus both physical and human geography. That is, students' and teachers' ability to manoeuvre mentally along large spans of time, space and multitude is a core component of obtaining a deep understanding of sustainability thinking.

Concepts of scale permeate the study of both human and physical geography. Given the multiple understandings and usages of scale, it can be a challenging concept to engage. A useful distinction between different approaches to the concept is that adopted by Montello [14], through which he has a delineation between the cartographic, analysis and phenomenon scales. Cartographic scale is the relationship between the dimensions of a constructed representation and the reality it represents, such as maps and physical models. Analysis scale refers to at what level or unit, for example town or nation-level, a given issue is analysed. In this paper we mainly engage with the third understanding of scale, namely the phenomenon scale, which can be understood as the dimensions in which structures or processes exist, regardless of how they are studied or represented. Our concern in this paper is with understanding how students' misconceptions in sustainability education within geography often have their roots in issues of how they perceive phenomenon scales. In particular, we argue that the concept of time, space and multitude are important scalable dimensions that it would be useful to include in the sustainability education of geography.

The challenge of helping geography students to develop a deep understanding of geological time, microscopic and vast spans of space and immense numbers is nothing new to geography education (e.g., [15–17]). In particular, Cheek et al. [15] have formulated the conceptual challenges of scale for students in geography education. Yet, it is still a topic that receives too little emphasis and research, and virtually no attention has been paid to the issue of scale in sustainability education.

By first exploring sustainability issues of relevance to geography and then giving examples on three topics of interest, namely greenwashing, shifting baselines and climate change education (see Section 7), we illustrate how issues of scale can influence how well students perceive, understand and make sense of sustainability topics. We argue that many common misconceptions in this context relate to the inability of students to identify relevant scales in the process or phenomenon at hand. We then attempt to suggest important scalable dimensions in geography and sustainability education and identify relevant research and ideas on how to improve students' understanding of these dimensions of scale, with special attention to the usefulness of digital tools in this context.

Thus, the purpose of this literature-informed perspective paper is, firstly, to identify relevant scales to promote geography students' deep understanding of sustainability, and secondly, to suggest creative and useful educational approaches to teaching about scale in geography.

## **2. Core Issues and Challenges of Sustainability Education in Geography**

According to our definition, sustainability education is about promoting both ecological literacy and social justice understanding. It is practice oriented [18] and critical [19]; it draws attention to the preconceived assumptions that governs human actions; it intersects well-established beliefs and encourages students to think independently [19,20]. Sustainability education is a process in which students develop their own ability to analyse, negotiate, search for alternatives and make choices [21]. They must deal with issues such as equality and constellations of power and are encouraged to criticize the systems they are a part of. This acknowledges that sustainability education is more than content knowledge within the various topics of science education and recognizes that its holistic and transformative nature depends upon students developing a sense of agency and empowerment. That is, students need not only to be able to understand but also how to reflect, feel and act critically.

Geography education has often been the school subject responsible for sustainability education [22]. However, the ways sustainability is implemented in geography education vary a lot, especially at the university level (e.g., [23]), likewise the names of the courses are heterogenous [23]. Nevertheless, geography has much unused potential when it comes to sustainability [22,24]. This might have to do with how sustainability like geography lies between two disciplines taught by universities: social sciences and arts, as well as science. Nonetheless, the quest for sustainability deals with holistic approaches and questions where human, social and nature topics encounter. Like sustainability, geography also needs to focus on ecological, social, economic and political views. The fact that geography focuses on global issues and on scales (temporally and spatially) are other reasons to why sustainability suits geography so well [22].

Geography as a school subject, defined broadly as the study of the landforms, features, inhabitants and phenomena of the Earth, touches on virtually all aspects of sustainability thinking (e.g., [16,24–26]). In physical geography sustainability-related issues would include an understanding of geology and the geological processes of the Earth, resource distribution, landforms, weather and climate. Issues of the importance of sustainability in human geography involves the distribution and changes of populations and population demographics, resource usage, environmental impact of human activity, resource and pollution-related conflicts, poverty issues, and political governance.

Gradually, geography studies and geography education have been shifting focus from viewing the world objectively to a subjective view. Accordingly, the students become participating agents in world processes; geography describes processes in which the students relate to places through their involvement in politics, ethnic cultures, social groups, patterns of consumption, et cetera (e.g., [27]). A crucial geography task is then to promote the students' understanding of their own potential as creative citizens in the global economy and culture [28] and to imagine alternative futures [29].

Connected to a higher-order level of student thinking are the dichotomies and complexities arising from present and future social activities related to sustainability in geography education. These include potential futures-orientation, systems thinking, local vs. global issues, individual agency vs. governmental control and social justice (e.g., [25,26,30–32]). Sustainability related issues are also scientifically, especially mathematically, extremely complicated. For example, if there is a decrease in the CO<sub>2</sub> level in the atmosphere, it is unclear how the planet will respond [33]. This is a non-linear problem with a multitude of synergetic interactions, with implicit unpredictability.

The complexity of geography questions is not only obvious at a physical level, but also at a social level. Sustainability and geography issues are connected to opposing voices, various ideas and belief systems and conflicting values [27,34]. The world is no uniform space, and for that reason it is important to promote global views and global efforts in geography [27,34,35]. In a sustainability education respect, "global" means that the students become critically aware of planetary social differences, develop deep

cross-cultural understanding and become familiar with and raise critical awareness of the conditions in other parts of the world than their own (e.g., [35]). Global understanding also includes perspectives of geography and temporal and spatial thinking skills. Initiating online collaboration can be one way to offer students opportunities to share learning experiences with students living under different conditions [35].

From this general list of sustainability-related topics of geography, it becomes clear that in addition to solid content knowledge, a geography approach to sustainability can offer an education that develops competencies which can empower and enable individuals to engage in socio-political processes of importance to sustainability. Yet, single geography courses are not enough to shed light on all the complex sustainability dilemmas. According to Fox et al. [36] resilience building and human adaptation to the Anthropocene need broad interdisciplinary understanding that connects social and environmental challenges. Therefore, an interdisciplinary approach could widen the perspectives. The geography programs can acknowledge this by arranging courses with experts from many fields and by participating in interdisciplinary projects, among other things [37].

### 3. Scalable Dimensions of Interest in Science, Geography and Sustainability Education

As illustrated by the core topics presented above, issues of scale are common in sustainability education. It is possible to imagine an endless number of scalable quantities in nature. In this paper we aim to explore three important categories of scalable axes of relevance to sustainability education, namely *time*, *space* and *multitude*.

*Time* is a concept that at first appears easy to grasp, but which is all but easily pinned down. Perhaps a useful definition is that time is a dimension that defines the sequence of events. Time allows one to map and refer to current and past events, and to imagine futures. It is a dimension which enables quantification of duration, from very short to very long events. Students of geography (and other subjects) should be able to make sense of timespans stretching back to virtually the beginning of time whilst also be able to visualize many potential futures. The examples of climate change education and shifting baselines below (see Sections 7.1 and 7.3) illustrate that students' conceptions of time at different scales and magnitudes influence is important in how students make sense of sustainability issues.

*Space* is defined as "a boundless, three-dimensional extent in which objects and events occur and have relative position and direction" [38]. The concept of space in natural science describes spatial distances, areas and volumes using continuous measures or terms such as "close", "distant", "short", "long", "small" or "large". It can be considered to be a tangible and readily understood concept, yet when we attempt to make sense of smaller and larger things than our everyday perceptions allow us to experience, scale issues appear. In a single science lesson, students are regularly challenged to jump from spatial scales in which they make sense of elementary particles to scales that make them struggle with interstellar distances. The spatial scales are also related to other continuous quantities, such as volume and density. In the examples of climate change education and greenwashing efforts (see Sections 7.1 and 7.2 below), students' conceptions of these issues will be influenced by their ability to move along different scales and magnitudes of volume and density, relative sizes and distances.

Human geography distinguishes between the concept of space and the concept of place. Yet, there are many views of this distinction [39]. According to a study of many other authors, Saar and Palang divides space into three forms. Firstly, they separate *perceived space*, like invisible 'bubbles' that people live inside. These spaces are complex spatial organizations of practices for activities in buildings, neighbourhoods, cities, etc. To these spaces belong the world economy and global geopolitics. Secondly, they refer to space as *conceived space*, knowledge primarily produced by discourses of power and ideology. Various professionals, such as engineers or researchers create and use such spaces. The third form, 'thirdspace', of spaces is the most difficult to grasp, since there the abstract and the concrete meet. They can be understood as mental spaces influenced by wider social, economic and political processes. *Place*, on the other hand, is a location created by experiences. In physics, Aristotle [40] said

that place definitely is something, but it is hard to say what is its essential nature. According to Saar and Palang [39] a place is multidisciplinary and socially constructed:

“Place for us is socially constructed and operating, including interaction between people and groups, institutionalized land uses, political and economic decisions, and the language of representation” [39] (p. 7).

*Multitude* is a form of quantity which describes the number of discontinuous entities under study. Multitudes are measured by the process of counting objects, and they are expressed using integers or terms such as “few” and “more”. As with the concept of space, the concept of multitude is easily graspable when exploring quantities found in everyday experiences, yet significant challenges arise when one attempts to make sense of very large numbers, such as human population size. Furthermore, being able to meaningfully compare large multitudes is key to grasping issues of climate change and the true nature of greenwashing activities, as explored further in the examples in Section 7.

As humans, we have always had a relationship to time, space and multitude, and their relevant combinations. For example, a particularly important combination of time and space is the speed, direction and acceleration of objects with which humans seek to react to, be that catching moving prey, avoiding a thrown rock or navigating complex terrain while running.

Time, like space, is something that most people are familiar with, and yet it might be difficult to answer a question about what time is. Time relates to many topics, not the least language. In many languages, the verbs explain what has happened, what is happening now and what will happen (e.g., English), but in other languages, the adjectives can also denote different modes of time (e.g., Japanese) [41]. Physical scientists view time as either absolute or relational [42]. According to the absolute view of time, time like space, forms an arena of physics. That means that all material processes have backgrounds of ‘time’ whereas relative time is dependent on, that is related to, matters [42]. Roark [43] calls time one of the knottiest conceptual problems in philosophy. Aristotle relates time to motion. Yet, he argues to and fro and his interpretation is all but easily grasped (e.g., [43]).

“Now we perceive movement and time together: for even when it is dark and we are not being affected through the body, if any movement takes place in the mind we at once suppose that some time also has elapsed; and not only that but also, when some time is thought to have passed, some movement also along with it seems to have taken place. Hence time is either movement or something that belongs to movement. Since then it is not movement, it must be the other.” [40].

A student of geography will encounter issues of scale related to time, space and multitude in virtually every aspect of geography, be it physical or human geography. It is beyond the scope of this paper to provide an exhaustive overview over all such issues.

#### 4. Scale and Sustainability

The core assumption of sustainability thinking is that all human beings have the same right to live good and fair lives by means which, if scaled to a global level, do not transgress the biophysical boundaries of the planet. This means that an understanding of social, environmental and economic challenges at and across local and global scales is crucial for students to obtain the knowledge, incentive and ability competent sustainability citizens will need. At the core of developing such deep knowledge lays the ability to engage with relevant issues of scale along axes of time, space and multitude. The subject involves embracing related issues on hugely different scales, such as individual agency and governmental policy, individual footprint and human population size effects on the world, lifespans of humans/societies/cultures/nations and local and global pollution effects, imagining alternative futures, unhinged from past trajectories. Therefore, sustainability is a subject more or less impossible to handle within the scales of daily experiences. Immediately, the many-faceted topic of sustainability requires learners to be confident in scaling orders of magnitude all of time, space and multitude.



The first core challenge in sustainability thinking is an ability to see and understand relationships between local and global issues and actions, one's own welfare and prosperity in contrast to how other people live. The second is the challenge of short-sightedness as opposed to long term thinking, and the third is the individual's choices in contrast to decisions made at regional, national and global levels (e.g., [44–46]). Familiar challenges within sustainability education are how social and environmental problems are often perceived as challenges only related to humans far away in a distant future. These are all interdisciplinary challenges which require a well-developed ability to choose useful perspectives, apply relevant magnitudes and to scale axes of time, space and multitude cognitively.

Sustainability thinking challenges learners' ability to scale their empathy and sense of justice, equality and fairness to encompass family, friends, community and virtually the whole of humanity. Similarly, the ability to scale the environmental impact of one's own lifestyle to the environmental impact of 7.6 billion people acquiring a similar standard of living is another useful exercise. Furthermore, grasping historical human population growth, a cornerstone of sustainable development thinking, is also riddled with challenges with regard to understanding both quantity and rates of change, in order to understand the strain on environmental capacity caused by human population growth and increasing global standards of living.

From the preceding few paragraphs it is obvious that within sustainability thinking, the challenges of understanding how to navigate across magnitudes of space, time and multitude are intertwined.

#### *Scale and the Case of Population Growth*

Social sustainability connects to the challenges of scope and scale [47]. However, it is difficult to find common frameworks to measure local, regional and international levels of population-related issues. These issues are inextricably linked to the development itself. Elements that are usually thought of as functioning on local or global levels have become extremely complex [48,49]. Even if different processes may be going on in individual countries, environmental and demographic changes are interrelated and have implications for other countries far away, and for natural resources across the world [49].

Demographic and environmental changes exert influence simultaneously; they are affected by environmental conditions and climate change, shaped and reshaped by economics, employment and poverty, and in turn they affect health, education, sanitation, food, energy, and other demographics [49]. Population growth, ageing, urbanization and migration might demand totally new ways of considering and conceptualizing human development and demographic changes [49]. According to Güney [50], the level of development in a country affects how much its population growth affects sustainability; consumption in rich countries is much higher than in poor countries in relation to the relative population sizes. It is also higher than the goal of achieving a sustainable consumption level [50]. A major distinction between countries and regions is that while poor countries have contributed less than rich countries to climate change, they are more exposed to the negative effects [49]. The population growth of different age groups also has different effects on sustainability [49].

Even if there is space for three billion more people on Earth, there are not enough spaces that are safe from natural and human-caused hazards. There are also limits to how much megacities can grow before they become unmanageable. Space is not the biggest problem with a big world population, but availability of necessary needs [51], and this is more demanding to calculate and foresee. Many citizens of the world already live under stress because of lack of food, shelter and clean drinking water [51]. The reason that so many lack basic means of subsistence and livelihood has connection to neoliberal world capitalism and corruption [8].

Without redistribution and a new world economy this problem cannot be solved. In the report from United Nations Development Programme 2019, it says that "assessing inequalities in human development demands a revolution in metrics" [52] (p. 3). This means that the world needs a new way of measuring using clearer concepts, a combining of data sources and sharper data tools. However,

even it is possible to measure and predict better, the climate problem has first and foremost to be met by changed policy [53]. This is obvious in the Australian bushfire situation [54].

Global warming is a major factor affecting the human population socially and economically, including increased unpredictability of the future. Scientists estimating the effects of a rising sea level reach differing conclusions [51]. Since the effects of climate is nonlinear (disproportionality between causes and effects), the future impact of global warming is unevenly distributed around the planet, with different populations being affected differently [53,55]. Global warming and its outcomes also affect a population's subgroups differently [55]. In addition, global warming may have an influence on sexual behaviour and fertility rates [55].

Yet, students should not only view humans as vulnerable victims, but they also need to see humans as empowered and able to change the direction of the developmental process [53]. "We do have a choice, and we must exercise it now" [52] (p. 4) has to be the leading proposition in education. Since measuring and counting will not be easy, ethical discussions and multiple ways of comparing statistics is a way to approach the development problems. The United Nations, for example, produces a lot of digital data about the state of the world in figures that can be used in learning situations to base discussions on. The sustainability dilemmas are complex, even 'hypercomplex', which means that they are infused with constraints and emergence, interdependent and dependent, congruous and incongruous [53]. Therefore, the required methods are also complex, encompassing multiple disciplines including especially natural science, social science and philosophy, and employing both quantitative and qualitative methods [53]. Geographers who want to study the multiplicity of sustainability need a steady companion of philosophy in addition to human geography and natural geography. Many contemporary sustainability problems relate to ethics (e.g., [56]).

Marston et al. [48] have gone as far as to suggest a total elimination of the concept of scale when studying human geography. Instead they suggest a flat ontology. It is difficult to find common frameworks for measuring local, regional and international levels of social sustainability. Perhaps it is not even possible to compare rural and urban contexts, not to mention finding useful tools to compare northern and southern countries. The variability in individual countries in spatial population distribution may already be high and differences across countries due to internal reasons can outline distinct demographic patterns at the regional scale [57]. Multiple, non-linear forces shape natural balance and migratory movements in unique ways on different temporal and spatial scales [57].

## **5. The Issue of Scale in Science Education**

"If the universe is queerer than we can suppose, is it just because we've been naturally selected to suppose only what we needed to suppose in the Pleistocene of Africa? Or are our brains so versatile and expandable that we can train ourselves to break out of the box of our evolution? Or finally, are there some things in the universe so queer that no philosophy of beings, however godlike, could dream them." [58].

Many of the misconceptions students bring into geography studies, and particularly within issues pertaining to sustainability, relate to how they are able to understand the issue of scale, and how they are able to make cognitive jumps between different magnitudes of time, space and multitude. The issue of scale is a major, yet under communicated, hurdle of science education at any educational level and every topic [11–13,59–61]. As an incredibly successful approach to understanding the physical reality around us, the natural sciences seek to explain aspects of reality on vastly different dimensions of time and space: from the smallest elementary particles to the size of the universe; from the age of that same universe to the speed of light. Scale is about grappling with the smallest and the largest, the fastest and the slowest, the few and the many. It also has bearing on phenomena as unrelated to each other as the understanding of molecular structures to how we relate to climate change, how we visualize urbanization to how we perceive the size of the human population. The ability to make relevant sense in these different contexts depends on our cognitive propensity for scaling [13].

It is an important skill to be able to move cognitively between an understanding of the time in minutes it takes for light to reach us from our own sun, to the time in hundreds of thousands of years light has to travel to reach us from other stars. Being able to view issues at their proper scales has significant implications for how humans as individuals, as societies and as humanity, understand the world around them and consequently how they view the pressing issues of the current epoch. Take as an example a number as large as 7.6 billion, the current human population size. This is a number that is more or less cognitively impossible to comprehend, yet it is a number of dire importance for any issue of sustainability.

Most students have not developed a good cognitive grasp of how enormous our current population is, and how extremely rapid our population has changed over the past few hundred years. Since humans evolved into being as a species around 200,000 years ago, it took most of that time to reach a worldwide population of about 1 billion humans. Yet, it took only 200 more years to explode into a population of nearly 8 billion people. Such a rapid change in the number of people on the Earth is simply mind boggling, and it is perhaps both the clearest and most pressing issue of scale, further complicated by the enormous heterogeneity in the carbon footprint and levels of consumption of people in the Global North and South. When faced with such large numbers, we are left grappling with how to make sense of such multitudes.

It falls on the geography teacher to help students move along scales of time and space in a manner which makes sense to the students, and to help them learn how to understand large multitudes and how to choose the most useful orders of magnitudes, with the goal of enabling them to develop a deep sense of scale.

## 6. Alternative Conceptions in Geography and Sustainability Education

Common challenges to student learning and meaning making in science, including geography, are students' alternative conceptions (here used as *ideas that people have which are inconsistent with scientifically acceptable ideas*) (e.g., [62,63]). The subject of alternative conceptions in science education exists within the framework of constructivist thinking, where learning occurs as the learner actively constructs meaning by reinterpreting current conceptions (e.g., [64–66]). Alternative conceptions can arise through informal learning experiences occurring outside the classroom and from misunderstandings arising during education [67]. Consequently, students enter geography education with mental models of geography issues constructed from everyday experiences which align or correspond to varying degrees with the currently accepted geography narrative. Furthermore, during their education students may construct mental models that conflict with or only partly overlap with current geographical thinking. Consequently, high-quality teaching requires teachers to be aware of the relevant mental models their students have constructed, and by which means they are best moved towards the current geography theory, taking into consideration the common misunderstandings usually encountered in the educational process [63,68].

In an extensive review of recent literature, Francek [69] lists over 500 misconceptions in geoscience, of which a large proportion relates directly or indirectly to issues of physical geography of relevance to sustainability education. These misconceptions include topics such as: formation, distribution and origin of fossil fuels; formation of modern landscapes; formation and distribution of natural resources; causes, frequency and distribution of vulnerability to climatic changes; age of the Earth and appearance of geological features, species evolution; understanding of geological time periods; geoscience dating techniques; age and evolution of the human species; causes and frequency of mass extinction episodes; causes and occurrence of megafauna extinctions; uniformitarianism; formation and movement of groundwater; speed of and processes driving continental drift; sizes of continents relative to familiar local distances; driving forces of and time scale of erosion processes; frequency and causes of flooding; anthropogenic and divine influence on landscapes; soil origin, distribution and erosion speeds; and relative magnitude of local versus global distances.

Several studies have shown that alternative conceptions are common with regards to climate change [70–75]. These alternative conceptions relate to the causes and frequency of changes to the climate, but also the issues of immediacy, concern and consequence of current anthropogenic climate change. Students' alternative conceptions regarding issues such as causes of and distribution of world hunger issues are also obvious, as are dilemmas related to social, temporal and spatial issues surrounding environmental commons [76].

Geography and geography education, as well as sustainability, connect remarkably with development issues. Such issues depend on spatial variability, place dependent processes, processes operating through intersecting spatial scales, situated agency (who shapes the development?) and they also concern the nature-society relationship [27]. Questions like gender, ethnicity and competition and their relations to the dominant worldview, global and place specific political struggles as well as historical power constellations become relevant for the understanding of and critical reflection in geography. A common example of a topic in which all these elements are visible is the production, distribution and consumption of food. It is possible to study food issues as a geography theme on the scale of a household, village/city, nation state or as a global phenomenon [27].

This short list of sustainability related challenges and alternative conceptions connected to geography is far from exhaustive and it is only meant as an illustration of how common issues can be traced to challenges directly or indirectly related to how students perceive time, space and multitude.

## **7. Three Tangible Issues of Sustainability Education in Geography and the Role of Scale**

To illustrate how issues of scale can be seen as important challenges to sustainability education, we explore three examples of topics of relevance to sustainability thinking.

### *7.1. Climate Change Education*

Understanding the enormous challenge of human-induced climate change and its challenge to human society is a relevant and illustrative example of a complicated issue of sustainability education. Firstly, the natural science behind our understanding of how we influence the climate is complicated and requires geography students to understand key concepts of several different science disciplines, and how to bring them together into one cohesive story. Secondly, the challenge of human induced climate change poses for human society is a political and cultural issue, with questions and answers about the degree of reality, urgency and importance, as well as potential solutions, goals and desired futures, distributing themselves along fairly well understood political and cultural divides [77–84].

Students construct many misconceptions when trying to familiarise themselves with the climate change issue [72,74,75,85], and it can be argued that many core climate change-related misconceptions arise from how students perceive phenomena and processes at different scales. For example, students struggle with understanding how changes in the levels of CO<sub>2</sub> in the atmosphere can influence the greenhouse effect, despite this gas only contributing to a fraction of a percentage of the gases in the atmosphere. Similarly, how can humans bring about carbon emissions large enough to drive this global process? Many students also fail to understand how unprecedented the current observed rate of change in CO<sub>2</sub> levels are, compared to previous fluctuations.

Another common challenge to climate change education is to grasp how far into the future the CO<sub>2</sub> emissions of today will remain in the atmosphere, and consequently how current emissions could be changing the Earth for hundreds and thousands of generations to come. How a global average temperature increase of 2.0 °C, an increase in temperature smaller than the temperature difference between the top of a dining room table and the floor, can have catastrophic consequences for ecosystems all over the world is also a common conceptual challenge to students. It is worth noting that many of the challenges to climate change understanding listed here are used by climate skeptics as arguments against the idea of human induced climate change [86].

Climate change education is also made difficult with regards to students' conceptions regarding social and economic aspects of the climate change challenge. To envision the social and political

components of the solutions to this crisis, students need to cope with issues such as individual versus governmental action, the current and changing carbon footprints of people and countries of the global south compared to the global north.

These few and selected examples of misconceptions in climate change education are all related to how students can perceive quantities, sizes, distances, volumes, rates of change and spans of time smaller or larger than those offered by the range of everyday human experience.

### *7.2. The Scale-Issues of Greenwashing Efforts*

An important aspect of sustainability education is information literacy, including critical thinking and source criticism. Perhaps particularly within geography education, students of sustainability must be adept at critically evaluating the validity and intent of a host of information sources, given the strong political and economic interests involved in sustainability questions. Tangible examples of such situations are the greenwashing efforts of various companies and governments involved in activities that negatively affect the environment [87,88]. Greenwashing can be understood as the act of spreading disinformation by an organization to present an environmentally responsible public image (Concise Oxford English Dictionary, 10th Edition). Greenwashing attempts by interest groups are common and are often aimed at attempting to shift attention towards small and symbolic green efforts, and consequently away from the larger environmental challenges of the relevant industry. Furthermore, greenwashing efforts tend to emphasize benefits close to home and ignore or discredit claims of disadvantages further afar.

Petroleum companies and governments with oil-dependent economies are, in the current climate challenge discourse, known to resort to greenwashing arguments [89,90], of which the long-term efforts of the Norwegian government and Norwegian oil companies are useful examples [91]. For several years the idea that Norwegian oil is preferable to oil produced elsewhere due to the manner in which its oil is produced, i.e., extracted and refined, has been promoted in Norway [92,93]. That is, they claim that the CO<sub>2</sub> emissions needed to produce a given amount of crude oil or gas are higher elsewhere compared to the Norwegian oil production. Although this has an element of truth to it [94], it underscores the fact that the CO<sub>2</sub> emissions from production accounts for only about 5% of the total CO<sub>2</sub> emissions of fossil fuel usage. Consequently, the benefits of Norwegian oil in a bigger picture are somewhere between small to insignificant, and definitely irrelevant in a post-fossil fuelled future. Similar examples are efforts by oil companies to over-emphasize their small renewable energy departments whilst under-communicating the degree to which they still base most of their revenue on fossil fuel extraction [91].

Based on this, the ability to identify company or governmental greenwashing efforts requires the ability to identify the correct frame of comparison. That is, it is important to understand what the relative effect of the greening effort of a company is compared to its regular activities. Similarly, who are the beneficiaries of any benefits from such greening efforts, and across what periods of time are these efforts relevant?

### *7.3. The Concept of Shifting Baselines and Its Relevance to Sustainability Education*

The shifting baselines syndrome relates to how our perception of time influences how we perceive change over spans of time [95]. When looking at an environmental phenomenon or process that is undergoing slow change, as time passes, humans tend to align their perception of what is normal (i.e., the baseline) to the current situation [96]. The consequence of this is that accepted levels of environmental conditions are gradually being lowered.

Such shifting baselines in our perception of what is normal can include climatic shifts [97], involving seasons, temperature change, snow distribution, frequency of bushfires and precipitation patterns. It can involve aspects of natural history [98–101], as exemplified through how we perceive changes in biodiversity, commercial fish population sizes, migratory bird arrivals, tick prevalence and

the extent of urban sprawl. This could influence management goals and public perception and support of management efforts [95,102–106].

Our perception of human ways of living also experience shifting baselines, such as our expectations with regards to disease prevalence, standard of living and consumerism. Examples of shifting baseline syndrome in conservation efforts are plentiful [99,107–109], and the consequences this might have for our ability to create an awareness, understanding and accepting of anthropogenic change need to be explored further [110]. If we constantly adjust our understanding of what we consider normal to describe the current situation, our ability to notice long term change will be severely limited [111].

To avoid shifting baselines, and instead obtain a deeper understanding of how various aspects of culture, human life and the surrounding environment are changing, requires an ability to view change through time framed on scales beyond personal and individual experiences.

## **8. Geography Education for Scale Understanding**

A handful of studies have been published on how the concept of scale is of consequence in science and more specifically, geography education [11,15,17,59–61,112–114]. A common theme in most of these studies touches on the importance of experience in determining a student's proficiency at conceptualizing scale and shifting magnitudes. Two kinds of experience are emphasized as increasing the ability to handle scale-shifts: direct experience with the relevant dimensions at different magnitudes; and, secondly, experience with cognitively visualizing scales that do not offer themselves to direct human observation.

Direct experiences: In a study of how a sense of scale develops, most of the respondents suggest that direct experiences such as moving over distances by foot, by bicycle, by car or by plane played a crucial part in the development of their sense of scale for objects that are directly available for humans to experience [11].

Experience with visualizing scales outside direct human observation: Simply being exposed to thinking about and working with scale are experiences that help students become more scale adept. Several authors have pointed out how a sense of scale develops from childhood to adulthood, through repeatedly having both in- and out-of-school experiences dealing with scale [11,15]. Similarly, learning labels for different scales and quantity, as well as developing strategies for measuring, imaging, estimating and using measuring tools are important for this process [11,61]. Through experience, many people develop conceptual anchor points like the size of an atom, density of water, size of body parts, continental and celestial distances to make rapid shifts from one scale to another [11,61]. Cheek [15] also suggests building relevant experience by visualizing different scales of time, space and multitude through students working with and developing their own object- or event-models of entities outside of human direct experience. For example, Janowska et al. [115] found that training students in creative visual imagining is linked with the knowledge and understanding of space, and aids children's understanding of basic astronomical concepts.

Furthermore, dialogic teaching practices (e.g., [65]) might be of particular use for helping students become scale competent on issues related to geography. A feature of dialogic thinking is that students, in conversations with fellow students and/or their teacher, will experience dissonance in their understanding of the issue at hand compared with fellow students or the teacher. Such dissonance can encourage students to consolidate their conceptual models with the current concepts and models of geography. Through classroom dialogue, students will experience the cognitive models that other students have constructed in their meaning making around issues of scale, and to express and reconstruct their own.

In their paper on age and experience-related differences in scale conceptions, Tretter et al. [13] emphasized that to have the ability to conceptualize different scales, one must be able to make cognitive leaps to different cognitive worlds. Consequently, a useful approach for teachers might be to help students think of shifting magnitudes as a journey outside of the realms of direct human perception.

What follows are some simple rules of thumb for scale-travel in order to become adept at traversing scales outside of human experience:

*Be aware of departure:* Many of the issues regarding scale in science education might stem from students simply not understanding that they need to make a conceptual shift. That is, they have not understood that it is time to depart from the magnitudes of everyday human direct experiences. Such departures should be announced whenever they happen in the classroom. That is, in order to help students to understand that the part of reality that the scientific story currently being investigated in the classroom is on a scale outside direct experience. Students need to be reminded that they are crossing “borders of magnitudes”, that is, this area of natural science requires a shift in which order of magnitude to apply to make sense of it.

*Pick your mode of travel:* Just as important as understanding that you are leaving magnitudes available for direct experience is the ability to know how to get where you are going. Which modes of travel are at our disposal? That is, what tools are available for scaling our cognitive images up or down to the location outside the sphere of direct experience that we are trying to travel to? These modes of travel can be dialogue, digital tools (see below), digital animations (see below), or different kinds of object or event models.

*Know where you are:* Constantly being made or making oneself aware of where the student is in relation to our everyday world of experiences is essential for appreciating the qualities offered by the new environment. That is, by which order of magnitude removed from the human experience range of a parameter are we currently trying to conceptualize?

*Bring local currency:* Unitize is the process of developing a new unit from existing (and understood) objects, in order to make sense of quantitative levels outside of human scales [114]. For example, when working with astronomical distances, introducing the unit of light years helps students conceptualize distances at celestial scales better than working with kilometres or miles [13].

*Always bring a good map:* It has been suggested that the use of analogies is a method to help students reason with issues of scale [112]. In this context, analogies by comparing something outside of human perception to something within, enables the student to make sense of the entity or process under study. In the same way as using a topographical map to navigate the real world, analogies offer the student something comparable and graspable to tackle the incomprehensible.

*Choose your future:* Béneker and van der Schee [30] give examples on the benefit of having students building future scenarios. This could make them reflect about what kind of world they want to live in, and to argue, select, discuss and compare alternatives. Being aware of scales and multitudes, shaping future scenarios could be a way to rethink the present critically and actively work for change.

*Know how to count:* Mathematics and statistics are traditional tools for dealing with scales. Yet, the students find it easier to understand scales and differences when they themselves have counting tasks. When they realize that the pH scale is logarithmic, which means that an increase or decrease of an integer value changes the concentration by tenfold, makes it understandable why a decrease of pH in the oceans is such a tremendous problem. Another scale and multitude-related task is to try to assess some of the consequences of the world population doubling over time, or the possible savings accruing from arranging digital events instead of holding face-to-face life gatherings. Walter [33] presents many ideas and good examples of how to use mathematics to understand sustainability issues, and many of them suit geography education.

Comparisons is a way to examine options mathematically. Wilcke and Budke [116] present a systematic step-by-step model on how to use comparisons in secondary education settings. In their example, students compared refugee arrival figures in European countries and lists which elements and what order is required to allow for students to improve their ability to argue, reflect, and promote good judgement. And comparisons, Liu et al. [117] argues, can develop students' higher-order spatial thinking skills, in her case using comparisons of geo-information obtained with GIS-systems. This brings us to the benefits of digital tools when learning about scales in geography.

*Digital tools as scaffolding while becoming scale-adept: “Look! The stars move together . . . at the same time!”* exclaims a 14-year-old student. “And the moon is following along . . .,” chimes in her classmate. Three science students are watching a time-lapse video of the sky of the previous night and have stumbled on what for them is a novel realization: the stars in the night sky appear to move in concert, from east to west. This sparks off a discussion that effortlessly, and unaided by the teacher, skips between the heliocentric world view, the direction of the Earth’s rotation and the nature of the moon’s trajectory around the Earth. Then another student points out frequent lights that buzz across the bottom of the view. They agree that the lights are on boats coming and going from the local harbour, and another student exclaims: “I never knew there was so much activity in the harbour . . . what are all these ships, where are they going, what cargo are they carrying?”

This is an example of students suddenly seeing patterns around them when given tools that help them move between different magnitudes of time, allowing them to notice phenomena appearing on a slower time scale than they would usually notice. The students in question became engaged and curious and had become aware of patterns that they could have seen every starlight night they might have experienced, but which evaded detection because it happens at such a slow rate. They may have seen videos like this before, but in a world of digital special effects, who will believe anything? However, in this time-lapse movie which they had shot and produced themselves, they saw the silhouette of their home village in the lower part of the screen. It is as real as it gets, they were able to discover a pattern in nature, and they eagerly made sense of it using bits and pieces that each of them brought to the table of what they already know in order to talk their way towards an explanation of what they captured. And they noticed something about human activity and commerce in their home village previously unknown to them: cargo vessels shipping goods to and from the world.

One would assume that spending time in settings that allow students to move between different orders of magnitude on scales of time, space and quantity, to be a helpful exercise in getting used to mentally visualizing scales outside of human direct experience. Being unable to see very slow or very fast processes is a common challenge of scale in science education. Similarly, being unable to zoom in very close or to be able to get a broader overview is also an issue of scale. Easily available digital tools such as cameras, digital microscopes and camera equipped drones can enable students to make brief trips to the neighbourhoods outside of their everyday experiences.

Slowing down or speeding up time with slow-motion and time-lapse-photography respectively, can be an effective way to make students observe and make sense of slow or fast processes they had previously been unaware of. This can include fast processes such as chemical reactions and measurements of velocity, and slow processes such as tidal movement, plant growth, snail movements and seasonal variations. Such exercises can develop students understanding of and relationship to nature, an important component of sustainability education.

Additionally, digital tools offer a host of visual models, static, animated and interactive, that can help students become more scale-adept in sustainability issues. For example, serious games, that is, games created “to have underlying objectives beyond mere entertainment such as instructional goals” [118], can provide students with simulations that can make them experienced at imagining processes, scenarios and dilemmas on scales of time, space and multitude outside of their everyday experiences (e.g., [11]). Map services such as Google Earth™ and others and a host of animations on virtually any geography related sustainability topic touched upon in this paper are currently available online. This also includes virtual reality approaches to visualizing aspects of reality outside of direct human physical experience [119].

## 9. Conclusions

The purpose of this paper has been to point out how most of the common alternative conceptions held by students within sustainability topics in geography education are related to issues of scale. That is, how students make sense of different magnitudes of particularly time, space and multitude appears to be the cause of many alternative conceptions within sustainability thinking in geography



education. Furthermore, we have presented several educational approaches and tools that previous studies have emphasized in scale-related education, and we have suggested several novel approaches. One example is slow-motion and time-lapse functions of digital cameras as easily accessible tools to allow students to experience and develop familiarity with processes and features that are too fast, slow, large or small to be experienced directly.

We have chosen to apply the issue of scale to novel topics within sustainability education in geography, such as the reach of empathy, alternative futures and the issue of greenwashing efforts. These are core issues in sustainability education, and the ability to grasp the concept of scale will influence students' deep understanding of sustainability thinking on a local, global level and even universe-level. In addition, they start to reflect critically on sustainability issues from both personal and collective perspectives.

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Article

# Teaching and Learning Methods in Geography Promoting Sustainability

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**Abstract:** Understanding and learning geographic knowledge and applying it to sustainable development (SD) depends not only on the knowledge itself, but also on how it is taught and studied. The teaching and learning methods for promoting sustainability in geography have not been thoroughly studied. This qualitative study examined articles on geography teaching and SD. The material was selected using keywords related to geography education. The study describes 17 articles published in peer-reviewed scientific journals from 2008 to 2018. The focus group varied from primary to higher education. The proportion of teaching and learning methods were determined. The data were analyzed using qualitative content analysis. The foci of the analyses were the teaching and learning methods, topics, goals, and levels of thinking skills. Additionally, features of the teaching methods used in geography education, including outdoor education, to achieve the sustainable development goals (SDGs) were investigated. Different teaching methods used together and interactive learning were the most often preferred. Group work and teachers' presentations were mentioned in 12 articles, and inquiry-based learning and argumentation in half of the articles. The most often written expressions promoting SD in geography education concerned environmental sustainability (42%), followed by social (25%), economic (19%), and cultural sustainability (14%). The most emphasized features of the current teaching methods were active participation, thinking skills, animation, evaluation, dialog, demonstrations, and information and communication technology skills. The whole school approach and forward-looking perspective in geography should be implemented in school education to reach the SDGs and to support SD.

**Keywords:** general education; geography education; higher education; literature review; outdoor education; sustainability education

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## 1. Introduction

The International Charter on Geographical Education defines geography as, “the study of Earth and its natural, physical, and human environment” [1]. Geography involves the study of human activities and their interrelationships and interactions with environments on local to global scales. It bridges the natural and social sciences, and thus deals with spatial variability, that is, that phenomena, events, and processes vary within and between places and therefore should be regarded as an essential part of the education of all citizens in all societies. The abovementioned bases of geography can be regarded as supporting sustainability education (SE). According to Day and Spronken-Smith [2], interdisciplinary approaches which integrate three aspects—the economic, social, and physical aspects of sustainability—are not only well suited for geography, but remain the pre-conditions for understanding its multiple dimensions.

The core concepts in geography education are space, place, landscape, and sustainability [3]. Furthermore, sustainability can be conceptualized as a core geographical concept and also as a cross-curricular theme. In SE, sustainable development (SD) exercises can generate holistic experiences around philosophical, theoretical, and practical sustainability issues. Examples of the latter are forest schools [4], learning outside the classroom [5], and a range of creative approaches to education [6].

Education is seen as a key strategy for achieving sustainable development. Global Education and SE can help students develop their critical thinking skills and values and help them to understand a globalized and interdependent world and their own rights and responsibilities towards each other and the planet. These are the topics in human geography which must be comprehended by learners if they are to reach these goals in geography. The environmental anxiety caused by environmental problems has increased the need for SE. For their part, decision-makers should promote citizens' commitment to the environment and 'ecological literacy' [7–9]. According to McBride, Brewer, Berkowitz, and Borrie [10], ecological literacy frameworks emphasize systems thinking, which involves identifying the various biophysical and social components in a given environmental context and distinguishing their interrelations. An ecologically literate individual has a clear perception and understanding of a system's dynamics and ruptures, as well as its past and alternate future trajectories. They understand the complexity of studied objects and phenomena, thus enabling better decision-making. Higher order thinking skills, such as systems thinking, can be developed, for example, by place-based education (PBE) [11].

According to Woodhouse and Knapp [12], PBE refers to community-focused schooling, ecological education, and bioregional education. Stone [13] argued that PBE is fundamental to schooling for sustainability and that sustainability should be holistic in its approach. He also argued that familiar and beloved places are most likely to be protected and preserved for future generations.

Teaching SD in geography depends not only on high-quality subject matter knowledge, but also on modern researched pedagogical content knowledge, which means teachers' interpretations and transformations of subject matter knowledge in the context of facilitating student learning [14]. However, the teaching and learning methods in connection to education for SD in geography have not been thoroughly studied. This study should fill this gap in the research. The aim of this study was to investigate the most supported teaching and learning methods which promote sustainability.

## **2. Theoretical Background**

### *2.1. Geography and Sustainability Education*

Many geographers are critical of the concepts of environmental education (EE), education for sustainable development (ESD), and sustainable development education (SDE) [15–17]. The definition of concepts varies depending on the context [18]. According to Lucas [19], EE is a lifelong learning process which aims to raise environmental awareness and to promote local, regional, and global environmental activities [20]. According to UNESCO [21], ESD aims to make people aware of current and future environmental problems and challenges, and to create more sustainable and resilient societies. SDE, for its part, looks at the interaction between ecological and social systems with a view to developing solutions to a variety of unexpected situations [22]. All three are focused on quality education and a society that takes into account the carrying capacity of the globe [23]. Thus, they can be considered to include all dimensions of SD. In this study we use the term sustainability education (SE) [24], as it can be thought to include all forms of EE, ESD, and SDE.

In her study, Pauw [25] described future societies as rapidly changing, interconnected, interdependent, competitive, individualized, and knowledge-intensive. Geography and sustainability education offer ways to understand this increasingly complex and unsafe world. Based on geographic information, it is possible to predict order, uncertainties, crisis, and chaos. Geography's tradition in the human environment theme provides a methodological basis for dealing with issues of sustainability and geographical approaches concerning dynamics, complexity, and interactions which support the

understanding of the spatio-temporal dimensions of sustainability. In addition, geography also bridges, by its interdisciplinary approaches, the social and natural sciences [15]. Education in geography fosters knowledge, skills, and concepts for better understanding our being, our relationships with other people, and the universe [26]. So, geographic awareness and geographic consciousness are also important goals in SE cf. [27].

## *2.2. Geographical Competencies and Skills for Sustainable Development*

The International Charter on Geographical Education [1] states that studying geography should support young people to understand and appreciate how places and landscapes are formed, how people and environments interact, the consequences that arise from our everyday spatial decisions, and Earth's diverse and interconnected mosaic of cultures and societies. According to Haubrich [28], the achievement of SD requires geographic competences such as knowledge and understanding of the major natural systems of the Earth (landforms, soils, water bodies, climate, vegetation) and the interactions within and between ecosystems and the major socio-economic systems of the Earth (agriculture, settlement, transport, industry, trade, energy, population, and others).

Valuable geographical skills are the ability to communicate, think about, and use practical and social skills to explore geographical topics on a range of scales, from local to international. In addition, attitudes and values dedicated to seeking solutions to local, regional, national, and international problems on the basis of the Universal Declaration on Human Rights are indispensable [28,29]. Moreover, teaching about SD means teaching holistically. Geography, as a bridge between natural and human sciences, is used to practice such an approach. Geographical education contributes to this by ensuring that individuals become aware of the impact of their own behaviour and that of their societies, and that they have access to accurate information and skills to enable them to make environmentally sound decisions and to develop an environmental ethic to guide their actions [29].

## *2.3. Learning Topics and Interdisciplinary Skills for Sustainable Development through Geography Education*

The Lucerne Declaration states that the themes of the UN Decade of Education for Sustainable Development (DESD) 2005–2014 have much in common with geography's objects of study [30]. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) is involved in monitoring the progress towards Target 4.7 of SDG 4 on Education, which focuses on Global Citizenship Education (GCED) and Education for Sustainable Development (ESD). Target 4.7 states: "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development" [31]. According to Haubrich [29], the paradigm of SD should be integrated into the teaching of geography at all levels.

In Agenda 21 [32] and in the 2030 Agenda for Sustainable Development [33], the following topics for teaching can be identified: soil/land degradation; desertification; biodiversity/biodiversity loss; climate change; water/oceans; poverty and justice; health and food; consumption; gender differences/gender equality; and housing/safe, resilient, and sustainable human settlements and participation. The former also mentioned environment and development; pollution; agriculture; biotechnology; and new technologies. The latter also emphasize protection of ecosystems, sustainable energy, and sustainable industrialization. Thus, based on these descriptions, it can be stated that suitable teaching topics for education in geography include issues relevant to Earth science and human geography.

Creativity and innovation, creative thinking and problem solving, and communication and collaboration skills help students face future challenges [34]. Creativity includes using imagination, pursuing purpose, being original, and judging values [35]. Imagination involves looking at a situation from a different perspective or thinking of alternatives. Pursuing purpose and being original enable



the student to have a set action or intention while conceiving of new ideas. Creative thinking involves trying new possibilities and rejecting those that do not work. An essential skill that also fits with geography is problem-solving. It involves six key steps: observation of the problem; examination of the potential causes of the problem; identification of alternatives to solve the problem; selection of an approach to solve the problem; implementation of the solution; and verification that the problem has been resolved [34]. Communication and collaboration develop understanding and respect for others' perceptions and arguments, thinking and evaluating one's own personal motives, the relationship of common tasks to one's own competencies, setting your own goals, and thinking about problems and phenomena from different perspectives [29]. Developing communication and collaboration skills also develops global awareness [34]. All of these skills are part of the action competence needed for SD, which should be based on an adequate value orientation [29]. However, many research outcomes have shown that knowledge and skills are not sufficient to produce adequate sustainable behaviour [36–39]. Students should have a chance to experience how beautiful nature can be, how precious culture is, how worthwhile communities and societies are, so they will be ready to protect all these parts of the human–earth ecosystem [29].

#### *2.4. Teaching and Learning Principles and Methods Promoting Sustainability in Geography Education*

There are several principles in geography education that support the learning of sustainability issues in connection with various teaching and learning methods. According to Haubrich [29], group discussions concerning the structure of a problem, the causes of the problem, and the potential responses to solve the problem from an ecological, economical, and societal point of view are appropriate methods for studying ecological issues. In geography education, it is also important to practice how to behave ecologically, socially, economically, or politically. Group work and projects with activities, such as letters to newspapers and exhibitions at public places, are some well-known teaching methods.

According to Catling [40], geography education should be based on children's geographies or geographical knowledge and the active role of children in their own learning. Valuable environmental experiences can arise when studying takes place with appropriate activities in different environments [41]. The interaction between the student and the place gives birth to the meaning of the place. Meaningful learning experiences support the students' sense of place and identity, arousing their attachment to people and the landscape [5]. According to Hutson [42], "place-based education seeks to connect students to local environments through a variety of principles and strategies that increase environmental awareness and connectedness."

#### *2.5. Outdoor Learning Promotes Sustainability in Geography Education*

In this study, the definition of outdoor learning is based on the findings of Blenkinsop, Telford, and Morse [43]. They generated a list of pedagogical skills, such as, "becoming more outdoor, environmental, place-based, emergent and/or experiential in the teachers' own practices". The list was based on experienced outdoor school teachers' teaching and learning strategies and the skills that can be regarded as the important skills developed by learners when learning outdoors. Experiential learning was identified as the key teaching and learning strategy in their study. Thus, it is important to pay attention to PBE when learning geography outdoors. According to Way [44], participants acquired meaningful learning on their research topic through PBE. It is an interdisciplinary and experiential learning approach which uses the local environment and society [45].

Outdoor learning is based on holistic, experiential learning, and the integration of knowledge and skills across disciplines [46]. So, learning outdoors can be used for all subjects as well as SE [47,48] for supporting personal and social development, even on a primary school level [49,50]. Moreover, learning outdoors can foster individuals' physical well-being, social and emotional well-being, and deeper levels of learning [51]. Learning in the natural environment develops students' environmental sensitivity, fosters their concrete understanding of environmental issues, and engages students actively with ecological issues [52].

Geography, for its part, supports understanding how people intervene in the world's natural and social processes and, in turn, how spaces, places, landscapes, and environments are affected by such interventions [5,53]. The development of identity, community, and environmental responsibility is supported by a sense of space [54]. Consequently, geography education has a central role in connecting the outdoor physical environment, the sense of space and place, and man's actions in it to support SE.

Creativity is a fundamental part of learning for all learners, but especially for young ones. It requires space and time, as well as a degree of freedom and deep immersion in an area [55]. A variety of multi-modal teaching approaches support this kind of creative learning by involving learners in imaginative experiences and by connecting their learning to their lives [56]. Learning about geographical issues, such as climate change, and developing geographical thinking in outdoor environments offers good opportunities for creativity, which can support the problem-solving skills needed for addressing environmental problems. The outdoor environment provides an opportunity for holistic learning, integrative approaches, and building one's own relationship with nature. Outdoor education also promotes students' concentration, learning, and retention better than teaching and learning in a classroom [57]. These basic skills can be used when confronting the central outdoor environmental issues, and, thus, they support effective learning about sustainability.

Children's connections to the landscape, nature, and people in it can also be developed through outdoor learning, as children learn issues about their living environment and develop their place knowledge. Such learning would be possible if children were studying co-operatively and collaboratively [58] through "ground learning" in local phenomena, gaining "lived experiences" [59]. Consequently, through geographical cross-curricular themes, which foster a strong sense of place and space, understanding of sustainability can also be supported.

### **3. Research Aim and Questions**

Promoting sustainability should also be at the heart of geography. Teaching and learning methods play an important role in learning. However, comparative and evaluative studies have not been conducted from the perspective of SE. This study fills this gap. The results can be used to develop geography curricula and teaching in teacher and school education.

The research was guided by the following research questions:

RQ1: What are the teaching and learning methods used in geography education for achieving the sustainable development goals (SDGs) in general and higher education?

RQ2: What are the goals and topics in geography education for achieving SDGs?

RQ3: What are the features of the teaching and learning methods currently used in geography education and SE, including outdoor education, for achieving SDGs?

### **4. Materials and Methods**

#### *4.1. Data Collection*

In this qualitative study, the focus was on articles that concerned geography teaching and SD. The data collection method was a modification of the method used by Jeronen et al. [23]. Articles for the analysis were sourced from scientific databases, such as ERIC, Web of Science, and Education Database. All searches were done in English and conducted in October 2018. The search strategy was based on a systematic organization, categorization, and selection of Boolean keywords related to geography education. A word search was conducted in relation to the terms of geography education and instruction, teaching methods, SD, sustainability, environment, and outdoor education. For each scientific database, a hierarchical search strategy was applied, starting from the simplest combination of Boolean forms and then progressing to more complex forms. Additionally, manual examinations of key journals in geographical education were performed.

The initial searches of the scientific databases and the manual examinations of scientific journals came up with over 2000 search results, from which 52 were chosen for reviewing (covering 2005–2017). However, of these 52 articles, only 17 met the following inclusion criteria and were chosen for the analysis. To be more comparable with the earlier study of the research group [60], the present study ended up with similar data collection criteria applied to geography and its natural and social sciences character:

- (a) Scope: national and international research;
- (b) Type of research: empirical research on teaching methods in geography education and SE, including outdoor education;
- (c) Period: 2008–2018;
- (d) Target groups: students in primary schools, secondary schools, and higher education;
- (e) Language: English;
- (f) Quality: academic papers published in peer-reviewed journals.

The rejected articles focused on curriculum, did not include elements of sustainable development, or included more general descriptions of large courses or education programs, not about the teaching or learning methods themselves. The chosen articles were published in 2008–2018 (Table 1) and their focus groups varied from primary school level to student teachers.

**Table 1.** The journals of the analyzed articles and the teaching and learning target groups.

Journal	Article Number	Level
Children's Geographies	[61]	S
Education Sciences: Theory and Practice	[62]	S
Environmental Education Research	[63,64]	H, P
Hydrology and Earth Sciences	[65]	S/ST
Interactive Learning Environments	[66]	
International Research in Geography and Environmental Education	[67–70]	S, ST, ST/P, S
Journal of Computer Assisted Learning	[71]	S
Journal of Education for Teaching	[72]	ST/S/H
Journal of Geography	[73]	ST
Journal of Geography in Higher Education	[74]	ST
Journal of Teacher Education for Sustainability	[75]	P
Review of International Geographical Education Online	[76,77]	H, P

Notes: P = primary, S = secondary school, H = high school, ST = student teacher education level, e.g., ST/P student teacher education for primary level.

#### 4.2. Analyses

The material was analyzed using content analysis methods [78,79]. Firstly, the material regarding the teaching and learning methods (RQ1) and the topics and goals (RQ2) in geography education for achieving SDGs was divided into two sections for the analyses. The first section contained the entire articles and every teaching and learning method mentioned in them, including the background theory. In the second section, consisting of articles in which the teaching and learning methods, level of knowledge, and thinking skills were studied, only those parts of the articles (excluding the theory part and references) which described the teaching and learning methods used and studied were reviewed. The proportions of the teaching and learning methods used were counted. The proportions were counted with the method of using inductively created Boolean operators and search tools to count the occurrences of each method in each article. Each search result of the Boolean operator was manually checked to verify if it corresponded with the method in question, and then it was counted into the sum of the occurrences. Titles, tables, or references were not included in the sum of the occurrences. Some of the Boolean operators did not result in any occurrences, even though the method had been mentioned in the article. Despite the weaknesses of the method, it was found to be the most effective, as corresponding mentions of each method might be as many as over 90 per article.

Thereafter, deductive analyses were carried out (RQ1) for identifying the level of knowledge [80] and thinking skills [81] included in the teaching and learning methods.

To determine different topics and goals of SDE presented in the expressions collected from the reviewed articles, the expressions were classified deductively according to the UN's definitions of the 17 SDGs (RQ2). These subcategories of the 17 SDGs were then classified into four different main categories: social, cultural, economic, and ecological SD (Table 2).

**Table 2.** The 17 subcategories concerning SDGs.

Subcategory	Main Category
Goal 1. No poverty	Social
Goal 2. Zero hunger	Social
Goal 3. Good health and well-being	Social
Goal 4. Quality education	Social
Goal 5. Gender equality	Social
Goal 6. Clean water and sanitation	Social
Goal 7. Affordable and clean energy	Economic
Goal 8. Decent work and economic growth	Economic
Goal 9. Industry, innovation and infrastructure	Economic
Goal 10. Reduced inequalities	Cultural
Goal 11. Sustainable cities and communities	Cultural
Goal 12. Responsible consumption and production	Environmental
Goal 13. Climate action	Environmental
Goal 14. Life below water	Environmental
Goal 15. Life on land	Environmental
Goal 16. Peace, justice and strong institutions	Cultural
Goal 17. Partnership for the goals	Cultural

The material was also analyzed using a qualitative–quantitative mixed method approach [82] to be able to answer RQ3 concerning features of the teaching and learning methods currently used in geography education and SE, including outdoor education for achieving SDGs. Initially, the articles were read thrice and all substantive expressions concerning features of the teaching and learning methods currently used were written down. After the collection of the expressions, they were inductively classified into subcategories. This subcategorization was repeated independently with the created subcategories to reduce the risk of subjectivity. In the rare case of conflicting subcategories, each of the subcategories was reconsidered, and if any were applicable, they were included in the final subcategorization. The final subcategories were then classified into inductively created higher-order main categories, which enabled us to identify features of the currently used teaching methods.

In order to ensure the reliability of the process, one researcher read the article thrice, and thereafter, all three members of the research groups checked the selections.

## 5. Results

### 5.1. The Most Often Used Teaching and Learning Methods in Geography Promoting SE: The Supported Thinking Skills

The results showed that the teaching and learning methods most often used in geography education for achieving the SDGs in different educational levels were different teaching methods used together, followed by interactive learning (both were noted in 16 of 17 articles). Group work and teacher presentations were mentioned in 12 out of 17 articles (Table A1 in Appendix A). Inquiry-based learning and argumentation were mentioned in half of the articles. Experiential learning (seven articles), information and communication technology (ICT), group discussion, co-operative and collaborative learning (all mentioned in six articles) were also supported, as well as outdoor learning and field work, teacher inquiry, and also games, role plays, and debates were all in five articles.

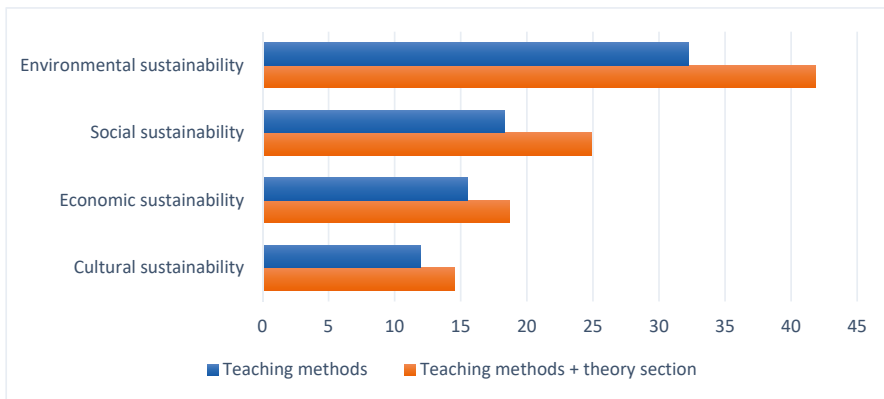
In counting how many times the term for a certain teaching and learning method was mentioned in the 17 articles altogether in their material, methods, results, and discussion sections, we found interactive learning was mentioned 389 times, followed by ICT, which was mentioned 208 times. The following were mentioned over 100 times in this order: experiential learning (198), group work (144), place-based pedagogy (133), and outdoor learning and field work (118). Problem-oriented and problem-based learning (PBL) and argumentation reached nearly 100 mentions, as did inquiry-based learning. The least popular were both art education methods, such as art instruction, drama, story-line, and reading stories, and service-learning approaches.

The levels of knowledge and thinking skills concerning geography teaching and learning that promotes sustainability were also studied (Table A2 in Appendix A). Fact knowledge and concept knowledge were supported in all articles. Method knowledge was supported in 14 articles and metacognitive knowledge less often, in 11 of the articles.

The lower level of thinking skills (remembering, understanding, and application) were introduced in all 17 articles and analysis and synthesis in 16 articles. The highest level of thinking skills, evaluation, was not present in five articles.

### 5.2. The Topics and Goals in Geography Education Concerning SDGs

In 17 articles on topics in geography education concerning SDGs, there were 461 expressions excluding the theory part of the articles and 584 expressions including these parts. The most often written expressions promoting SD in geography education (Figure 1) were directed to environmental (ecological) sustainability (such as climate change, ground water) (42%), followed by social sustainability (such as gender equality, sustainable lifestyle, healthcare) (25%), and economic (19%) and cultural sustainability (such as traditional cultural knowledge, cultural knowledge of place) (14%). In 11 articles, the sustainability issues were examined both at the local and global levels.



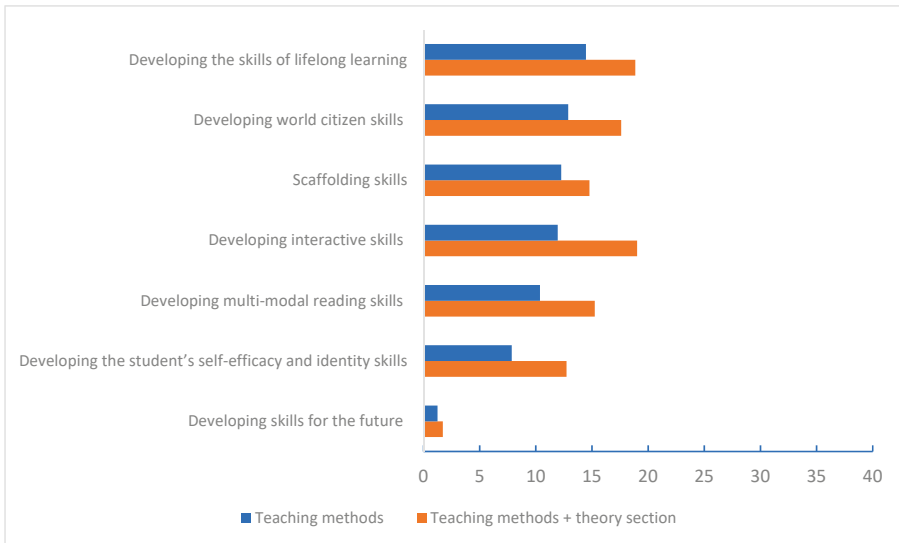
**Figure 1.** Percentage of the dimensions of the sustainability education promoted in geography education, including outdoor education, analyzed in the 17 articles. The four categories were based on expressions in the articles ( $n = 584$  expressions including the theory part) and on the stated goals in geography education.

Several goals were identified regarding geography education promoting SE in the 17 analyzed articles: to promote the teaching of SD; to understand the interdependency between humans and nature; to encourage information retrieval and essential discovery; to encourage an interdisciplinary approach; to develop civic skills, system thinking, and sustainable lifestyle; to form your own opinion; to develop pedagogical content knowledge of SD; and to understand the forming and maintaining of ground water, positive future images, and awakening environmental sensitivity.

5.3. The Features of the Teaching and Learning Methods Currently Used in Geography Education and Sustainable Education, Including Outdoor Education, for Achieving SDGs

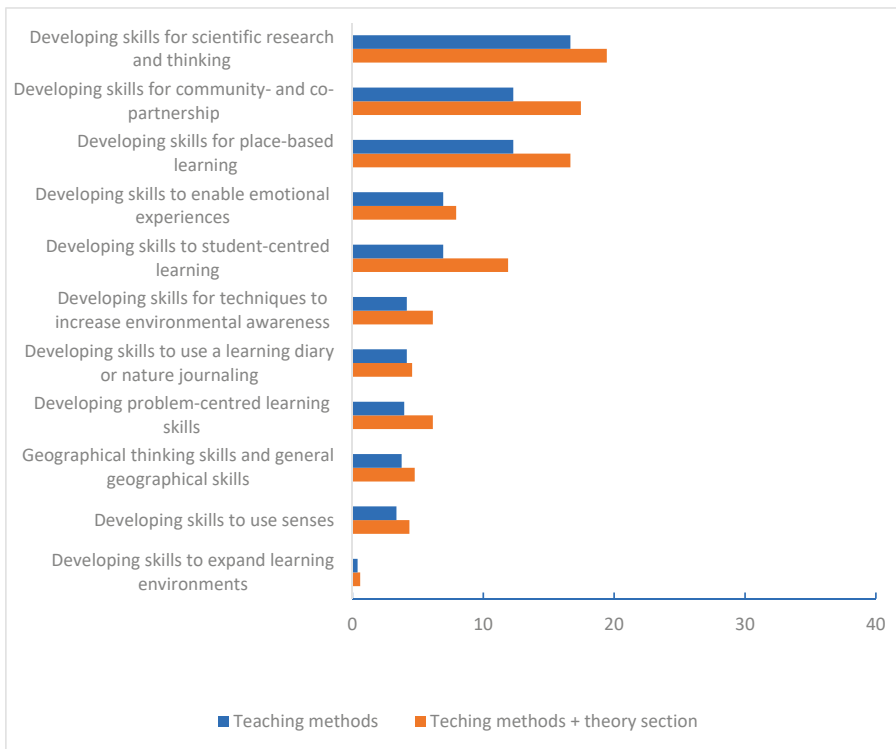
Altogether, there were 1427 expressions concerning the features of the teaching and learning methods currently used in geography and SE, including outdoor education, for achieving SDGs. They were various. One example of these expressions was, “I used diaries as a medium for discussion, holding a ‘conversation’ with students about their learning of sustainable development across the course of one academic year”, which reflected interactive skills between the teacher and students. All in all, 105 different categories of the expressions were classified and, among others, included active participation, thinking skills, animation, evaluation, dialog, demonstrations, and ICT-skills.

General teaching and learning skills (Figure 2) were expressed 636 times as ways to support SD in geography, such as developing skills of lifelong learning (expressed in 19%) and global citizen skills (18% of all expressions). Developing skills for the future was found in only in 2% of the articles about promoting SD in geography. The others were scaffolding, developing interactive skills, developing multi-modal reading skills, and students’ self-efficacy and identity.



**Figure 2.** Percentage of the general teaching and learning skills in geography that promote sustainable education, including outdoor education, for achieving sustainable development goals ( $n = 636$  expressions including the theory part).

Teaching and learning skills in geography (Figure 3) were identified 504 times in the articles about promoting sustainable education, including outdoor education. Among the most often expressed were the skills of scientific research and thinking skills (19%), developing community and co-partnership skills (17%), and place-based learning (17%), and less often mentioned were the general geographical thinking skills and general geographical skills (5%), the use of the senses (4%), and expanded learning environments (<1%).



**Figure 3.** Percentage of the expressions ( $n = 504$ , including the theory part) of teaching and learning skills in geography that promote sustainability, including outdoor education, for achieving sustainable development goals.

Concerning teaching skills in geography, the articles studied mentioned that integrative and interdisciplinary approaches, development of the teaching skills of a teacher, and encouragement of students to be creative are important features to be taken into account.

## 6. Discussion

Citizenship Education and SE support the development of critical thinking skills and help young students understand the complexities of a globalized and interdependent world, as well as reflect on their rights and responsibilities towards each other and the globe. Thus, environmental awareness and consciousness can be seen as important goals, both in geography and in SE [27]. Education in geography fosters knowledge, skills, and concepts for better understanding our own existence and our relationships with other people and the universe [26]. Teaching SD in geography depends not only on high-quality subject matter knowledge, but also on modern pedagogical content knowledge, meaning the teachers’ interpretations and transformations of subject matter knowledge support students’ learning [14]. Teaching and learning methods should include goal-oriented activities and information exchange between a teacher and students [23]. It is important to study teaching and learning methods, as they have effects on cognitive, affective, and psychomotor learning [83,84].

Yli-Panula et al. [60] emphasized in the earlier study regarding biology teaching methods promoting biodiversity learning that comparative evaluation is needed in relation to the expected results of teaching methods. This study filled the gap concerning geography teaching methods promoting sustainability. The results showed that the teaching and learning methods most often

used in geography education for achieving the SDGs in different educational levels were different teaching methods used together, followed by interactive learning. Using different teaching methods together and incorporating ICT can improve learning. As in the study of biology teaching methods [23], ICT, group work, and teacher presentations were popular. Haubrich [29] recommended group work and discussions as appropriate teaching and learning methods for studying ecological issues. Inquiry-based learning, experiential learning, co-operative and collaborative learning, group discussion, and argumentation were all emphasized, as well as outdoor learning and field work. Co-operation and sharing their own experiences, views, and reasoning in a group helps students understand their own thinking [85] and can support critical thinking and commitment to science education [86]. Through outdoor learning and field work, students' environmental sensitivity, and their concrete understandings of environmental and ecological issues can be developed cf. [52].

The least popular were art education methods, such as art instruction, drama, story-line, and reading stories. The reduced use of these was surprising, as it would be possible to incorporate emotional experiences into studying through these teaching and learning methods, and thus foster individuals' physical, emotional, and social well-being, and deeper levels of learning [51]. Collaborative reading and discussion of read text helps students to understand the text in depth [87]. Although place-based learning was considered important in the reviewed articles, the whole-school approaches were not used at all and service-learning approaches were only mentioned in a few articles. This result is similar to that of a previous study of biology teaching methods by Jeronen et al. [23]. The two approaches mentioned above represent PBL, which enables students to get to know their own neighborhood and community [88,89]. In geography education too, such approaches have been used more extensively than before, as they can generate public interest and motivate local, regional, and national decision-makers to integrate SE into school curricula [90].

The most often mentioned topics promoting SD in geography education were directed to environmental (ecological) sustainability, such as climate change and ground water, followed by social sustainability, such as gender equality, sustainable lifestyle, and healthcare, and then by economic and cultural sustainability, such as traditional cultural knowledge and cultural knowledge of place. The sustainability issues were examined both at local and global levels in most articles.

In this respect, the topics were consistent with the topics presented in Agenda 21 [32] and in the 2030 Agenda for Sustainable Development [33]. There were surprisingly few ecological topics. Issues such as desertification, biodiversity loss, pollution, and protection of ecosystems were hardly addressed. The following economic issues were also missing, consumption, sustainable energy, and sustainable industrialization, which are topics for teaching identified in the lists by the UN [32] and in the 2030 Agenda for Sustainable Development [33].

As important goals in geography education, promoting SD and teaching of SD were mentioned in such a way that students are able to understand the interdependency between humans and nature. Haubrich [29] stressed that individuals should become aware of the impact of their own behaviour. According to UNESCO [31], students should have the possibility to acquire the knowledge and skills needed to understand what human rights, gender equality, a culture of peace and non-violence, global citizenship, and cultural diversity mean. In the articles, it was also emphasized that students should be encouraged to discover information for forming their own opinion. This supports the statement by UNESCO [31], which includes the idea that valuable skills for developing SD are communication and practical and social skills to explore important topics in a range of scales, from local to international. It was also noted as an important goal that teaching should be interdisciplinary, and that it should support and foster positive images of the future, awaken environmental sensitivity, support system thinking, and develop civic skills for sustainable lifestyles cf. [27]. In addition, another important goal was to develop pedagogical content knowledge of SD.

A number of the features of the teaching and learning methods currently used in geography education and SE, including outdoor education, for achieving SDGs features of general learning skills and learning skills in geography were seen to be important. The most important concerning the former



was seen to be the development of lifelong learning and global citizen skills. Surprisingly, “developing skills for the future” was found only in couple of the articles, although it was seen that important goals are fostering positive images of the future and development of civic skills for a sustainable lifestyle to promote SD in geography. The other emphasized features were scaffolding, developing interactive skills, developing multi-modal reading skills, and students’ self-efficacy and identity. Among the most often expressed learning skills in geography were the scientific research and thinking skills, developing community and co-partnership skills, and place-based learning, and less often were the geographical thinking skills and general geographical skills and the use of senses. Expanded learning environments were not seen as an important feature of teaching methods, although they could offer good possibilities for PBL [88,89]. Also, Smith [59] argued that geographical education should be based on local phenomena and students’ lived experiences. Thus, students, places, and purposeful activities together can produce viable and valuable environmental educational experiences [41], supporting students to develop a sense of place and identity. This again would be a meaningful starting point for a sustained engagement with people and the landscape itself [5].

## **7. Main Conclusions and Implications**

This study aimed to identify and describe useful teaching methods in geography education, including outdoor education, to promote sustainability and the goals, topics, and features regarding the teaching methods. Teaching methods in geography which include both physical and human environments cannot be listed from most to least effective, as they are content- and subject-dependent. However, it can be concluded that the whole-school approach, service learning, and future prospect of using different teaching methods together and PBL in learning geography should be implemented in school education to reach the SDGs and to support all four (environmental, social, economic, and cultural) dimensions of SE.

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Appendix A

Table A1. The teaching and learning methods mentioned in the 17 articles analyzed.

Teaching Methods/Article Number	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
Teacher's presentation	x		x	x	x	x	x	x			x		x				
Teacher's inquiry	x		x	x		x					x						
Teaching discussion						x					x						
Group work			x	x	x	x	x	x		x	x	x	x	x	x	x	x
Co-operative/collaborative learning			x	x							x	x	x	x		x	x
Different teaching methods together	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ICT					x	x					x			x	x	x	
Hands-on instruction							x	x				x					x
Inquiry-based learning			x	x	x	x	x		x				x		x	x	
Argumentation		x	x	x		x				x	x				x	x	
Case teaching; Socratic method					x					x	x			x	x		
Interactive learning		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Problem-oriented/problem-based learning										x							x
Experimental learning							x						x		x		x
Project work							x						x		x		x
Service learning																	x
Outdoor learning and field work				x						x			x				x
Place-based pedagogy				x									x				x
Study trips and visits										x							x
Games, role plays, debates			x														x
Art instruction																	x
Drama or story line					x												x
Reading stories				x													x

Table A2. The level of thinking skills and knowledge in the 17 articles analyzed.

Level of Thinking Skills and Knowledge/Article Number	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
Remembering	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Understanding	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Application	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Analysis	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Synthesis	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Evaluation	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fact knowledge	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Concept knowledge	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Method knowledge	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Metacognitive knowledge	x		x	x				x	x			x	x	x	x	x	x

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Article

# Regional Collaboration for Sustainability via Place-Based Ecology Education: A Mixed-Methods Case Study of the Upper Valley Teaching Place Collaborative

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**Abstract:** Place-based Ecology Education (PBEE) has emerged as a compelling approach to achieving the sustainability goals of Environmental Education (EE), including helping children understand, care about, and take action to protect the environment. Collaboration for teacher training can amplify and expand the reach and effectiveness of PBEE within a given geographic region. This case study of a collaborative of five PBEE professional development organizations provided a noteworthy example of collective evaluation. The primary data source was quantitative and qualitative analysis of 156 survey responses from K-12 classroom teachers, administered from 2016 to 2018 in the Upper Valley region of New Hampshire and Vermont. On average, teachers reported medium-sized (Cohen's  $d$  0.4 to 0.6), statistically significant changes over the prior year for all six PBEE core practices measured. Teacher responses to open-ended survey items suggested that PBEE often involves coordination between and contribution from multiple players with different roles but similar goals. Cross tabulation with quantitative results suggested that collaboration within schools was a central factor associated with high levels of PBEE practice.

**Keywords:** collaboration; environmental education; place-based education; ecology education; mixed methods; evaluation; professional development; K-12 education; collective evaluation

## 1. Introduction

Over thirty years ago, the founding document establishing Environmental Education (EE) as a strategy for achieving sustainability at national and global levels called for EE to focus outward toward the community [1]. More recent international declarations [2] have both broadened and deepened the aims of sustainable development to include issues of poverty and empowerment, even as evidence of the undesirable consequences of anthropogenic climate change and exponentially increasing population and resource consumption continues to mount. Geography as a discipline is well suited as a conceptual framework for translating these broad goals into tangible educational action. Geo-literacy has been defined as “the ability to reason about Earth systems and interconnections to make far-reaching decisions” [3,4]. But what does that look like in practice?

Environmental educators have often used the geographic notion of “place” to examine food systems, forest resources, watersheds, and other local resources to make broader and more complex ecological phenomena more relevant and understandable [5]. Place-based Ecology Education (PBEE) integrates community connections and seeks to use local places to achieve the sustainability goals of EE and the educational goals of geo-literacy. PBEE has been defined as “... the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics,



social studies, science, and other subjects across the curriculum” ([6], p. 7). Although the content of PBEE explorations is often not explicitly environmental sustainability or geography per se, PBEE does incorporate a developmental perspective [6]. The most developmentally appropriate (and thus most potent) scale of inquiry for school age children on a path toward environmental values and behaviors as adults is often the local community [7].

An emphasis on place and local contexts, however, is often unsupported by national standardized curricula [8,9]. To make a sustainable, rather than idiosyncratic, connection between schools and communities, collaborations are necessary [10]. PBEE researchers have posited that collaborations with experts and community resources outside of the school system are potentially one of the most important strategies for successful PBEE [9]. Although partnerships between schools and community organizations (and related student outcomes) have been examined in the literature, collaborations focused on teacher training have received less attention. Collaboration for teacher training is a particularly important issue for EE sustainability because shared resources and networks among educators can amplify and expand the reach of PBEE within a shared geography.

This case study of ways in which a regional PBEE collaborative for teacher training contributed to changes in teacher practice was an opportunity to investigate the rich intersection between the ideas of collaboration and community connections described in the literature.

### *1.1. The Case*

The Upper Valley Teaching Place Collaborative (UVTPC, or the Collaborative) is a group of five organizations providing PBEE professional development (PD) programs. They met from 2015–2018 to “increase the quality, capacity, coordination, collaboration, and accessibility of PBEE professional development offerings in the Upper Valley,” (UVTPC, personal communication, 26 January 2016). The Upper Valley is a region consisting of 61 towns spanning part of the Connecticut River watershed in Vermont and New Hampshire, USA. The partner organizations are Shelburne Farms’ Forest for Every Classroom (FFEC), Four Winds Upper Valley Linkages for Environmental Literacy (UVLEL), Vermont Institute of Natural Science—Center for Environmental Education (VINS), Vital Communities—Upper Valley Farm to School (UVFTS), and the Wellborn Institute (WI). The two main objectives of the Collaborative were to implement rigorous and replicable tracking of PBEE teacher practice in the region and to promote higher quality collaboration among the PD providers that make up the Collaborative. The organizations interacted routinely through in-person and remote meetings as well as through subgroup interactions on related projects, including a structured protocol (adapted from [11]) for documenting how participating in the Collaborative led to useful changes in practice for members.

From its inception, the UVTPC integrated program evaluation into their work. They hired professional evaluators to guide and execute a shared evaluation and research agenda, and to provide critical, supportive insight into the Collaborative’s direction and operations. The Collaborative’s commitment to evaluation was notable given that the EE community is still at the beginning stages of embracing evaluation into its culture as a capacity-building tool for reflection and growth [12].

Starting in the early 2000’s, various UVTPC programs began receiving funding for both program implementation and program evaluation from the Wellborn Ecology Fund of the New Hampshire Charitable Foundation. Many other related organizations in the Upper Valley region have also received consistent and substantive financial support from the Wellborn Ecology Fund for sustainability related work. This includes the Place-based Education Evaluation Collaborative (PEEC), whose work from 2002 to 2010 laid much of the specific groundwork on which activities of the Collaborative were built. In sum, UVTPC’s results occurred in a context of consistent support from a regional community foundation.

### *1.2. Research on Collaboration for PBEE*

Research outside of formal education suggests that collaborations for community-focused EE are a powerful way for EE to reach its intended audience and promote its goal of educational transformation

through collective involvement [13–16]. In a comprehensive review of the community-based EE peer-reviewed literature from 1994–2013, Aguilar [13] found the majority of the programs being studied were the product of some form of collaboration (e.g., NGO/grassroots, government agencies, university research). Collaboration helped the programs to maintain sustainability and reach their objectives. Similarly, Norlander and colleagues [7] found that successfully engaging interpretive staff in a collaboration among informal science education institutions required a trusting and diverse team, an iterative development process, and effective structures for sharing resources and ideas.

Small groups of programs pursuing EE have been successful when they viewed differences of approach as complementary and beneficial [17,18]. Gupta and colleagues [19] examined two types of collaborations in the USA for incorporating EE in K-12 education: between community groups and between established EE groups. Although both types of collaboration had differences in power balances and EE perspectives, the authors found that awareness among collaborators in both groups about these differences supported more integrated and sustainable group dynamics. Smith and colleagues [9] studied four Australian EE-related professional associations collaborating on sustainability education and teacher professional development. The groups identified ways in which their goals and terminology did and did not overlap. The researchers found that promoting shared goals was associated with more positive and sustainable group dynamics.

In evaluating the collaborative processes and outcomes of a group of four PBEE programs in New England, Powers [20] found that participants expected to learn from the other programs in the group and enrich their own program offerings through these interactions. For the classroom teachers served by these programs, six areas were consistently positively impacted: teachers' use of local resources and locations, interdisciplinary approaches, peer collaborations, leadership and growth, curriculum planning and delivery skills, and integration of service-learning.

The UVTPC case explored in this manuscript exemplified all of the collaboration dynamics described in these previous studies. Participants in the Collaborative worked very well together toward their shared sustainability goals. It was within this context that we investigated the PBEE practices of the classroom teachers served by the UVTPC.

### *1.3. Research on Collaborations for Teacher Professional Development (PD)*

Teacher practice change is a logical precursor to changes in student learning [21]. Yet, outcomes research routinely focuses on student or participant assessments [12,13,22] more than on outcomes for the connecting agent, the teacher. Investigations of teacher training also routinely use factual knowledge (e.g., environmental literacy) as a measure of training effectiveness, rather than change in practice [13,23,24]. Examining how teachers are trained via pre-service schooling and through in-service PD is an important way to improve the field of PBEE [8,25,26].

Examples of how collaborations for teacher training have promoted teacher preparedness to deliver PBEE have been detailed in relatively few contexts in the literature. McKeown-Ice [25] and Powers [27] noted that training for EE tends to be partial or non-existent in many university-level preservice teacher training programs. The PBEE training they found tended to emphasize individual practice rather than engaging in a learning community [25] or to emphasize printed EE resources that focus on topical knowledge rather than knowledge networks [27]. Both authors highlight the potential role of professional organizations and community partners as a means to enhance teacher preparedness. Additionally, Smith [9] noted that teachers are often underprepared for how to seek out collaborations for PBEE with their colleagues and/or the community.

A few notable instances of PBEE teacher training in the research literature occurred in the southeastern USA and Australia. In Kentucky, an evaluation of a 6-day professional development program found post-training increases in: building teacher confidence for integrating EE across the curriculum, engaging in collaboration with community members and fellow participants, incorporating reflective learning practices, incorporating experiential learning practices, linking classroom content to relevant current issues, and promoting citizenship education [26]. McNerney and colleagues [8]

examined these types of collaborations in Australia. They found that a team approach to teacher training involving multiple courses and topics with university partners helped nurture a more inclusive understanding about local geographies and cultures, establish collaboration as a primary means of functioning for EE in the region, and instill reflective practices as teachers grew in their learning.

Because all member programs of the UVTPC are explicitly teacher professional development programs, examination of their case was well suited to contribute to the relatively few instances of related work in the empirical, peer-reviewed literature.

#### *1.4. Research Question*

Given the current knowledge about collaborations for sustainability and PBEE, and, in particular, teacher training for PBEE, the broad research question guiding this case investigation was: In what ways did the UVTPC contribute to changes in PBEE teacher practice? To examine this overarching question, we present detail on three specific areas of inquiry:

- What trends characterized teacher changes in PBEE core practices?
- What helped and hindered teachers in making progress on PBEE core practices?
- How did practice changes and reported helps and hindrances vary by the amount of recent PD and current level of PBEE practice?

## **2. Methods**

Data for this case study consisted of quantitative analysis of closed-ended survey items, and qualitative analysis of open-ended survey items and notes from meaning making conversations between program staff and evaluators, as described in detail below.

### *2.1. Groundhog Day Survey Instrument Development*

At the beginning of the three-year engagement with the UVTPC, a central task was to build a tool to measure delivery and outcomes of PBEE across the five programs' collective professional development offerings. Staff from organizations in the Collaborative worked together with evaluators and the main funder to identify and refine six diagnostic features of PBEE, and labeled them the "PBEE core practices" (Table 1). They include using local areas, collaborating with the community, collaborating with fellow educators, adapting teaching style, adapting standardized curricula, and using locally relevant curricular content. These practices are consistent with the distinctive characteristics of place-based EE [28] and are articulated at a level of detail that is approachable for teachers from varied grades, schools, and pedagogical approaches. Essentially, this definitional work completed efforts begun by the Place-based Education Evaluation Collaborative (PEEC) [29] and reflected in published research by Powers [20,27].

The main content of the survey included a retrospective-pre structure asking teachers to self-report their level of practice "one year ago" and "now" on the six PBEE core practices (Table 1). Members of the Collaborative selected a five-point Stages of Change response scale for these items. The scale was adapted from research on behavior change in smoking cessation [30], with terminology further adapted for climate change studies [31]. The five Stages of Change are: (1) Disinterest—Not necessarily opposed to making this part of my teaching practice, but not intending to change soon; (2) Deliberation—Thinking about making this part of my teaching practice, perhaps unsure about costs versus benefits; (3) Designing—Actively preparing to make this part of my teaching practice soon, feeling fully convinced; (4) Doing—This is my regular teaching practice; and (5) Deepening—This has been my normal, automatic teaching practice for a long while, I'm seen as an enthusiastic "champion".

**Table 1.** Core Place-based Ecology Education practices reported for “One year ago” (Pre X) & “Now” (Post X) for the Upper Valley Teaching Place Collaborative, aggregated for 2016, 2017, and 2018.

Description <sup>1</sup>	Pre X	Post X	$\Delta X$	SD	Cohen's <i>d</i> Effect Size	$\Delta R^2$	df
<i>Average of six place-based ecology education core practices items</i>	3.2	3.7	+0.5 ***	0.9	+0.6	0.06 **	119
I regularly use the area immediately around the school and other community locations as places for learning	3.4	3.9	+0.5 ***	1.1	+0.5	0.02	119
I regularly collaborate with local organizations and community members for planning and teaching	3.2	3.6	+0.4 ***	1.1	+0.4	0.06 **	119
I regularly collaborate with fellow teachers to make our teaching more place-based	3.3	3.7	+0.4 ***	1.0	+0.4	0.06 **	119
I regularly adapt my day to day teaching choices, language, and cultural references to incorporate locally relevant content	3.2	3.6	+0.4 ***	1.0	+0.4	0.03	119
I regularly adapt standardized curriculum to make it more locally relevant	3.2	3.6	+0.4 ***	1.1	+0.4	0.04 *	119
I regularly use locally relevant content to anchor interdisciplinary curriculum units or overarching learning themes	3.1	3.6	+0.5 ***	1.1	+0.5	0.05 *	119

<sup>1</sup>  $n = 160$ , with participation within each of the five programs  $n = 22-45$  and  $X = 32$ . \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Other questions on the survey included open-ended items about helps and hindrances for PBEE implementation, and quantification of the amount of PBEE training received from various sources over the previous year. Additional program-specific items were included as well, but are beyond the scope of this case study of the UVTPC as a whole.

## 2.2. Groundhog Day Survey Administration

The survey population was defined as formal K-12 teachers who had been active in at least one UVTPC program in the past three years. From this population, evaluators created a sampling frame consisting of either a census of program participants for the smaller programs, or a random sample of 20–30% of program participants for larger programs, resulting in a range of 10–27 teachers per program.

In 2016, 2017, and 2018, on or around February 2nd (Groundhog Day in the USA), the survey was administered to teachers participating in UVTPC programs. This time of year was chosen because it coincided with a relatively flexible period in the school year rhythm. Also, there was an attempt to make an analogy with the promise of the pending season of spring and growth symbolized by Groundhog Day, as well as with the Audubon Christmas Bird Count, an annual data collection event that is both fun and useful. In December and January of each year, individual programs in the Collaborative sent notification of the survey directly to their own program populations within their routine communications (e.g., newsletters, workshops). The sampling frame was then contacted via email and invited to participate in the online survey. Non-respondents received up to five email invites and a phone call. The survey was open for six weeks and closed mid-March.

Over the three years, 156 teachers (of the 288 teachers invited) provided usable survey responses, yielding an overall effective response rate of 54%. This was below the target of 70% that evaluators had established as sufficient to confidently claim representativeness. Response rates for subsample strata by program ranged from 32–100%, with higher rates coming from subsamples that had more recently participated in an in-person PD event. Thus, the sample may be biased somewhat toward teachers who were more engaged in PBEE.

The survey tool itself underwent minor refinements from year to year. There were no substantial changes to the Collaborative, the five programs, or the respondent pool in the three years.

### *2.3. Member Checking*

Another way the UVTPC embodied collaboration was in the process of holding meaning-making conversations between program staff and evaluators after preliminary data analysis but before final reporting. For each year's data set, this comprised at least one two-hour face to face discussion between evaluators and the Collaborative as a whole, plus two to four one-hour conference calls with various combinations of program staff and evaluators. The purpose was to integrate the external, data-driven perspective of evaluators with the rich understanding of people with day-to-day knowledge of a program's inner workings and nuance. This dialectical interactionist approach built trust and strengthened data interpretation through critical discourse.

### *2.4. Analysis*

Multiple sources of quantitative and qualitative data were interpreted to generate overall conclusions for this case study. Survey data were aggregated over the three years of administration. Changes over time of within group means from pre- to post- for PBEE practices (individually and as an aggregate index) were tested for statistical significance with *t*-tests. Regression analyses were used to test if the dose of PBEE PD (i.e., the weighted sum of all reported training over the prior year, ranging from 0–325 h [0–8 weeks] equivalents) significantly predicted changes in PBEE practices. Open-ended survey responses about PBEE implementation were analyzed for themes using a constant comparative qualitative data analysis process, grouping for main themes. Cross tabulations of dosage clusters and Stage of Change response categories with themes from the open-ended survey items provided a finer-grained look into the question of what factors were associated with the highest levels of PBEE teacher practice change. Quantitative analyses were conducted using SPSS v24. Qualitative analyses were conducted with Google Sheets and HyperResearch v4.

## **3. Results**

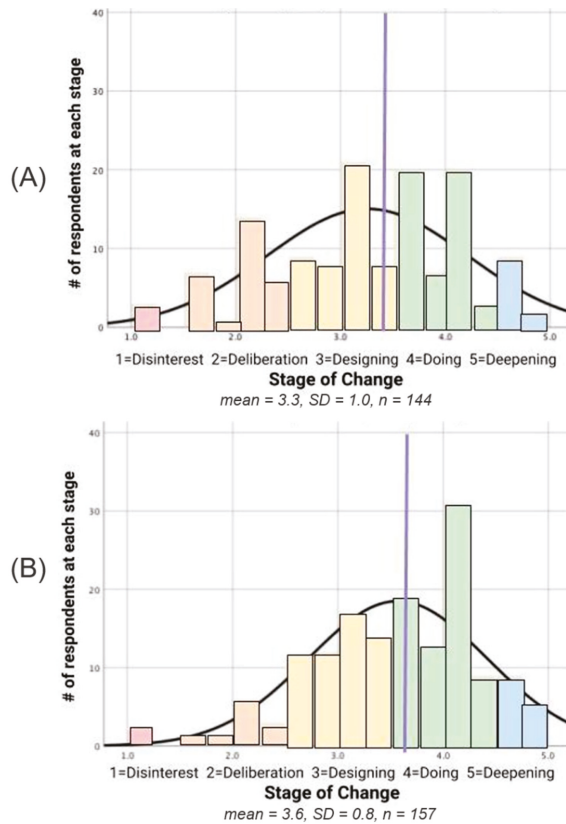
### *3.1. Teacher Practice Change*

The main finding relevant to our research question was that teachers reported strong, medium-sized, statistically significant changes over the prior year for all PBEE core practices. The magnitude of change pre- to post- was approximately a half a standard deviation (see Cohen's *d* in Table 1). On average, this represented a move from a little above "Designing" to a little below "Doing" on the Stages of Change scale (Figure 1).

The relationship between dose of PD over the prior year and PBEE core practices ( $\Delta R^2$  in Table 1) was statistically significant ( $p < 0.05$ ) for some PBEE core practices. However, inconsistent patterns at the finer-grained level of individual programs led us to conclude that this analysis did not yet warrant confident interpretation. We suspect that there was noise in the mechanics of the way the PD dose variable is measured, and that other factors that contribute to practice change (e.g., cultural norms within schools) were not captured by this instrument.

### *3.2. Qualitative Descriptions of PBEE Implementation*

Teacher responses to open-ended survey items suggested that PBEE often involves coordination between and contribution from multiple players with different roles but similar goals. In that way, PBEE is like a team sport. Respondents expressed appreciation for collaboration with teacher colleagues as well as for the ongoing, personalized coaching and support they received from PD providers. Teachers reported wanting hands-on support for themselves to overcome logistical and time challenges in implementing PBEE, often characterized as competing school priorities. An example that captured this dominant theme is the teacher who wrote that the most helpful support factors were "my colleagues and outside resources".



**Figure 1.** Distribution of place-based ecology education core practice index for aggregate 2016, 2017, and 2018 samples (A) One year ago and (B) Now.

Teachers also reported that PBEE was engaging and hands-on for their students. A quote that exemplified this theme was: “PBEE has absolutely made learning more relevant for my students, particularly with the local connections we have made”.

When asked which topics they would like support on as they relate to PBEE, the seven most common selections from the list of options were, in descending order of frequency: addressing state or national standards (e.g., Next Generation Science Standards, Common Core), student-driven learning, nature play, differentiated instruction/personalized learning, engineering and design, service-learning, and integrating technology into outdoor learning.

### 3.3. Factors Associated with Higher Levels of PBEE Implementation

To discover insights into best practices for PBEE professional development, themes from some open-ended survey items were cross tabulated with the level of PD dose and with reported Stage of Change of PBEE practice (Tables 2–6). The open-ended items asked what helped or hindered teachers in making progress on any of the PBEE core practices. The driving idea was to look for clues about how to move teachers from “Doing” to “Deepening” in their PBEE practice. A cluster analysis of 105 eligible cases yielded three groups of PD dosage from the prior year: Low ( $n = 36$ ,  $X = 37$  h); Medium ( $n = 59$ ,  $X = 142$  h); and High ( $n = 10$ ,  $X = 246$  h).

The highest levels of PBEE practice were reported by teachers who had the highest dosage of PD (Table 2). This group also found the connections to a learning community and local resources to be the

most valuable for improving their PBEE practice (Table 3). On the other hand, many teachers in the lowest PD dosage group also reported relatively high levels of PBEE practice (Table 2). These teachers reported feeling most supported by the curriculum content and the expertise of PD providers (Table 3). This contrast suggests that the role PD plays in supporting high levels of PBEE implementation was not the same for everyone. This is consistent with the Concerns Based Adoption Model, which describes ways in which different teachers need different levels and types of PD [32]. It is also consistent with the idea that PBEE, by definition, adapts and responds to variety in local conditions.

**Table 2.** Percentage of responses by professional development dosage cluster for composite index of mean response to six Place-based Ecology Education core practices.

Stage of Change <sup>1</sup>	Low PD Dosage	Medium PD Dosage	High PD Dosage
N/A or Unsure	6	5	0
Disinterest (1.0–1.9)	6	5	0
Deliberating (2.0–2.9)	14	24	0
Designing (3.0–3.9)	36	42	40
Doing (4.0–4.9)	36	17	50
Deepening (5)	2	7	10

<sup>1</sup> Composite is the mean of a respondent’s answers to the six place-based ecology education measures (Table 1). All respondents answered at least three of the six measures, and most answered all six.

**Table 3.** Percentage of responses by professional development (PD) dosage cluster for main theme of response to “What helped you make progress on any of the practices?”

Theme <sup>1</sup>	Low PD Dosage	Medium PD Dosage	High PD Dosage
Community and mentoring connections/support from program	13	13	38
Knowledge of and connection to local resources	10	16	38
PD—specific programs or generally	23	19	12
Curriculum (specific and cross-discipline) support from program	20	19	0
Team mentality and support in-school	20	17	12
Program staff support (communications, personal connections, and in-person assistance)	10	7	0
Teacher reassignment	0	9	0
Seeing results	4	0	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. These exclusions totaled  $n = 6$  for Low PD Dosage,  $n = 15$  for Medium PD Dosage, and  $n = 2$  for High PD Dosage.

**Table 4.** Percentage of responses by professional development (PD) dosage cluster for main theme of response to “What hindered your progress on any of the practices?”

Theme <sup>1</sup>	Low PD Dosage	Medium PD Dosage	High PD Dosage
Logistics (funding, location, personal issues, weather, etc.)	19	10	0
Lack of team mentality, time with colleagues/professional community	15	10	43
Time (generally or in/with the class)	20	33	1
Competing school priorities	15	6	29
Teacher reassignment	11	17	14
Curriculum challenges	8	10	0
Lack of administrative support	8	10	0
Class composition	4	4	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. These exclusions totaled  $n = 10$  for Low PD Dosage,  $n = 10$  for Medium PD Dosage, and  $n = 3$  for High PD Dosage.

**Table 5.** Percentage of responses by stage of change for main theme of response to “What helped you make progress on any of the practices?” by Place-based Ecology Education composite index and with progressively darker shading for higher percentages of response.

Theme <sup>1</sup>	NA or Unsure (0)	Disinterest (1.0–1.9)	Deliberating (2.0–2.9)	Designing (3.0–3.9)	Doing (4.0–4.9)	Deepening (5)
Team mentality, support in-school	0	0	4	7	4	4
PD—specific programs or generally	0	0	4	7	6	2
Community, mentoring/support connections	0	0	2	6	7	0
Knowledge of, connection to local resources	0	0	0	11	5	0
Curriculum (specific and cross-discipline) support from program	0	1	4	9	4	0
Program staff support (personal communications, in-person help)	0	0	2	1	4	0
Seeing results	0	0	0	0	1	0
Teacher reassignment	1	2	1	0	0	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. Percentages based on *n* = 82.

**Table 6.** Percentage of responses by stage of change for main theme of response to “What hindered your progress on any of the practices?” by Place-based Ecology Education composite index and with progressively darker shading for higher percentages of response.

Theme <sup>1</sup>	NA or Unsure (0)	Disinterest (1.0–1.9)	Deliberating (2.0–2.9)	Designing (3.0–3.9)	Doing (4.0–4.9)	Deepening (5)
Lack of team mentality, time with colleagues, and/or professional community	0	0	4	2	6	2
Competing school priorities	0	0	0	7	2	1
Time (generally or in/with the class)	0	1	6	12	7	0
Logistics (funding, location, personal issues, weather, etc.)	1	0	2	5	4	0
Lack of administrative support	1	0	2	1	2	1
Curriculum challenges	0	1	1	5	1	0
Teacher reassignment	2	2	4	6	0	0
Class composition	0	1	1	1	0	0

<sup>1</sup> No response and responses of “nothing” were excluded from the depiction of results and percentages. Percentages based on *n* = 82.

The highest levels of PBEE practice were also reported by teachers who were helped by a team mentality in their school or hindered by the lack of it (Tables 4–6). These teachers more strongly embraced connections with community members and mentors. This suggests that although PD may be an important activity, the highest levels of PBEE practice also require a supportive culture, network, and context of collaboration within the school and community.



## **4. Discussion**

The overall goal of this case study was to explore ways in which the UVTPC contributed to changes in teacher practice around sustainability or geo-literacy more broadly, and PBEE more specifically. A holistic synthesis of multiple types and sources of data revealed that collaboration was a theme that unifies at least three scales of phenomena in this case: the teacher, the school, and the region.

### *4.1. Collaboration for Teachers*

Perhaps the clearest, most straight forward finding of this study was that teachers consistently reported strong, medium-sized, statistically significant changes over the prior year for all PBEE core practices. The data suggest that the professional development provided by UVTPC programs was at least one contributing factor to that teacher practice change. A closer examination of the content of those PBEE core practices reveals something of a tautology between PBEE and collaboration. PBEE is inherently about collaboration. Collaboration is explicit in several of the core practices and implicit in the others. For instance, the practices described as adapting teaching styles, themes, and curricula could also be seen as a kind of collaboration in that there is a dialectical interaction between the teacher and the content of what they teach. PBEE is about working with fellow teachers, community members, and elements of the local natural and built environment to make learning real and meaningful for students. This focus on collaboration among a variety of communities echoes the original intent of EE 40 years ago [1], as well as recent research on the power of collective efficacy [33] of teams of teachers in schools [34].

### *4.2. Collaboration for Schools*

The finer-grained analysis of factors associated with the highest levels of PBEE practice in this study pointed to the importance of collaboration at the school level. Although professional development for PBEE may be an important hook for many individual teachers, our data suggest that teacher teams and school leadership and culture may be the powerful levers for allowing PBEE to flourish and be sustainable. This intermediate scale of school community (i.e., bigger than the classroom but smaller than a school district or supervisory union) should frame further investigation of the cultures and networks that grease the wheels of change for PBEE and sustainability.

### *4.3. Collaboration in the Region*

The collaborative nature of the UVTPC itself was evident in several ways. The ability to create a tool to measure PBEE teacher practice change was predicated on the Collaborative working together. None of the participating organizations had the resources or ability to design and administer such a measure on their own, but collectively they could. The regular meetings of participants in the Collaborative also served as a kind of professional development and support for the PD providers themselves. In the words of one participant: "The UVTPC is building the possibility of creating true collaboration such that anyone in the region can engage in 'seamless entry' into PBEE, no matter who they talk to first...AND continue to learn from each other". The fact that each of the five programs in the Collaborative offers PD that reflects common tenets of PBEE via pedagogically and geographically variable programs means that teachers in the Upper Valley region have a richer array of options for customizing their PBEE learning. This is consistent with research from Boyer and Roth [35], who contend that EE collaborations aid in accessibility as participants have options for enrollment in a program that suits their particular needs. This balance between collaborative and individual program identity was found to be an important aspect for program sustainability in other contexts as well (e.g., [10,14]).

#### 4.4. Limitations and Future Research

Two limitations warrant explicit mention. First, with an overall effective response of 54%, non-response bias was a factor to the extent that there were any systematic (though unknowable) characteristics of the slightly less than half of teachers in the sampling frame who did not provide usable survey responses. Second, effect sizes (Cohen's *d* in Table 1) were probably slightly exaggerated due to social desirability bias. We suspect this even though the reliability of the retrospective-pre design was tested each year by analyzing the responses of teachers who filled out the survey two years in a row ( $n = 22$  in 2017,  $n = 24$  in 2018). In both years, reported practices for "now" from the prior year were consistently higher than reported levels for "one year ago" in the current year, though *t*-tests and interaction effects typically revealed a lack of statistical significance. To increase the effective response rate, future administrations of this survey in the Upper Valley region could employ more rigorous messaging campaigns prior to administration, and/or could adjust the timing to align more tightly with the timing of in person trainings. Response rates could likely also be increased by shifting the sampling frame from individual teachers participating in PD programs to all teachers in a target school (e.g., by administering the survey at all staff meetings). Such reframing of the sampling could also extend the analysis by including teachers who had not participated in PBEE professional development.

#### 5. Conclusions

How might the lessons from this case study of regional collaboration for sustainability via Place-based Ecology Education be usefully transferred to other contexts?

First, articulation and operationalization of PBEE into six core practices could be adopted by the field of PBEE more broadly as one response to the historical challenge of differentiating PBEE from other related and overlapping progressive educational pedagogies [16]. We encourage adapting and testing these measures of six practices in different contexts to elicit further reflections on the utility and generalizability of this six-item battery.

Second, UVTPC's main measurement instrument, affectionately referred to as the "Groundhog Day Survey" tool, could be easily replicated and adapted to other PBEE research and evaluation contexts. This would address a challenge noted in the literature that evaluations are often inconsistent across cases [12,13]. Sharing measurement tools like this across PBEE programs is one way to support current momentum for collective evaluation and building the field of EE promoted by groups such as the Pisces Foundation, Blue Sky Funders Forum, Children and Nature Network, and the North American Association of Environmental Education. One feature of the Groundhog Day Survey tool that was only cursorily detailed in this manuscript, but that would likely be essential to replication efforts, is that the survey also included program-specific items. This allowed individual programs in the Collaborative to replace prior evaluation instruments with a modified version that served multiple evaluation needs, as opposed to adding another instrument to the existing battery. This type of structuring for core principles while leaving room for program-specific inquiries is consistent with the "enabling sustainable actions" component of Monroe and colleagues' [5] framework for EE strategies. The Groundhog Day Survey tool is downloadable from the website of the evaluators who worked with the Collaborative (see [www.PEERassociates.net](http://www.PEERassociates.net)).

Third, findings from this case study provide guidance to other PBEE professional development providers. According to requests and reports from UVTPC teachers, optimal PD for PBEE is ongoing, personalized, and collaborative. To overcome the challenges of limited time and constrained curriculum requirements, teachers want hands-on, ongoing mentoring that includes tangible examples from coaches and colleagues, especially with respect to connecting PBEE to Next Generation Science Standards and other curricular frameworks. Providing time for planning is critical. Although broadly consistent with literature on best practices for PD in general [36,37], UVTPC findings tended to place greater emphasis on collaboration.

Finally, incorporating collaborations in PBEE (both within a school and between a school and community resources) highlights the central role that relationship-building has in supporting an

engaged community of EE practitioners and community members working toward sustainability and geo-literacy goals [1,38]. Indeed, research on collaborations in other environmental contexts suggests that this idea of cross-scale interactions that harmonize local context with overall goals can contribute toward sustainability and relevance in a powerful way [10]. The motivation and urgency to achieve national and global sustainability must fundamentally come from a growing societal recognition of the ecological and social stakes involved in our rapidly changing modern world. But it may be that collaboration at every scale becomes a necessary, if not sufficient, feature of education for sustainability.

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Article

# Education for Sustainable Development through International Collaboration. A Case Study on Concepts and Conceptual Change of School-Students from India and Austria on Gender Equality and Sustainable Growth

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**Abstract:** Dealing with the great challenges of the 21st century requires far reaching changes in the lifestyle and perceptions of humans to ensure an appropriate quality of life for all, now and in the future. To provide people with the necessary competencies, the UN initiated the Education for Sustainable Development (ESD) program. The two-year research-education, cooperative project ‘AustrIndia-4QOL’ aims to contribute to the goals of ESD. It is based on a collaboration between students from schools in Austria and India on the topics of quality of life, sustainability and global justice. The purpose of this particular case study is to explore the effects of a weeklong face-to-face collaboration in the final part of the AustrIndia-4QOL project. Therefore, it is examined whether or not Austrian and Indian students’ concepts regarding the Sustainable Development Goals ‘Gender Equality’ and ‘Decent Work and Economic Growth’ change as a consequence of encountering differing perspectives. Short texts written by the students at the beginning and at the end of this collaboration, according to guiding questions, form the basis for a qualitative content analysis. The findings illustrate that the students’ awareness increased and their evaluation of topics related to the discussed sustainable development goals changed.

**Keywords:** education for sustainable development; international collaboration; gender equality; quality of life; conceptual change; case study

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## 1. Introduction

The great challenges of the 21st century urgently require far reaching measures on a global scale to ensure an appropriate Quality of Life for all humans now and in the future. Nevertheless, sustainability can only be achieved, if people are willing to (re-)orientate their individual lifestyles towards this aim. The UN Decade for Education for Sustainable Development (ESD) from 2005 to 2014 and in succession the Global Action Program on ESD, are an attempt to reach this aim. ESD is seen as a key instrument for achieving the 17 Sustainable Development Goals (SDGs), defined in 2015 by the UN and describing major development challenges which are fundamental for the survival of humans [1]. ESD has the objective to provide learners with the knowledge, skills, values and attitudes for attaining a sustainable lifestyle [1–3]. It must be taken into consideration that environmental knowledge alone does not automatically lead to behavioral change. Among others, collaboration competency is seen as one of the necessary key competencies required to deal with the complexity of global challenges [1,4,5].

The two-year research-education cooperative project ‘AustrIndia-4QOL’ brought 57 teenagers from an Indian high school and 46 teenagers from an Austrian high school around the age of 16 together to jointly perform research on the connection between quality of life and sustainability

in a research-based moderate constructivist learning setting. This offers from a scientific point of view, the opportunity to investigate if this collaboration of students from different socio-cultural backgrounds provides a suitable approach for successfully promoting ESD. While the collaboration was mainly processed with the help of social media, this particular study provides insights from a face-to-face collaboration with 10 Indian and 22 Austrian students, which took place in Austria in the final part of the AustrIndia-4QOL project. Prior to this face-to-face collaboration, the students decided to focus on the topics of gender inequality and the apparent tension between the economy and the environment. These issues are in line with the fifth and eighth SDG [6]. Working with each other on topics affecting their real lives, the results deliver an authentic insight into the concepts of Indian and Austrian students and the change of their concepts due to this collaboration.

Although prior research enables insights into existing concepts about topics in the social sciences, there is still a lack of research about the change of these concepts [7]. To facilitate far reaching changes of existing concepts, the potential of collaborative learning settings is stressed by several studies [3,8–12]. However, when conducting an international collaboration, caution has to be taken to avoid perpetuating dependency-relations between the Global North and the Global South [13–20].

In this article, the theoretical framework is explained in more detail and the methodological implementation of the project is described. The presented results illustrate that this collaboration encouraged students to modify their initial concepts.

## **2. Conceptual Change through International Collaboration**

Conceptual change research offers extensive insights into processes connected with the natural sciences. Today's conceptual change theories (for an overview see [21]) frequently share the idea that learning is understood as a constructivist process of restructuring non-scientific concepts towards concepts which meet or come closer to the scientific state of the art knowledge [22]. Education settings in the natural sciences built on conceptual change theories, according to many studies, seem to be more successful in comparison to traditional learning settings [23,24]. Over the past years, these findings have influenced learning settings of social sciences as well (e.g., on concepts about the environment [25,26] or matters of sustainability [27]). The scientific evidence demonstrating the change of such social sciences concepts, however, is still inadequate [7]. Efforts to provoke a conceptual change in social sciences topics face a number of challenges. Different than in the natural sciences, for example, the concepts in the social sciences often differ depending on the theoretical background of the scientific disciplines. The necessity in the social sciences to look at topics from a systemic and multidisciplinary point of view thus often overstrains learners [7,24].

The situation becomes even more complicated in the context of the Great Challenges of the 21st century. First, most, if not all, environmental challenges require social decisions based on processes out of natural sciences. Second, tackling these challenges requires far reaching changes in the lifestyle concepts of individuals and societies and the empowerment of humans to act on the local as well as on the global level [1,28,29]. The question remains as to whether such complicated and also deeply rooted concepts can be changed at all and if, how? According to transformation education research, learning processes cannot be steered or controlled by the educator [30,31] but rather supported by participative learning settings that enable personal engagement and include a process of reflection [32,33]. Learning as an intrinsic process has to be accompanied with the paradigm of transformation in the context of ESD [34]. Therefore, 'recognizing the interconnectedness among universe, planet, natural environment, human community and personal world through critical reflection, holistic approaches and positive relationship with others' is required to enable a transformation [33] (p. 126).

To enable a far-reaching conceptual change, social constructivist (e.g., [35]) and participative approaches (e.g., [36]) on conceptual change require learning to be seen not only as a cognitive process but also to put the focus on the social context as well. Furthermore, learning includes not only cognitive but also metacognitive, affective and motivational aspects and happens in a complex

socio-cultural context [24,37,38]. Critical discourses with other learners can contribute to individuals questioning their own non-sustainable actions [31]. For this reason, discourses in small groups are essential for successful learning [3,10–12,15]. A collaborative learning setting enables learners to continuously change their position between acting and observing. By observing, one can take a more objective position and this helps to modify her or his own concept. Due to critique from others, learners start to develop more abstract and complex concepts. This observation applies even for learners who are already on a relatively higher level of understanding and even when learners themselves do not recognize the value of collaboration [8,9]. Critical for success is that the interaction takes place with people who have different ideas, views, values and perspectives in order to enable ‘transformative disruptions’ [12] (p. 385).

Having this theoretical framework in mind, the question arises how far a collaboration between school students from different socio-cultural backgrounds could be a suitable approach to lead the participants to questioning their own point of view and, therefore, to modify their initial concepts. Expectations of international collaboration in general and in school partnerships are often very high [14,39,40] but the reality can be very different. International school partnerships with partner schools from the Global South in particular frequently run the danger of reinforcing existing clichés and stereotypes among the participants. A classification of one side being humanitarian and generous and the other group being poor and helpless may be supported, leading to a constant updating of global dependency relations [13–15,18,19,41]. Disney [20] (p. 7) even emphasizes the danger of ‘epitomizing a new form of colonialism’ in which the dependency of the South is perpetuated. Teachers need to be sensitive towards the tendency of western students to see the world from a perspective of superiority [14,18]. Against this background, the Intercultural Centre in Vienna [42] recommends for international school partnerships not to learn *about* each other but rather to learn *with* each other. Both schools need to hold an equal position within the project [16,20]. Collaboration has to be focused on negotiation and discussion and based on ‘reciprocity, equality and mutuality’ [19] (p. 923).

Keeping these recommendations in mind by designing the learning-settings for the research-education cooperative AustrIndia-4QOL project, we hypothesize in detail that the collaboration between students from Austria and India

1. raises the students’ awareness that the topics gender equality and the apparent tension between the economy and the environment influence their personal quality of life and
2. leads to a change in the valuation of matters connected with these two topics.

### 3. Methods

#### 3.1. Project Implementation and Study Samples

Months before the actual project started, general information about the central project ideas was presented to Austrian as well as to Indian students and they were asked whether they would be interested in taking part in the project. It quickly became apparent that the students were not only willing to participate but enthusiastic about the chance to take part in an international collaboration with students from totally different socio-cultural backgrounds. Additionally, they all voluntarily agreed on data collection for scientific research. Without their enormous engagement, it would have not been possible to implement this project.

The AustrIndia-4QOL project was divided into two parts. During the first part, the students designed questionnaires and collected and evaluated their own data about the similarities and differences between the quality of life concepts of youth in these two countries. The results out of their research were presented and discussed via the social media platform ‘Facebook.’ This process was conducted over a period of three months.

In the second part, ten Indian students (seven girls and three boys) of the Day Star School (DSS) [43] in Manali in Himachal Pradesh had the opportunity to visit their project partners at the



Gymnasium Schillerstrasse (GYS) [44] in Feldkirch in the western part of Austria. The GYS is a state operated high school and the DSS an English-speaking, privately-operated school, which prepares students for A-levels. According to Mr. Paul Elias, the former headmaster of the DSS who supported this project and was responsible for the travel organization of the Indian students, the ten Indian students originate from different religious and social caste groups (the Indian caste-system still has some influence on daily life in this region). In financial terms, all these families are rather well-off. They were able to bear the travel costs on their own. Most of the 22 Austrian students come from middle-class families. They belong to the 46.3% [45] (p. 30) of Austrian teenagers in their age group who attend a higher secondary school which prepares them for the school-leaving examination ('Matura') which is a precondition for further studies.

The students were all around the age of 16. This age can be seen as 'a current "blind spot" of investigations' in the context of conceptual change [7] (p. 301). At this stage of life, teenagers start to participate in formal democratic decisions, become more emancipated from their parents and increasingly occupy themselves with thoughts about their own future. Therefore, it seems particularly interesting to focus on this age with conceptual change research [7].

The students are from the two comparable small towns Manali with approx. 43.000 inhabitants (sub-district Manali) [46] and Feldkirch with approx. 35.000 inhabitants or the surrounding areas. In the following, the terms 'Indian students' and 'Austrian students' are used for the teenagers who participated in this project. When interpreting the collected data, the provincial background of the students, as well as their education level and financial background must be considered next to the small sample size.

People from India represent no classical migrant group in the western part of Austria and personal contacts of the Austrian students with people from India are unlikely to exist. Due to Austria's minor presence on a global scale, it can be assumed that the Indian students are hardly confronted with medial reporting from and about Austria.

For all ten Indian students, it was the first journey outside India. A lot of persuasive efforts by representatives from the Indian and Austrian school and from the Institute for Geography at the University of Innsbruck made it finally possible to get the Visa for the Indian students. The need of the necessary documents to apply for a passport in advance made it impossible for a few more interested students to take part in the project. These challenges and the high financial burden for the involved Indian families are responsible for the small sample size of this survey. During their ten days in Austria, they stayed with the families of the Austrian students. This made it not only possible to reduce the financial costs but also to enable the Indian students a direct insight into the lifestyle of their project partners.

According to the ideas of a moderate constructivism, the students could choose which quality of life topic they would like to work on in the second part of the AustrIndia-4QOL project and connect this topic with sustainability. With the help of the social media platform 'Facebook' a topic finding process was initiated in advance of this face-to-face collaboration. The participants reached an agreement on the two overarching topics 'gender inequality' and the 'tension between economy and environment.' With their choices made, the students laid a focus on the SDG number five: 'Achieve gender equality and empower all women and girls' and on the SDG number eight: 'Promote inclusive and sustainable economic growth, employment and decent work for all' [6]. For the common workshops in Austria, learning settings were tailored to these two topics with the focus of enabling an active participation of the students and encouraging intensive discussions between them. To enhance a learning process by dealing with contradictions and dilemmas [15,35], methods such as dilemma discussions [47] and mysteries [48] were chosen. Applying the latter method, small groups of students structure given information (short texts, diagrams, pictures etc.) in order to answer a key question. Aside from the workshops at school, additional inputs were given by external experts during various excursions. During the topic finding process at the beginning, as well as later during the workshops, a special focus was given to the contribution of all teenagers in order to support a collaboration as equals.

Decisions had to get the approval of all students. Additionally, the students from Austria and India were separated several times in succession to the workshops to enable reflection phases within their own groups. Thereby, the students had the opportunity to express challenges they perceived during the workshops and to discuss possible solution approaches.

### 3.2. Data Collection and Analysis

To gain an insight into the students' concepts as well as an insight into possible changes of these concepts a pre- post-test design was developed for this survey. For both topics two guiding questions were given to the students and they had to write one text with approximately 200 words for each topic at the beginning and at the end of the collaboration.

When interpreting the results of this case study, the small sample size has to be considered. A mixed methods design was chosen for the data analysis in order to combine the strengths of both quantitative and qualitative approaches in a single research design. The quantitative information helps to get an overall impression of the effects of the collaboration and the qualitative information provides a deeper insight which additionally underpins the quantitative results. Therefore, the statements were analyzed following the criteria of a qualitative content analysis [49,50] by using the software MAXQDA. The initial coding followed deductively determined categories that were chosen by the authors in advance according to the guiding questions given to the students. For example, in case of the topic 'gender inequality,' the students' statements about their personal experiences with this issue were assigned to one of the four categories: 'no inequality,' 'minor inequality,' 'rather inequality' or 'inequality.' Comparing the quantitative distribution of the statements among the different categories between pre- and post-test enables to see overall patterns of the effects of the international collaboration on the participating group of students. As a second step, the answers were qualitatively analyzed in more detail and further categories were developed inductively in order to specify the forms of gender inequality as well as the environmental problems mentioned by the students. Two researchers performed this analysis independently and they merged their categories afterwards. To ensure the validity, the coding of the statements of all 32 students was done independently by these two researchers and compared afterwards. Some minor differences were identified, discussed and finally reconciled. Additionally, the meanings of unclear statements were clarified by direct request.

To enable a deeper insight into the students' concepts, sample quotations of the students have been cited next to the results of the quantitative analyses. Obvious spelling and grammar mistakes were corrected for better readability and the statements of the Austrian students were translated into English. An anonymized code is used instead of the student's names. Thereby, 'IN' signifies an Indian student and 'AT' an Austrian student. The last letter of the code provides information about the sex ('f' signifies a female and 'm' a male student). For an additional insight into the specific response behavior in the pre- and post-test of each single student, see the figures in the Supplementary Materials.

## 4. Results and Discussion

### 4.1. Students' Concepts of Gender Inequality

To get an insight into the student's concepts of gender inequality and possible changes of these concepts, the following guiding questions were given to the students:

- A) What **personal experiences** have you had within your family, your circle of friends and in your personal environment regarding issues of gender inequality?
- B) How do you evaluate the situation **in your own country** in general regarding issues of gender inequality?
  - (A) What **personal experiences** have you had within your family, your circle of friends and in your personal environment regarding issues of gender inequality?
  - (B) How do you evaluate the situation **in your own country** in general regarding issues of gender inequality?

By analyzing the students' statements in the pre-test three main points can be determined.

1. The idea of gender equality in general is clearly supported among teenagers [51]. While seven out of the ten Indian students reported perceptions of gender inequality in their personal surrounding ('rather inequality' and 'inequality') this is the case for only eight out of the 22 Austrian students (Figure 1). These differences correspond with the different ranks of these countries within the 'gender inequality index' of the United Nations. Austria occupies rank 14 and India occupies rank 125 out of 188 countries [52] (pp. 214–217). Their descriptions are mostly limited to perceptions they made in their social environment but four Austrian and three Indian girls even mentioned specific personal experiences.

*'There are some boys who believe they have a greater value and I can often hear comments like "women should stay in the kitchen" and "girls are not capable of anything"' (AT12f). 'The discrimination I felt was about going out to roam around. Boys are always allowed to roam around but girls cannot go out after 6'. (IN01f)*

2. Despite the high number of reported cases of gender inequality, it is surprising that seven out of the ten Indian students and 13 out of the 22 Austrian students argued that there is no or only minor gender inequality in their country nowadays (Figure 2). 9 of the Indian students and 7 of the Austrian students emphasized the point that progressive changes have occurred in their country.

*'But as development is taking place, our society is more exposed to equality of gender' (IN10m). 'It is difficult to determine specific differences between men and women in everyday life because equality has reached an advanced stage in Austria already'. (AT19m)*

Gender inequality is sometimes seen as a problem of the past. The limited observations and awareness for still existing deficiencies is in line with several other studies [53,54].

3. A deeper look into the described manifestations of gender inequality shows clear differences. Most of the Austrian students (19 students) referred to occupational disadvantages such as lower income and less career opportunities and four of the Austrian girls highlighted the double burden of women with families and jobs.

*'Women still earn less compared to men and have less chances to get a promotion because it has always to be worried that they drop out due to pregnancy' (AT03f). 'Can I be a mother and a respected architect in future?'. (AT14f)*

On the contrary, eight out of the ten Indian students stressed the lower status of women in society and a lack of personal freedom while seven students emphasized fewer opportunities for education. Four Indian students even mentioned violence against women or the dowry system as well as the strongly connected problem of selective abortion of female fetuses.

*'And one big thing is still surviving in our place. That is the dowry system. The bride's family is demanded huge amounts to be given to the bridegroom's family. So, people expect only male children to be born in their families. People think it is a burden to have a girl child. They also think it is due to their sin they have a girl child in their families. Therefore, abortion is done in some cases'. (IN02f)*

#### 4.2. Changes in the Students' Concepts of Gender Inequality

By comparing the pre- and post-test, three changes in the students' concepts can be shown.

1. More students (9 out of the 10 Indian and 15 out of the 22 Austrian students) referred to specific cases of gender inequality in the post-test ('rather inequality' and 'inequality') than in the pre-test (Figure 1).

2. Due to experiences of the Indian students while in Austria, these students identified even stronger perceptions of inequality in their own country during the post-test. The Indian students

observed that women in Austria have more options on the job market as well as in leisure activities compared to women in India. In the post-test, only two of them described India as a country in which gender equality ('no inequality' and 'minor inequality') is given (Figure 2). All Indian students referred to personal observations they made in Austria.

*'Here my hostess is the one who every day goes out for her hobbies like singing, dancing and acting but we in our place are not allowed to go out in the night for something, generally it is not safe'. (IN04f)*

Although 16 of the Austrian students rated their country differently in the post-test, their overall rating remained almost constant (Figure 2). Information given by the Indian students about the situation in India was mentioned by 18 of the Austrian students in the post-test. Personal experiences also played an important role in the discussions between the students during the workshops. The Austrian students became, on the one hand aware, that things they have taken for granted are by no means natural all over the world and they came to the conclusion that Austria is advanced compared to India in terms of gender inequality.

*'Even if Austria comes off badly in statistics in an international comparison my subjective feeling is that the situation is better when compared with India. A lot of jobs can be done by women here which would be unimaginable in India'. (AT19m)*

On the other hand, they began to actively seek situations that demonstrate gender inequality in their personal surrounding and in their own country.

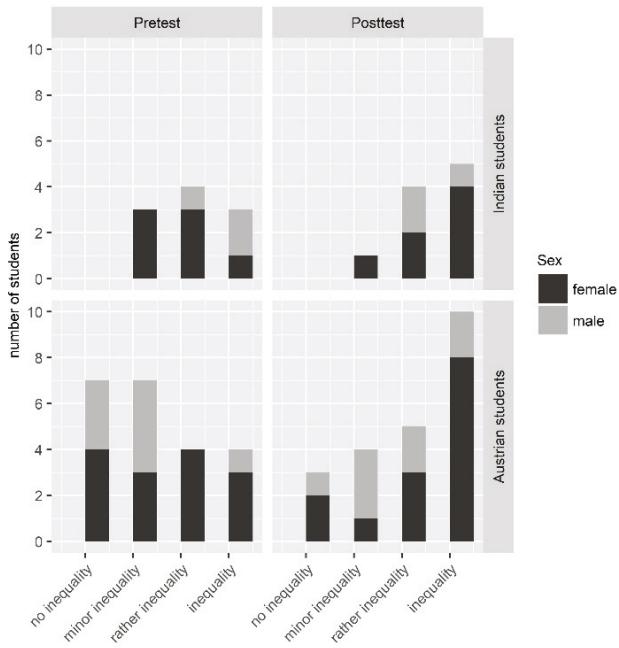
*'My personal experience regarding gender equality as well as my ideas about my future plans didn't change. Nevertheless, I got a different perspective of this topic, inter-alia because of the intensive involvement during writing my work. Therefore, I became aware of many fields in which women are treated with discrimination, such as payment for a job or performing additional work in the home'. (AT22f)*

Obviously, the danger of building simple generalizations about the situation in the other country still remains but these new pictures gathered from personal experiences and first-hand reports can be seen as far more realistic compared to pictures students gather through other sources such as mass media. Some students even wrote down explicitly that the collaboration led them to change their viewpoint.

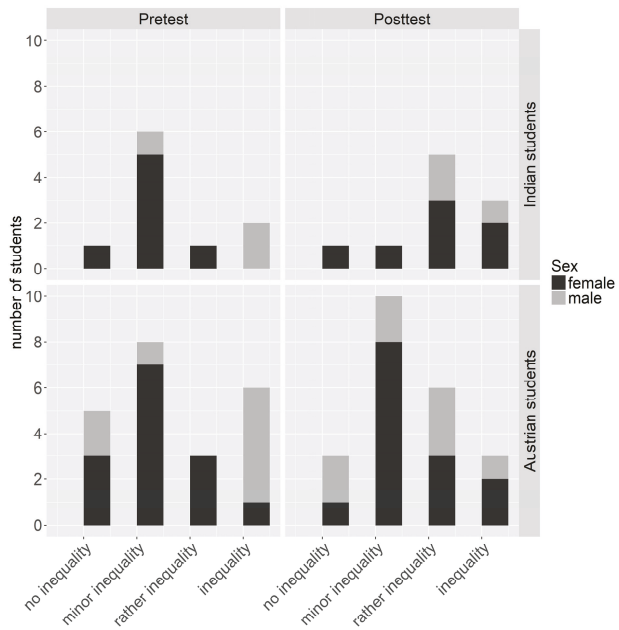
*'The exchange with the Indian students gave me a lot of additional information which changed my point of view. [ . . . ] I was not aware that also in small villages / towns in India there are many people who change their mind and try to provide the same education and career opportunities for their daughters'. (AT15f)*

3. While the above-mentioned manifestations of gender inequality of the pre-test are picked up again in the post-test by both groups of students, the Indian students now mention inequalities regarding job opportunities to a higher extent (eight out of ten) as well. This topic was discussed intensively among the students during the workshops.

*'In Austria, we can find woman conductors, waitresses, cashiers (IN05f). I saw some women driving the bus but in India no woman drives a bus because they are not allowed to do so. It is considered as shame'. (IN08f)*



**Figure 1.** The students’ awareness regarding gender inequality in their personal surrounding. Indian students: N = 10; Austrian students: N = 22.



**Figure 2.** The students’ evaluation of their own country in terms of gender inequality. Indian students: N = 10; Austrian students: N = 22.

#### 4.3. Students' Concepts of the Relationship Between Economy and Environment

To get an insight into the students' concepts of the relationship between economy and environment and the changes of these concepts, the following guiding questions were given to the students:

- A) *In his speech alongside the climate conference in Paris 2015 the Indian Prime Minister Modi stressed that the poor countries cannot be blamed for the actual climate change and their pursuit of economic development must not be neglected [55]. How do you personally evaluate this statement?*
- B) *Are there environmental problems due to economic development which have a direct negative impact on your personal life? If yes, specify the impact!*
- C) *If there are negative impacts: Are there personal possibilities to act in order to reduce negative impacts on the environment?*

By analyzing the students' statements in the pre-test three main points can be determined.

1. The statement of Prime Minister Modi was evaluated controversially by the students. Approximately half of the Indian and Austrian students agreed ('rather agree' and 'agree') with this statement (Figure 3). The clear disagreement of half of the Indian students is surprising when considering the high portion of the population in India, which are suffering due to their low economic development.

*'I don't agree with the Prime Minister of India because I think that India is also one of the countries which is polluting our environment. We should not blame other countries. Compared to India other countries are clean'. (IN03f)*

2. When teenagers are asked about relevant factors for their quality of life, environmental aspects are hardly mentioned [56–58]. In this particular survey, the students mostly mentioned different environmental problems due to economic development but none of the Indian students and only two of the Austrian students believed that these problems already have a negative effect on their personal quality of life (Figure 4).

*'I cannot say if my generation will directly perceive the impacts of environmental problems—I don't hope' (AT03f). 'Manali is not so much industrialized. Therefore, one can't see a direct impact due to climate change or other problems now'. (IN07f)*

By going into detail, differences between the Austrian and Indian students can be determined. While the Austrian teenagers mostly refer to climate change and the pollution of the seas (12 out of 22 students) to have a negative impact on humans in the future, the Indian teenagers most often mention the scarcity of resources next to climate change (three out of ten students).

3. Nearly all students (28 out of the 32) agreed that they have the opportunity to act in order to reduce negative impacts of economic development on the environment. To avoid waste (12 students), to reduce car travel and to encourage sensible energy consumption (9 students each) are specific actions the Austrian students suggest most frequently. The Indian students most often referred to collecting and recycling of waste (6 students).

*'My family for example renounces on plastic as far as possible, even plastic waste is not stored in plastic bags. Also, the car is only taken if really needed and if there is no public bus going in the right direction on time' (AT20m). 'First of all, we should personally segregate our waste from house into wet and dry waste, then it would be easy to treat our waste. As an individual, our responsibilities are to not litter around'. (IN07f)*

#### 4.4. Changes in the Students' Concepts of the Relationship Between Economy and Environment

By reviewing existing literature, Sternäng and Lundholm [59] show that scientific knowledge is hardly used by students for the decision-making in terms of a dilemma between economic growth

and environmental protection. Instead, their decisions are mostly based on personal values and emotional arguments. But how far does this international collaboration lead the students to change their concepts?

1. The statement of the Indian Prime Minister Modi gained higher approval among the Indian teenagers (Figure 3). Seven out of ten Indian students agreed ('rather agree' and 'agree') with this statement in the post-test. After visiting a region with one of the highest living standards worldwide, eight of the Indian students stressed the higher negative impact on the environment of the developed countries in general and four of them demanded better economic possibilities for developing countries at the end of the project

*'I as the individual agree with the Prime Minister of India because developed countries are creating more emissions and the western countries laid the development of industries and also used most of the resources. Now it is difficult for the developing countries which are dependent on the industries and they are much dominated by the countries in the west. We need to promote global justice for developing countries so that they do not match with the other countries and it will help in making the world a better place' (IN09m). 'The first world countries are also responsible for the climate change of the whole world due to their large carbon footprint. And the developing countries are dominated by the climate change'. (IN01f)*

One of the Indian students explicitly expressed his critique about the experienced lifestyle in Austria.

*'I think that people in the west have a higher standard of living and they need to rethink and change their lifestyle so that they look after quality of life and not higher standard of living. It will connect to the eastern countries too as it will become easier for them to develop and not to think about the carbon concentration. I think it's always the people who need to be blamed, every single one of us but it's more impacted by the western countries as they have more demand and higher standard of living. They want facilities though they don't use them'. (IN10m)*

20 out of the 22 Austrian students expressed their general understanding for the desire for economic development and four explicitly referred to information they gathered from the Indian students concerning economic problems in India. Nevertheless, 13 students disagreed or rather disagreed with Modi's statement. The average assessment of the Austrian students concerning the controversial statement remained almost constant, although most of them changed their individual rating. Findings by Miyake [8] may offer an explanation here: She points out that a collaboration in order to find a solution for a specific problem leads to different mental models. The participants have the impression that they worked out a common solution together and are not aware that their explanatory approaches and results differ in fact. The interaction causes an individual conceptual change based on the different concepts at the beginning.

The seven Austrian students who agreed with the statement of Prime Minister Modi to a higher extent in the post-test, placed greater emphasis on the question of global justice compared to the pre-test and they partly referred to information they got from the Indian teenagers.

*'Together with the Indian students we had a debate about the topic economy–environment. In this context they brought up the bad living conditions they face during winter time and that they sometimes have no electricity for several days'. (AT22f)*

The eight Austrian students who had a stronger disagreement with the statement from Prime Minister Modi in the post-test argued that global problems affect all countries and, therefore, all have to contribute to possible solutions. Additionally, some of them referred to facts they learned when performing their own research, during the workshops, or during a lecture about climate change with a professor at the university.

*'After intensive discussions with my guest from India I became aware of the exploitation of developing countries, inter alia India, through Western powers to a higher extent and I could better understand the situation of India. The Western nations gained an economic advantage by polluting the earth, which had a global impact. Nevertheless, I still hold the opinion that a complex issue like this cannot be dealt with according to the principle of 'an eye for an eye, a tooth for a tooth,' because this will cause global harm and at the end of the day we are all in the same boat' (AT04m). 'Reportedly, India is planning to double the mining and heating of coal in order to make electricity accessible for the whole population by the year 2019. Considering [ . . . ] the actual climate situation, this plan of the Indian government must not be approved of at all'. (AT11m)*

The responsibility of the Global North is partly attributed to mistakes of the past. The fact that a sustainable and fair development on the global level would primarily imply a considerable reduction of resource consumption of people of the Global North and therefore a change of their own lifestyle, was not mentioned by the Austrian students. Instead of taking the individual economic footprint into account, some of them argued with the resource consumption of nations and pointed to the negative environmental impact of populous countries.

*'For me the statement of the Prime Minister seems arbitrary. It sounds as the Prime Minister thinks that India would have the right to produce the same amount of greenhouse gases as other nations did in the past' (AT19m). 'The development in the western world caused current problems wherefore one can understand Modi's statement. But the Indian Prime Minister cannot simply state that India is not responsible as well. Due to the rapid economic development, developing and emerging countries share an increasing responsibility. Additionally, all people on the planet will feel the consequences of environmental destruction. Therefore, nations like India with their high population have to be aware of their responsibility'. (AT15f)*

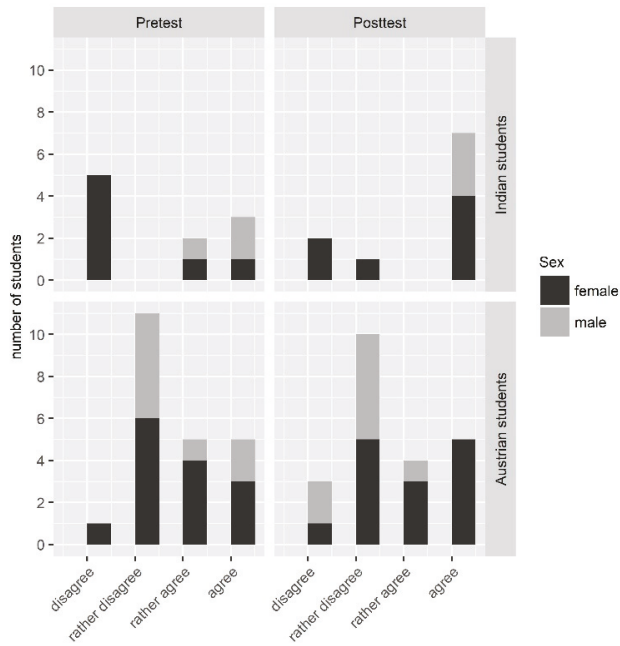
2. Due to the intensive discussions of environmental problems caused by economic development, the students realized to a higher amount that environmental problems caused by economic development already have an impact on one's personal life (Figure 4). Rising awareness is essential for ESD [60] and a precondition for the willingness to change individual behavior [61,62].

Negative effects of climate change were mentioned most often in this context. The high awareness of this specific topic is consistent with a survey conducted by Chhokar et al. [63] with Indian students, as well with survey results from Austria [64]. A lecture during the week at the University of Innsbruck about this issue may also have left a lasting impression on the students. This was followed by the problem of waste and the connected pollution of the seas.

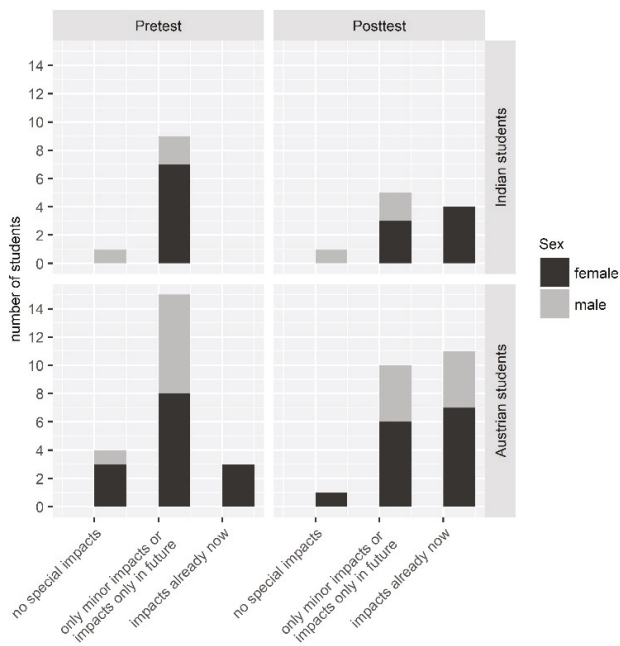
*'If temperature raises global 'only' two degrees, this can already have a massive impact on our whole life. Some skiing resorts already currently experience the consequences of global warming' (AT20m). 'Even by walking along a beach on holidays and the beach is polluted with plastic and other trash one recognizes the impact of the pollution of the seas' (AT03f). 'A huge amount of waste is already in the rivers and into the sea and is polluting drinking water and fishes. Yes, some people have lower standard of living because of this even nowadays'. (IN01f)*

3. The discussions at school and additional inputs at a hydro-energy plant, a water treatment plant, as well as a lecture at the university led to greater knowledge of this topic. This observation is reflected in the rising number of arguments the students mentioned to explain their concepts. The Austrian students increased their number of arguments by 17% and the Indian students even by 53%. Therefore, their post-concepts are distinguished by a higher degree of complexity.





**Figure 3.** The students' valuation of the statement of the Indian Prime Minister. Indian students: N = 10; Austrian students: N = 22.



**Figure 4.** The students' awareness of the impact of environmental problems due to economic development on their personal life. Indian students: N = 10; Austrian students: N = 22.

It could be argued that dealing with the topics of gender equality and the relationship between the economy and the environment in the absence of an international collaboration would have shown the same effects. The fact that all Indian students mentioned observations regarding gender equality they made in Austria and 18 Austrian students referred to specific information they got from the Indian students about the situation in India, however, clearly indicates that the collaboration had a huge effect on the students' concepts. In case of the relationship between the economy and the environment, the effect of the international collaboration seems less obvious. But still four of the Austrian students explicitly referred to specific information they got from the Indian students about economic challenges in India and three of the Indian students mentioned the situation in Austria in their statements. Furthermore, the huge impression of the collaboration on the students became obvious when the discussions about both topics continued even long after the end of the workshops. During the final event of the project, several of the invited parents also mentioned that these issues were subsequently discussed in their families.

## **5. Conclusions**

The students' awareness of gender inequality as well as their awareness of negative impacts of environmental problems on their quality of life increased during the project. Therefore, we are able to confirm our first research hypothesis. The collaboration between students from Austria and India raised the students' awareness that both topics influence their personal quality of life. The evaluation of matters connected with these topics changed as well. Between pre- and post-test 78% of all students rated their country differently in terms of gender inequality and 63% changed their rating of the controversial statement of the Indian Prime Minister. These results confirm our second research hypothesis. The collaboration between students from Austria and India leads to a change in the valuation of matters connected with these two topics.

It became apparent that the personal experiences of the Indian students while in Austria and their reports about the situation in India, dominated the discussions about gender (in)equality. On the other hand, additional information beyond sharing life experiences provided during workshops and during excursions played an important role for the discussions about the tension between economy and the environment as well. Nevertheless, it is important to keep in mind that the students changed their rating individually and partly in a completely different direction, based on their individual concepts at the beginning. Moreover, these changes are difficult to predict due to the high amount of different influencing factors which happened alongside the formal workshops.

The self-determined and collaborative way of learning during this project led to a high level of personal engagement of the students. All students were aware of the unique possibilities offered by this project. The intensive discussions continued after the workshops and even within the guest families. Hence, the project had an unintended multiplier effect that led to deep reflections that rarely can be reached in a normal learning setting. It is also worth mentioning, that two years after this project, some of the participants are still in contact with their counterparts.

To travel with students to another country or to host foreign students respectively requires an enormous organizational effort. This resulted in a small sample size for this study and, therefore, the findings must be interpreted with caution and cannot be simply generalized. Nevertheless, the results of the AustrIndia-4QOL project show that these efforts are worthwhile. International collaborations carried out with a high degree of active participation by the students and performed as a face-to-face collaboration can be a suitable approach to foster a conceptual change in the context of ESD.

According to our experiences during this project, a dilemma discussion about the tension between economy and environment at the beginning of the face-to-face workshops turned out to be an essential 'ice-breaker.' Fixed roles were given to the students in this first discussion and all students had to contribute. This laid the foundation for the subsequent intensive discussions and, therefore, the foundation for a confrontation of the students with numerous different arguments.

Additionally, regular self-reflection phases in homogenous groups in which the students reflected on their own behavior as well as the behavior of the 'others' during the discussions appeared important. The students could also reflect on probable causes of identified challenges and they could work out suggestions about how to deal with these challenges.

Most surveys in this field examine the impact on students from the Global North traveling to countries of the Global South. On the contrary, this particular survey offered the opportunity to switch the typical roles and to enable students from India to slip into the role of the discovering visitors. We believe that this fact could have helped to foster collaboration as equals and to prevent the often-criticized effect of the rich visiting the poor and helpless [13,19].

For this article, we only examined the impact on the students' awareness and how far this changing awareness led to a different evaluation of issues connected with the SDGs five and eight. A further evaluation of additional data will show if this international collaboration also had a wider impact on the students' concepts. Finally, we will compare the occurred conceptual changes of the students taking part in this face to face collaboration with those of students only taking part in the collaboration via social media during earlier stages of the AustrIndia-4QOL project.

**Supplementary Materials:** The following are available online at <http://www.mdpi.com/2227-7102/8/4/187/s1>, Figure S1. Individual response behavior of all students concerning the guiding question: 'What personal experiences have you had within your family, your circle of friends and in your personal environment regarding issues of gender inequality?,' Figure S2. Individual response behavior of all students concerning the guiding question: 'How do you evaluate the situation in your own country in general regarding issues of gender inequality?,' Figure S3. Individual response behavior of all students concerning the guiding question: 'In his speech alongside the climate conference in Paris 2015 the Indian Prime Minister Modi stressed that the poor countries cannot be blamed for the actual climate change and their pursuit of economic development must not be neglected. How do you personally evaluate this statement?,' Figure S4. Individual response behavior of all students concerning the guiding question: 'Are there environmental problems due to economic development which have a direct negative impact on your personal life? If yes, specify the impact!.'

**Author Contributions:** Conceptualization, M.D. and L.K.; Investigation, M.D.; Formal Analysis, M.D.; Writing-Original Draft Preparation, M.D.; Writing-Review & Editing, M.D. and L.K.; Supervision, L.K.; Project Administration, M.D.

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Article

# Conceptualization and Evaluation of a School Project on Climate Science in the Context of Education for Sustainable Development (ESD)

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**Abstract:** Anchored in the thirteenth of the Sustainable Development Goals (SDG), climate change is one of the key content areas in education for sustainable development. This evaluation study describes a school project that introduces students to scientific work and, more specifically, to scientific research methods in climate research. Using a pre-post design, the evaluation uses a scale measuring epistemological beliefs, as well as two other scales addressing the relevance of climate change in society and career prospects in the field of climate research. The quantitative questionnaire data indicate an increase in future career aspirations in the field of climate research. The qualitative interview data reveal positive changes in the understanding of science and show that an understanding of the *nature of science* can be promoted.

**Keywords:** epistemological beliefs; geography education; climate change; school project; education for sustainable development

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## 1. Introduction

The opening sentences of the Summary for Policymakers in the IPCC 2014 Synthesis Report state that “Human influence on the climate system is clear, and recent anthropogenic emissions of green-house gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems” [1]. Those who wish to be prepared to face these new challenges need the appropriate knowledge and skills [2]. For this reason, the United Nations Educational, Scientific and Cultural Organization (UNESCO) launched the Climate Change Education for Sustainable Development programme within the framework of the UN Decade of Education for Sustainable Development (2005–2014) as a key programme in Education for Sustainable Development [3]. Climate change education is designed to enable people to understand the causes, processes, and impacts of climate change [4].

In the climate change school project described here, 16–18-year-old students engaged with a climate-relevant issue over a period of three to six months. Supported by meteorology students and climate research scientists, they prepared and presented a comprehensive lecture (including written research work) on a climate-related issue. Within the framework of the project, they also participated in scientific lectures on climate research and remained in constant contact with science personnel. In this way, the project contributes to climate education, promotes scientific discussion of climate-relevant topics, and gets schools actively involved in climate research. As part of a general science-based education, schools teach (or should teach) epistemological beliefs—that is, a basic understanding of the genesis, justification, and distribution of knowledge—as a necessary grounding for participation in society [5]. By doing so, an understanding of the *nature of science* can be promoted and a scientific approach can be trained. In addition to basic scientific education, geography teaching is intended to



develop students' understanding of scientific ways of thinking and working, as well as the associated uncertainties [6].

The aim of the present study was to evaluate the climate change school project in terms of epistemological beliefs and attitudes regarding climate science. The evaluation employs a scale measuring epistemological beliefs, as well as two further scales addressing the relevance of climate change in society and career prospects in the field of climate research. The study examines changes in epistemological beliefs regarding climate change among grade 11 and grade 12 students who have participated in a science-based climate project over a period of several months. After outlining the conceptual basics and theoretical framework, the empirical approach is described, followed by results and a discussion of the findings.

## **2. Conceptualization of the School Project as a Collaboration Between Schools and Climate Scientists**

According to the educational standards for geography, the central task of geography teaching is to address phenomena and processes of current geographic and geoscientific relevance—such as climate change—and to develop strategies for action with students, based on well-founded expert knowledge, judgement, and problem-solving competences [7]. The school project Climate Change aligns with these aims. The project was established by a teacher and a climate scientist to promote science communication. Teachers are made aware of this project through further training courses, where they can make initial contacts with the project team. High school students spend about six months working on a climate-relevant issue (1–3 students per group), creating climate maps based on climate data models, and researching scientific sources. The students are supported at all times by climate scientists and meteorology students (meteorology students are far advanced in their studies; they are either undergraduates or graduating students) who conduct workshops, help to create maps, and recommend relevant literature. They visit schools a few times and are available to answer questions via email. The selection of participating schools was based on the time of the study. The participating schools were selected exclusively after the beginning of the study, since the project could not have taken place yet due to the pre-tests. The project enables participating students to learn more about climate change in their own pace.

The project's core elements are as follows:

- Cooperation with climate scientists;
- Insight into scientific research methods (climate modelling and visualization);
- Application of scientific methods to project work;
- Promoting argumentation skills excursions to research institutes; and
- Presentation of results to classmates, teachers, and scientists.

In addition, the project promotes the following skills described by Mochizuki and Bryan [3]:

- Critical thinking, systemic thinking, and problem-solving competences;
- Dealing with uncertainty;
- Analysing, producing, and evaluating information; and
- Information retrieval, media use, and technology.

The project topics encompass multiple areas of the natural and social sciences. This interdisciplinarity extends to teaching practices, as the project is integrated in geography, biology, physics, chemistry, and computer science courses.

## **3. Theoretical Background**

### *3.1. Epistemological Beliefs*

According to Mayer [8], epistemological beliefs are central to competence in the natural sciences and provide a good starting point for understanding the use of science-based knowledge in formal

learning contexts (e.g., school, university), as well as in informal settings (e.g., private online research) [5]. According to Kremer and Mayer [9] and Höttecke [10], the term *nature of science* refers to the characteristic features of scientific knowledge acquisition and the properties of scientific knowledge. Understanding the nature of science is a key aspect of basic education in the natural sciences [11], encompassing both the teaching of content and the generation of knowledge. The present research focuses on epistemological beliefs—that is, fundamental ideas about the nature of knowledge and knowing [11] and about the emergence and justification of scientific knowledge [5]. As these beliefs constitute the underlying assumptions that frame content, they influence learning. For that reason, appropriate epistemological beliefs are a core component of basic scientific education [11].

In their review of the nature of science and epistemological beliefs Neumann and Kremer [12] identified two main strands of research, developmental-psychological and cognitive-psychological. There is broad agreement that epistemological beliefs develop at three main levels [13] as the individual progresses, from an understanding of knowledge as right or wrong (*absolutism*) to a position of *relativism* and, finally, to an understanding that individuals are active constructors of meaning, making judgments and commitments in a relativistic context (*evaluatism*) [14]. According to Mayer and Rosman [15], however, this assumption of an epistemological progression may not always apply. In this regard, Bromme, et al. [16] introduced the idea of ‘division of cognitive labour’ to describe how the production and safeguarding of knowledge necessarily involves some degree of specialisation. In almost all areas, man is a layman and must make science-based decisions based on the knowledge of experts [15]. In the present context, this tension becomes apparent later in the evaluation of the results.

The cognitive psychological approach focuses on the structure of epistemological beliefs, which is the focus of the present work. According to Hofer and Pintrich [14], the certainty and complexity of knowledge relate to the dimension ‘nature of knowledge’ while the source and justification of knowledge relate to the dimension ‘nature of knowing’. In contrast to the developmental psychological approach, this approach assumes that epistemological beliefs are multidimensional and that those dimensions can change independently of each other [5]. In their theory of integrated domains in epistemology (TIDE), Muis, et al. [17] “present a framework that incorporates both positions and hypothesize how the belief systems might interact in terms of the development of personal epistemology and relations to various facets of cognition, motivation, and achievement”.

According to this theory, the three hierarchical levels of generalized, academic, and domain-specific epistemological beliefs coexist and influence each other. The model assumes that a person’s epistemological beliefs develop throughout life and that general beliefs are intertwined with academic beliefs. Urhahne, et al. [18] concluded that domain-specific epistemological beliefs play an important role in understanding the nature of science, and that certainty, development, simplicity, justification, and source are core dimensions of scientific knowledge. Epistemological beliefs also play an important role in the concept of teaching and learning. Based on various sources, Mayer and Rosman [19] concluded that the relevance of epistemological beliefs lies in their importance for learning and knowledge acquisition in formal educational contexts (i.e., school and university), as well as for informal learning and processing of scientific knowledge in everyday life. In this regard, Urhahne and Hopf [11] showed that highly developed epistemological beliefs are positively related to achievement motivation and subject-specific self-concept in biology and physics.

The present study examines students’ epistemological beliefs about climate change in greater depth by assessing the extent to which participation in a science-based climate project over several months changed those beliefs and the extent to which the project contributed to that change.

### 3.2. Attitudes

In addition to epistemological beliefs on the topic of climate change, the present study investigates attitudes to the relevance of climate change and attitudes to a career in science. The two scales used here are adapted from Dijkstra and Goedhart [20], referring to Oskamp and Schulz [21] as “a predisposition to respond in a favourable or unfavourable manner with respect to a given attitude object.” The latent

process perspective relied on here is described by Oskamp and Schulz [21] as a hidden process called attitude that occurs within the individual, and this is used to explain the relationship between stimulus events and the individual's response.

In psychology, research on attitudes has a long history; Francis and Greer [22] provided a useful overview of the correlations between scientific attitudes and multiple factors such as age, gender, and intelligence. The present study investigates the extent to which participation in a science-related project affects attitudes to the relevance of climate change and possible careers in climate science. As participation entails a number of issues, such as interest and authenticity, this question can only be addressed by reference to several factors. For example, instructional practices informed by constructivism and project-based learning influence students' attitudes and motivation [23] and interest also influences learning processes and outcomes, both in the sense of individual appreciation of certain subject areas and the desire to learn more about them [24].

Authentic extracurricular learning also promotes interest, where students leave the classroom and school environment to learn at some external location [25]. According to Dernbach, et al. [26], the objective of a science learning setting is to bring science closer to the students in order to provide information and to clarify scientific processes and findings. Existing research has focused mainly on science education, while epistemological beliefs remain largely unexplored in the field of geography education. However, climate change as a global phenomenon transcends the classical disciplinary boundaries and requires multiple approaches to teaching and learning, including a spatial perspective. In this regard, learning theories applied to the understanding of science are also relevant in the context of geography education. The present study contributes to the relatively neglected field of geography education.

## **4. Methods**

### *4.1. Sample*

The Climate Change school project targets students aged between 16 and 18 years. The students were divided into two classes in two different urban high schools. The climate scientists and meteorology students were the same people at both schools. The present quantitative study is based on a sample of students ( $n = 36$ ) on two geography courses, who completed a pre- and post-test questionnaire. In a mixed method study design, qualitative data ( $n = 18$ ) were collected in guideline-based interviews after completion of the post-test, following the approach described by Mayring [27]. According to Johnson and Onwuegbuzie [28], mixed method research can be defined as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study." We decided to use the Sequential Explanatory Design [29]. This design seems to be appropriate because we use qualitative results to assist in explaining and interpreting the findings of a primarily quantitative study [29]. After the post-test, 18 students were interviewed in four groups of four or five.

### *4.2. Study Design*

At two measurement points (before and after participation in the school project), students from both courses completed the questionnaire assessing their understanding of science and climate change (Figure 1). This was done during regular lessons and in the presence of the subject teacher. After a short introduction and joint completion of the first two pages (student codes, etc.), students completed the questionnaires, which took about 20 min. Data from the pre- and post-tests were analysed using the personal code assigned to each student.

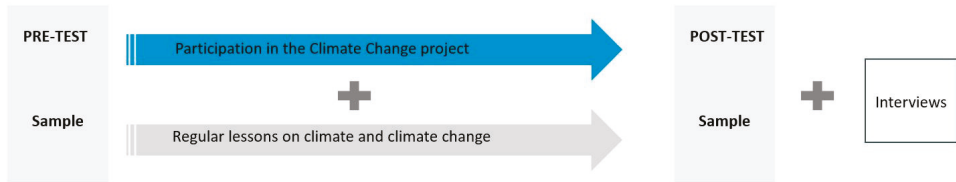


Figure 1. Design of the study.

4.3. Survey Instruments

4.3.1. Quantitative Instrument (Questionnaire)

The questionnaire was adapted from previously published and validated questionnaires developed by Conley, et al. [30], Kremer [31], Urhahne and Hopf [11] and Dijkstra and Goedhart [20]. It was necessary to modify the existing instruments for present purposes, adapting mostly science-oriented statements to the climate context. Table 1 shows some examples of scale items.

Table 1. Example items from the six scales of the questionnaire.

Dimension	Example Item	Number of Items
Source	Everyone should believe what climate scientists say.	5
Certainty	In climate research, knowledge can change at any time.	6
Development	In climate science, theories change or are replaced as new evidence becomes available.	5
Justification	Good theories are based on the results of many different experiments.	7
Relevance	Society should be more interested in climate change.	6
Career	It would be interesting to work in climate research.	5

The questionnaire comprises six scales, as follows: Source of knowledge, certainty of knowledge, development of knowledge, justification of knowledge, relevance of climate change, and career in climate science. The first four scales refer to epistemological beliefs and attitudes to the relevance of climate change and careers in climate science. The scales address the following issues.

*Source of knowledge:* The source of knowledge scale captures how scientific knowledge is discovered and acquired by learners themselves rather than merely received from omniscient authorities [32], with values ranging from 1 (critical view of scientific statements) to 5 (uncritical).

*Certainty of knowledge:* According to Lederman, et al. [33] scientific knowledge is “although reliable and durable, never absolute or certain” In this context, Urhahne, Kremer and Mayer [32] noted that different theories explaining the same phenomenon may be correct as long as there is no evidence to the contrary. Values range from 1 (complete certainty of scientific knowledge) to 5 (provisional view).

*Development of knowledge:* This scale captures the preliminary and changeable nature of scientific knowledge. According to Osborne, et al. [34], current scientific knowledge is “the best we have but may be subject to further change given new evidence” Values range from 1 (immutability of scientific knowledge) to 5 (continuous development of knowledge through new discoveries).

*Justification of knowledge:* In the natural sciences, knowledge is based on observations, experiments, reasoning, and scepticism; experimental data may support one’s ideas or reject them as unbelievable [32]. A value of 1 indicates perceived low relevance of experiments for scientific knowledge acquisition, as well as right/wrong thinking. A value of 5 indicates diverse opinions and well-founded judgements, as well as high relevance of experiments for knowledge acquisition.

According to Conley, Pintrich, Vekiri and Harrison [30] and Urhahne and Hopf [11], among others, the above four scales represent the dimensions of epistemological beliefs, accounting for the greater part of the questionnaire. The other two scales (relevance of climate change and career in climate science) refer to Dijkstra and Goedhart [20].

*Relevance of climate change:* This scale assesses perceived importance of climate change. If climate change has no relevance for the individual, this is indicated by a value of 1; if relevance is high, this is indicated by a value of 5.

*Career in climate science:* This scale measures interest in a future career in climate research. A value of 1 indicates lack of interest while a value of 5 indicates strong interest.

Items are measured on a five-point Likert scale (1 disagree, 2 somewhat disagree, 3 neutral, 4 somewhat agree, 5 fully agree). The climate change knowledge test is based on three options, as follows: Agree, disagree, and do not know.

After subjects completed the pre- and post-test ( $n = 36$ ), the questionnaire data were subjected to exploratory factor analysis using the main component method with Varimax rotation. Differences between the two measurement points were further assessed using *t*-tests for paired samples. Given the small sample size, calculated significances can only be interpreted as a tendency and the focus is on the effect strength of Cohen's *d*. This dimensionless value shows the practical importance of relevant effects and provides an estimate of effect strength, as it is not influenced by sample size [35]. Cohen's *d* is calculated as the quotient of the difference between the mean values of post- and pre-test divided by the standard deviations of the differences [36]. For  $d < 0.2$ , the effect is low,  $d < 0.5$  shows a mean effect, and the effect size can be described as large for  $d > 0.8$  [35].

#### 4.3.2. Qualitative Instrument (Interview)

Following the questionnaire-based post-test, guided interviews with two groups of students from each course ( $n = 18$ ) were conducted and recorded. Groups of up to five students sat in the same room with the interviewer and the interviews were conducted. The interviews were recorded and then transcribed. The analysis was carried out with the MAXQDA software and evaluated with qualitative content analysis. A second rater analysed the interviews with the created code system. In the case of subdivided classifications, we discussed this and decided together. The interview guide was informed by the four scales measuring epistemological beliefs. Each scale included one or two open questions to encourage responses and group discussion. As well as eliciting useful and complex thoughts, uncertainties and misconceptions were easier to explore than with the closed question format used in the questionnaire. An introductory question at the outset (warm-up) made it easier for students to get involved.

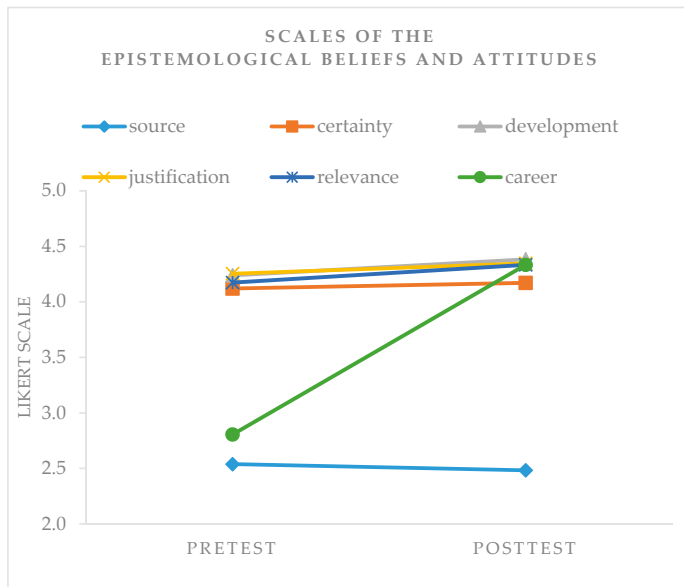
The evaluation was based on deductive-inductive category formation with content structuring, as described by Mayring [27]. For this purpose, four main deductive categories were first derived for the four scales, and these were then inductively subdivided within each scale according to content statements.

## 5. Results

This section describes and compares the quantitative data from the pre- and post-tests, followed by qualitative evaluation of the guideline-based interviews.

### 5.1. Quantitative Analysis

Figure 2 shows the results for the epistemological belief scales and attitudes to climate change and career in climate science. The *x*-axis indicates mean values for each scale and the *y*-axis indicates mean values on the five-point Likert scale.



**Figure 2.** Graphical representation of the mean values (pre- and post-test) for epistemological belief scales (source of knowledge, certainty of knowledge, development of knowledge, and justification of knowledge) and attitudes (relevance of climate change and career in climate science). The Likert scale ranges from 1 (I disagree) to 5 (I fully agree).

The effect strengths were calculated using Cohen’s d, as shown in Table 2. If the calculated value is  $d < 0.2$ , the effect strength is low,  $d < 0.5$  represents an average effect strength, and  $d > 0.8$  indicates a large effect strength [35]. Cohen’s d is defined from  $-\infty$  to  $+\infty$ . For  $d < 0$ , the effect is negative;  $d > 1$  indicates a large effect.

**Table 2.** Significance and effect strengths (Cohen’s d) for quantitative pre- and post-test data.

Dimension	Pre-test	Post-test	Significance (p)	Cohen’s d
Source	2.5389	2.4833	0.568	−0.096
Certainty	4.1204	4.1713	0.572	0.095
Development	4.2389	4.3833	0.022	0.398
Justification	4.2540	4.3472	0.027	0.384
Relevance	4.1736	4.3333	0.067	0.315
Career	2.8056	4.3333	0.000	1.881

The *source scale* values change nominally from 2.54 in the pre-test to 2.48 in the post-test ( $p = 0.568$ ). Mean values ranging from *somewhat disagree* to *neutral* reflect a slightly critical view of statements made by scientific authorities. From the respondents’ point of view, not everything said by scientists is necessarily correct or certain. A value of  $d < 0.2$  indicates only a small effect.

On the *certainty scale*, respondents’ belief that knowledge is provisional and variable is indicated by the high pre-test value of 4.12 and the post-test value of 4.17 (*somewhat agree*) ( $p = 0.572$ ), so rejecting the perfection of knowledge. Here, too, the values remain quite stable over the two measurement points and there is only a small effect strength of  $d < 0.2$ .

Values on the *development scale* change from 4.24 (pre-test) to 4.38 (post-test), indicating that scientific knowledge is considered subject to development and change. This shows a tendential change

( $p = 0.022$ ), with values ranging between *somewhat agree* and *fully agree* and effect strength in the middle range.

The *justification scale* also shows a trend change ( $p = 0.027$ ), with a pre-test value of 4.25, as compared to 4.35 post-test, and in the range between *more likely to agree* and *fully agree*. As the scale refers to the authority of scientists and multiple ways of acquiring knowledge, respondents tend to believe that scientific theories are based on different results and that scientists can change their minds. The effect strength here is also in the middle range.

Values on the *relevance of climate change scale* increase only slightly. The pre-test value is 4.17, as compared to 4.33 in the post-test (*somewhat agree*) ( $p = 0.067$ ). Both are high values, indicating the topic's perceived importance. Effect strength here is again in the middle range.

Pre- and post-test data for the *career scale* reveal differences between the two measurement points. While the pre-test value (2.81) is in the *neutral* range, interest increases in the post-test, with a value of 4.33 (*somewhat agree*) ( $p = 0.000$ ). This indicates strongly increased interest in working in the field of climate research. The Cohen's  $d$  value of 1.881 indicates a strong effect strength.

In summary, values on four scales remain high (*somewhat agree* to *agree*) while one scale remains stable and low (*somewhat disagree*) and one changes strongly (from *neutral* to *somewhat agree*).

## 5.2. Qualitative Analysis

The interview guide covered the four scales of epistemological beliefs used in the questionnaire. One or two questions were asked in relation to each scale, giving students an opportunity to respond more fully than in the multiple-choice questionnaire. The use of an introductory open question served as a warm-up to prompt insights on the topic of climate change. The answers focused on the drastic effects and complexity of climate change, which were variously described as 'destructive' (II: 4), 'drastic' (III: 6), 'worse than imagined' (III: 21) and 'far-reaching and diverse' (IV: 5). According to one participant, "industrialised countries—the polluters—do not have problems with, for example, low coastlines, as in developing countries. The countries that are actually to blame will get the most out of climate change" (III: 8).

The complexity of the issue was addressed by one student in the following terms, "you wouldn't expect so many and such strong factors as are actually involved in climate change". The same student expressed astonishment that "there are still people who say 'that's not man-made; there's no such thing as that'" (I: 6).

*Source of knowledge scale:* This question asked students to what extent their view of the source of climate data had changed as a result of their participation in the school project. Almost all mentioned the considerable effort involved in data collection and modelling, speaking of a 'meticulous process' (IV: 16) that is 'time-consuming' (IV: 21) and of computers that 'take months to calculate a data set' (IV: 23). In this context, one student addressed the ongoing development of the models, "[...] if everything has to be reconsidered now, it will probably take another few years until you have all the data and then something will probably have changed again that you will have to recalculate. So, I think the computers will never stand still" (IV: 25). The possibility of working with 'real' modelled climate data surprised the students, "And it was really easy to go through the website and then just download this dataset and do the maps with this program. Well, it was a lot easier than I had imagined; I thought all this data was locked and that only certain people could access it or something" (III: 19).

*Certainty of knowledge scale:* This question addressed the extent to which participation in the school project had shown students the possibilities and limitations of modelled climate data. In this context, some students stressed that they had learned little about the climate system and climate data and their generation in school lessons, "At least in class I didn't really learn that much about the climate in general" (I: 30) and "we didn't work so much with climate data" (I: 29). Another group addressed the increase in knowledge through participation in the school project, "the field of vision has increased enormously" (II: 24); "one simply thinks quite differently about the influences of climate change"

(II: 25); and “before, one hardly referred to data; because we have now done this in school, a lot has already changed there” (II: 26).

One student related the limitations of climate data to missing data sets, “Well, if you create the climate maps and there are no values, then there was simply a white area on the map [...]” (III: 40). Another referred to the uncertainties of the scenarios, “the limitations are that there are only these scenarios, and you don’t know which one will occur. [...] Only one scenario can be considered at a time” (III: 33).

*Development of knowledge scale:* This scale captured the extent to which students’ sense of the changeability and further development of climate models had changed following participation in the project. The student groups from both schools more or less agreed that there was only a small increase in knowledge about climate models, either because they “searched for more about facts about my personal topic than about the general topic” (I: 41) or because “I knew about modelling even before this semester and what is possible in principle, and my knowledge has not actually increased” (II: 34). The uncertainties of model calculations were also acknowledged, “Subject 2 has just mentioned that climate model 8.5 is now being changed again. This means that you are never actually at a point where you know that this is exactly what is likely to happen in the future. This is always a path that never ends. I would say this ongoing processing of the data is never absolute” (IV: 44); “But I think you should consider that any of these scenarios is theoretically possible, so you should talk about all of them” (IV: 57).

*Justification of knowledge scale:* The scale refers to the extent to which students have become more aware of how to arrive at scientific knowledge. Students associated this question with their online search for scientific articles. Much of the students’ homework consisted of literature research and only part of the work related to climate data. This explains their focus when answering this question, that they have learned “...to work with reliable sources and to refer to scientific results, and to get as good as they can into the matter they are researching, without relying on sources like Wikipedia or something like that but relying more on scientific institutes if they really want to work on something” (IV: 69). Some students spoke about measuring and observing data, “On the one hand, we collect data that we can collect everywhere in the world,” and “[...] through the behaviour of animals and plants, through their observation...” (IV: 69), (I: 43).

No explicit questions were asked about the *relevance of climate change* and *careers in climate science scales*, as these did not relate to epistemological beliefs. However, some of the content of student answers was relevant, which is why they are also listed here.

*Relevance of climate change scale:* The urgent need for good climate policy and more environmentally conscious attitudes was evident in some student responses, “[...] that it is now the last way to do anything and that now, through the Paris Accord [...] perhaps we are taking a step in the right direction” (I: 22); “I would say that in order to stop climate change, it is important that everyone looks at themselves and not just at others or at politics or other countries like the USA, where everything is even worse. Just ask yourself: What can I change in my everyday life to stop climate change or at least make a contribution [...]” (III: 21). One student concluded that “for [me], the most important insight was that everyone has to change something himself” (III: 25).

*Career in climate science scale:* While no explicit questions were formulated for this scale either, answers could be inferred. No student expressed a direct interest in a career in climate research, but their visits to the university and the German Climate Computing Center(DKRZ) remained memorable, “Yes, we have also heard this lecture from DKRZ (other B agree) about the complex computers they use and how long it takes to calculate (IV: 21); and “we were recently at the University of Hamburg and there I was also at such a researcher, climate day. (B4 agrees that he was there as well.) And they told us something that was very interesting, actually” (I: 9).



## 6. Discussion

This study represents a first step in evaluating the Climate Change school project, focusing on the extent to which participation changes the students' epistemological beliefs and possible career perspectives.

Of the four scales related to epistemological beliefs, three remained at a stable high level (*certainty*, *development*, *justification*) and one remained at a stable low level (*source*). The *relevance scale* also remained at a stable high level while the *career scale* values increased from pre-test to post-test ( $d < 0.3$ ;  $p < 0.10$ ).

Values for the *source scale* indicate students' slightly critical position regarding statements by scientific authorities. In that context, the TIDE model of Muis, Bendixen and Haerle [17] distinguishes between general, academic, and domain-specific areas.

As the questionnaire related specifically to natural scientists, these answers can be assigned to a specific domain, but different domains influence each other and contribute to academic and general beliefs. Early education (school) initiates the development of the individual's academic epistemic beliefs, which are also socially constructed and context-bound [17]. It would be interesting to investigate whether values from other domains (e.g., statements by politicians, journalists, or academics themselves) are viewed more or less critically, and whether they change throughout the life course.

The fact that values were 'only' within the slightly critical range can be explained by the theory of cognitive division of labour. As most people are not in a position to fully understand expert knowledge, it is important to deal appropriately with this lack of knowledge, and certain skills must be learned in order to evaluate second-hand assertions [16]. For this reason, it would be interesting to ascertain what the participants were thinking when they answered the question, as a lack of personal expertise means that one must rely in some way on statements made by scientists. Unfortunately, the question was differently interpreted by the students in the interview in terms of the considerable time and technical effort involved in data generation rather than the transfer of knowledge by authorities. In this respect, the qualitative data provide no further insights. On the other hand, it is generally necessary to evaluate sources as well as statements within the framework of possibilities if one is to avoid accepting everything at face value. The form of communication also plays a decisive role, but this is beyond the scope of the present discussion.

According to Lederman, Abd-El-Khalick, Bell and Schwartz [33], the possibilities and limitations of scientific data are reliable and permanent, but never absolutely certain, and this is discussed in the second interview question (*certainty scale*). Some participants recognised the limitations of the data and the process was also worked out by a group, showing awareness of the variability of model data and the importance of different scenarios. This is also reflected in responses to the questionnaire. Using Panoply (a map visualisation program) and MSCM (dynamic climate modelling software) allowed the students to handle different scenarios, deciding on one or comparing different scenarios.

The third interview question (*development scale*) focused on the fact that climate models are only projections and that generated climate data are always fraught with uncertainty. Most groups initially related the question to existential knowledge of climate models and spoke of a slight increase in knowledge, as they already knew that models project the future climate. The longer the question was discussed, however, the closer the students came to the core of the question. The ongoing development of climate models was described by one student as a path that never ends. Another participant indirectly addressed the diversity of models and the repetition of modelling runs.

At this point, it is worth noting the students' excursion to the German Climate Computing Centre (DKRZ), which left a lasting impression. Supercomputers occupying an entire floor of the building model climate data day and night and model runs sometimes last several months. A lecture by a scientist as part of this excursion referred, among other things, to the developments in raster resolution and additional parameters in recent decades, including the increased use of physical and chemical parameters in the newer models. These models are complex and reflect the inherent uncertainty of the climate system. The willingness and ability to engage with uncertainty and to deal with it 'productively'

are fundamental prerequisites for learning [37] and are building blocks in students' understanding of science.

The final interview question addressed the justification of scientific findings gained through observation, experimentation, and modelling and how they can be confirmed or refuted at any time [32]. The high values in the quantitative data (4.24 and 4.38) confirm the perceived importance of diverse opinions and of scientific methods of gaining knowledge as referred to above. As noted by Urhahne and Hopf [11], those who pursue scientific knowledge are more interested in the subject and more motivated to perform; they have a higher subject-specific self-concept and use learning strategies that are cognitively demanding. (It would be interesting to test this idea in another study, but this is beyond the scope of the present discussion.) The interview question was related more to literature search than to the generation of scientific findings. The reliability of serious sources was emphasised and positive reference was made to the increased ability to research scientific content. These outcomes were supported by the school project and are generally positive.

The importance of climate change to the students was reflected in the stable high approval ratings on the *Relevance of Climate Change scale*. Active, long-term, and in-depth examination of a topic not only imparts specialist knowledge but, at its best, creates situational interest. According to Krapp [24], this can also promote individual interest, which can be interpreted as a positive motivational disposition towards a certain field of knowledge or action. The classification of climate change as an important and relevant topic can also lead to increased interest in pursuing a career in climate science, possibly because of personal contact with scientists and increased familiarity with the field within the framework of the school project. The students visited a climate research institute, worked alongside scientists, and were exposed to high-performance computers, giving them an insight into the professional work of the climate researcher.

As described by Meyer [38], these can be characterised as extra-curricular learning venues that support the pursuit of cognitive, instrumental, social-communicative, and affective learning goals. In the interviews, the students referred repeatedly to the excursion to the German Climate Computing Centre (DKRZ), confirming that the visit was memorable and aroused their interest. These places of learning are notable as encounters with an authentic person in the scientist's mediation of science, [39]. In this context, Braund and Reiss [40] argued that "authentic school science should provide experiences that are more in line with the sorts of activities that scientists and technologists do in the real world of science and that such experiences should include student-directed tasks and more open-ended enquiries." The increased interest in a possible career in climate research can be linked, among other things, to the intensive exchange with climate scientists and the accompanying insight into this field of research.

### 6.1. Assessing the Project

The Climate Change project also brings education for sustainable development into schools. The 17 goals of Education for Sustainable Development adopted by UNESCO in September 2015 articulate major challenges for humanity. SDG 13 focuses on "measures to combat climate change and its effects" [2]. To that end, learners should work towards stated objectives in the cognitive, socio-emotional, and behavioural domains [41]. Each of these domains is subdivided into five detailed objectives. On closer inspection, it becomes clear that participation in the Climate Change School Project addresses several of these objectives.

- The learner understands the greenhouse effect as a natural phenomenon caused by an insulating layer of greenhouse gases [cognitive learning objectives].
- The learner is able to understand their personal impact on the world's climate, from a local to a global perspective [socio-emotional objectives].
- The learner is able to anticipate, estimate and assess the impact of personal, local and national decisions or activities on other people and world regions [behavioural learning objectives] [2].

The Climate Change project contributes both to deeper discussion of climate-relevant issues and to the development of skills within the framework of Education for Sustainable Development. Participation. The school project also promotes other key interdisciplinary competences considered ‘transversal, multifunctional, and context-independent’ [2]. The understanding of the “nature of science” and the scientific handling of data will continue to be promoted.

The four dimensions of science understanding (source, certainty, development, and justification) [19] are promoted by participation in the school project. The relevance of epistemological beliefs lies in their relevance for learning and knowledge acquisition in formal educational contexts, as well as for informal learning and processing scientific knowledge in everyday life [19].

## *6.2. Limitations of the Project*

One limitation of the present research is the small number of participants ( $n = 36$ ) in the quantitative part. This prevents any reliable statistical generalisation about the understanding of science at a wider level. Future studies should increase the sample size to enhance generalisability. In the present case, the use of Cohen’s  $d$  value facilitated evaluation of effect strength.

As respondents differed in their interpretations of the interview questions, which were based on the questionnaire scales exploring epistemological beliefs. It is reasonable to ask whether the questions were formulated too imprecisely or whether the respondents could not cope with the complexity of the questions. We asked, for example, for the possibilities and limitations of modeled climate data. Some students answered that they missed datasets they need for their project, so they did not come up with the idea that the question did not refer to their project, but to climate data in general. So, there was no dealing with the complexity of the climate system and the uncertainties (population growth, dealing with renewable energy, etc.). As such, we suspect that the two issues are linked and for that reason, no conclusion can be drawn as to whether participation in the project promotes understanding of science as a whole. The consideration of selected scales shows only a deeper understanding of aspects of climate change, data generation, and the limits of climate models. During the interviews, it was noticeable that the questions frequently had to be repeated at the participants’ request, but for reasons of comparability they were not reformulated or explained. This suggests that the questions were unclear and possibly too complex. In the future, the questions should be distributed in printed form throughout in order to make them easier to understand.

Many variables influence the formation of science understanding (e.g., teacher personality, lesson design, teacher knowledge, topic, group dynamics) and, as these cannot easily be controlled, it is not practicable to include an experimental control group in this setting. Although we have collected other data from upper school geography lessons on climate change (where students did not participate in the school project), we have not included these data as a control group because of the difficulties of variable control. It is important to acknowledge that students can respond well without participating in the project, but these data lie beyond the scope of this study.

It is also important to note that the content of the epistemological belief scales was not explicitly taught, but formed part of the project only implicitly. In a study of sixth graders’ views on the nature of science, Khishfe and Abd-El-Khalick [42] found that “an explicit and reflective inquiry-oriented approach is more effective than an implicit inquiry-oriented approach in enhancing sixth graders’ views of the target NOS aspects.” On that basis, it is reasonable to ask how the project concept might be adapted to explicitly promote appropriate epistemological beliefs. In addition, the accompanying regular geography lessons on climate change might usefully be more closely coordinated with such a project, with parts perhaps conducted by project members (e.g., meteorology students).

The Climate Change school project will be run over a longer period of time (approximately six months) in parallel with regular geography lessons, which will of course consume more teaching time. The pupil-oriented approach (in which the main topics are chosen by the students themselves) enhances interest in learning about this important contemporary topic. The Fridays for Future movement, in which many students participate, confirms the relevance of climate change for students and the

data on a potential career in climate science further confirm that authentic learning creates interest and attention.

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Article

# ‘Nature Is Something We Can’t Replace’: Mexican Students’ Views of the Landscape They Want to Conserve

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**Abstract:** The primary aim of this qualitative study was to identify the landscapes that 7–12-year old Mexican students (n = 440) would like to conserve by analysing their drawings. Another aim was to determine the environmental relationship and environmental values of 5th and 6th graders (n = 152) by studying their texts. The data were analysed using mixed methods. In this study, landscape is understood as a visual experience of the environment, comprising the visible features of an area. Based on the results, all of the three main landscapes—nature, social and built—were deemed worth conserving. Beyond students’ immediate environment, the polar regions, North America, Australia and Africa were mentioned; Europe and Asia were not. The landscape drawings were realistic and carefully made, and the descriptions attached to them were clearly written. The environmental approach was mainly humanistic, and aesthetic values were appreciated by both genders. Utilitarian values were mentioned more often by boys than girls. The students’ descriptions reflected their environmental relationship, e.g., concern about nature, showing causal relationships, appreciation and affection. Concern or worry was often accompanied by the mention of human’s responsibility in the students’ texts, but they seldom considered their own activities in relation to the environment. The students depicted threats to nature, but they externalized themselves from the mechanisms threatening nature. In addition, they did not show familiarity with natural processes and scientific terminology. The study reveals that it is not only theoretically important to have distinct values, but these also need to be recognized by individuals. If the humans’ pro-environmental actions are to be promoted through education, it is important to study students’ values, as they may be important barriers to behavioral change. As students showed concern about preserving nature, teachers can discuss environmental values and different ways to take action and make changes with them, in order to avoid anxiety.

**Keywords:** environmental approach; environmental relationship; environmental values; landscape drawings and texts; qualitative study

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## 1. Introduction

The knowledge of students’ subjective worldviews [1], their environmental conceptions and environmental relationships, are crucial to strengthening children’s connection to nature and expanding their knowledge base [2]. The present qualitative study aimed to explore Mexican (Monterrey) students’ views of landscapes they deem worth conserving and to determine their environmental relationship and environmental values.

This study is part of a bigger project aiming to investigate what children and adolescents draw in their landscapes and deem worthy of conserving. The project has been carried out in several countries. Mexico is an interesting place, due to its large diversity. Monterrey itself is an affluent,



constantly growing city, close to the border with Texas, where children are very much exposed to United States culture.

The basis for this study lies in the word landscape. The concept of landscape refers to a visual experience. The Finnish word for landscape 'maisema' has a strong connection to the 'bounded area' or 'region', just like the German word 'Landschaft'. However, it differs from the English word 'landscape' which covers more social aspects [3,4] and is used in Monterrey school due to the school language of the participants of the study.

Childhood environments in connection to place attachment, identity and dependence, as well as cultural and environmental experiences, form the basis for the environmental relationship [5,6]. Environmental relationship depicts a person's attitude toward his or her environment [7], whereas environmental values describe different ways to approach the environment [8,9]. Values are something that people consider important to them. Kellert [9] has empirically refined a set of nine environmental values (utilitarian, naturalistic, ecologicistic-scientific, aesthetic, symbolic, dominionistic, humanistic, moralistic, negativistic) which reflect what kind of values man associates with nature and the environment in general. According to Steg et al. [10], the distinction between the different types of values is not only theoretically meaningful but also recognized by individuals. So, if you want to promote pro-environmental actions through education, it is also good to study the values of the students, as these may be important barriers to behavioral change.

Many studies have shown that repeated nature experiences (e.g., [11,12]) and long-term nature education (e.g., [13]) develop environmental attitudes and views. Research shows that fewer children play outdoors and outdoor play is increasingly centered on the home, rather than the countryside, parks and beaches [14–16], because media and information technology take up more and more of youth's spare time [17]. Thus, schools and parents have a significant responsibility to provide children with experiences in nature and to develop a positive environmental relationship in children.

The qualitative data of the study consists of Mexican students' drawings and written descriptions of landscapes worth conserving. Drawings have been successfully used in previous environmental studies [18,19]. The use of drawings as data has been justified because children like to draw, and it is an easy and quick way to get information despite any language barriers. Previously, drawings of landscapes worthy of conservation have been collected from several countries, including Finland, Russia, Sweden and Nepal. Eloranta's [20] study explored landscape drawings of Finnish and Russian children and young people. According to the results, the girls drew more ecological landscapes, while the boys drew built and social landscapes. The girls also drew more animals than boys. In other countries, children have seen all three types of landscapes (nature, social and built landscapes) as worthy of conservation [20–23]. The results from Nepal, however, were different because they did not contain any nature landscapes [22]. Children especially appreciated a landscape where there were no signs or people of human activity, and they thought that man was not part of the natural world [20–24]. In the Yli-Panula and Eloranta [21] study, Finnish children and adolescents drew only a few animals in a landscape deemed worthy of conservation. Reasons for this may be that animals are difficult to draw and/or that animals move from place to place in their surroundings and are therefore not placed in a particular location. Moreover, according to previous studies, children and adolescents were worried about their environment. They wanted to conserve pure nature, so they did not include man in the landscape [15,21,23,25].

The first aim of this study was to identify what type of landscape 7–12-year-old Mexican students would like to conserve. The second aim was to determine the environmental relationship and the environmental values of the 5th and 6th graders. Using thematic analysis [26], the drawings and the texts of the students were divided into three groups: nature, social or built environments [27]. The Mexican students' environmental relationship was studied based on environmental relations and the ethical standards of nature [2,28,29]. Their environmental values were analysed by using Kellert's [8,9,30] categorization of environmental values. The results are presented for the students'

grade and gender. The findings are discussed in connection to landscape theories, environmental relationship theories and earlier findings of drawn and written descriptions of environments.

## **2. Theoretical Background**

### *2.1. Core Concepts of the Study*

The core concepts of this study are landscape, environment, environmental relationship and environmental values. There are various interpretations of the term 'landscape'. In geography, landscape refers, for example, to an area containing a mosaic of landscape elements and can be experienced [31,32]. 'Environment' can also mean all issues associated with human beings, including physical and social dimensions [27]. In this study, landscape is defined as thematic content, so it can be understood as a visual experience of the environment [33].

The concept of 'environmental relationship' describes a person's attitude toward his or her environment [6]. The development of a positive environmental relationship requires active work and contact with nature [17,27]. The interaction between man and environment is reciprocal. Not only does man affect the environment, but man is also affected by the environment [34]. Changes in the environment affect a person's experience and activities [27]. Nature experiences play an important role in the development of the environmental relationship.

There are many formulations of the essential components of environmental values [35,36]. Such formulations include, for example, living harmoniously within ecological systems, developing a caring, responsible attitude toward nature, and promoting a sense of continuity and community with other people and all living things. In this study, environmental values are related to those views which depict the underlying values of Mexican students in relation to the environment, and the role of humans and other living things in achieving sustainability.

### *2.2. Dimensions of Landscape and Environment*

The landscape and the environment gain significance through individual experiences, and observations [6,27] have shown how environmental relations and images in space and place are created, and how they are shaped by knowledge, experience and thinking. Feelings, attitudes and a sense of worthiness also have an important role in structuring the environmental relationship and environmental images. The landscape and environment always have cultural implications, and thus can be seen as a part of the process by which the natural environment becomes a cultural landscape due to human activity [32].

According to Aura et al. [23], the environment can be divided into the natural environment, the built environment and the social environment. The natural environment includes all living and non-living things that occur naturally in a particular region [37]. The built environment includes all places built by humans, such as yards, parks, streets or channels [38]. Social environments encompass the immediate physical surroundings, social relationships and cultural milieus within which defined groups of people function and interact [39]. Together, the natural environment and the built environment form the physical environment, while the social environment includes people and different communities [23]. According to the previous classifications, the landscape is divided in this study into the nature, built and social landscapes. The nature landscape refers to an environment that has not been influenced by human activity for a long time. The built environment is synonymous with the built landscape, meaning the landscape in which man is present. The social environment is used as a synonym for the social landscape.

### *2.3. Views of People about Environment and Environmental Relationship*

Many researchers have studied people's views of the environment and their environmental relationship. According to Loughland et al. [2], children and adolescents aged 9–17 described the environment in six different ways. In the first, and most limited view, the environment was seen as an

object only, and the students did not attach personal meanings to the environment. In the second, the environment was perceived as a place that contains life without man. In the third, man was taken into account as a part of the environment, but his role was not explained in any detail. In the fourth, the environment was thought of as a complex entity, which was perceived to make or give something to man. For example, the environment was perceived as a place of relaxation. In the fifth, man was a part of the environment and also responsible for it. The sixth emphasized the continuous interaction between man and the environment. The students understood that this interaction is mutual [2]. The last three views show that the students had a diverse understanding of the environment and that they were aware of their role as part of their environment. Such views contribute to the creation of environmentally friendly attitudes. The students' descriptions of environment also described their environmental relationship: how they felt about their environment and how they experienced it.

Findings similar to those of Lougland et al.'s [2] study have also been obtained in other environmental studies [15,40]. Children were found to be aware of global environmental problems and the need for environmental protection. They were also able to offer direct and indirect ways of taking care of the environment. In addition, children highlighted the importance of the environment as a place for recreation and relaxation, and they felt that the environment is important for human well-being [15].

Littunen and Lähde [28] distinguished four different levels of environmental relations and the ethical consideration of nature. The environmental relationship can exist at an individual level, whereby a person has a relationship with a single natural entity, such as her/his pet. At the next, and at a more interdimensional level, the environmental relationship is formed between man and various species. This may include, for example, the idea of protecting endangered species. On the third level, the protection of species is related to the protection of whole habitats. The most interdependent relationship is at the global level, for example, dealing with the problem of global warming [24]. In previous environmental studies, the children have been worried about the loss of proper living conditions for animals [18,19,35]. In Barraza's [18] study, nearly 40% of the students described environmental problems in their drawings, and half of the students thought that the state of the world would become worse in the next 50 years. The students' drawings included global environmental problems, such as pollution, acid rain, deforestation and lack of fresh water.

According to Willamo [29], there are three views of the human relationship with nature. In the first, nature is seen far from itself. The relationship with nature is remote, and nature is seen as being outside of man. In the second, man is seen as both part of and separate from nature, and two dimensions are distinguished in both man and nature: the human and the ecological one. In the third, man is considered to be one with nature.

#### *2.4. Nature Experiences Play an Important Role in the Environmental Relationship*

The environmental relationship is shaped by various factors, and the basis of the environmental relationship is created in childhood [5]. The home plays a major role in the formation of the environmental relationship. Environmentally friendly attitudes develop in children who are offered opportunities to observe and experience environmental issues, such as recycling, at home (Musser) [41]. Besides the home, schools and the media play important roles in developing environmental knowledge, attitudes and behaviour. For example, according to Lewis, Mansfield and Baudains [42], during and after completion of their environmental projects, the students were able to verbalise their environmental knowledge, explain associated values, express their attitudes toward local environmental issues and outline their behavioural intentions and actions to improve their environment. The media are effective in calling attention to environmental problems and making the public aware of the problems created by pollution, and, hence, they can be instrumental in creating public pressure to do something about them. Together with developing technologies, the media's importance and efficacy regarding environmental education has grown. However, since the media-mediated picture of the environment does not always meet the educational goals, students should be taught about media criticism [43].

According to Kellert [8], the concept of ‘direct nature experience’ means immediate physical contact with the natural environment, habitats, plants or animals. Direct nature experience is often spontaneous and unplanned. Today, true contacts with nature are often replaced by virtual channels providing children with transmitted nature experiences through photos, videos, images and metaphors. Therefore, children have fewer nature experiences than those of previous generations [14]. Their nature experiences are also increasingly organized and controlled by adults [8]. Consequently, nature can be something distant or exotic for the child.

Direct nature experiences play a crucial role in the development of the environmental relationship of children. They have an impact on children’s affective and cognitive development [8]. The natural environment has a positive effect on the happiness and well-being of students [44]. It can also develop children’s emotional affinity toward nature [8] and give rise to the appreciation of familiar and pleasant landscapes [17]. It can increase their positive mental, emotional and social health outcomes, such as their sense of achievement, self-confidence, self-esteem, adaptation to different learning styles, sensory engagement, skills in caring and nurturing, connectedness to others, feelings of freedom and creativity, and feelings of stress relief and engagement in school [45]. Also, Wistoft [46] has reported possible benefits on aspects of students’ learning motivation. However, children’s experiences of nature can be positive or negative, and both positive and negative feelings towards nature contribute to their affective development.

The environment shapes the child and the child’s actions. Interactions may vary from social relations, to the triggering of senses and emotions, to concrete acts. Rickinson et al. [47] highlighted the benefits of the school grounds/community projects on students’ science process skills, as well as the impact of fieldwork and visits on students’ long-term memory and higher order learning. Active learning develops the learning skills of inquiry, experimentation, feedback, reflection, review and cooperative learning [48]. While students learn outdoor skills, they also learn things about their environment, themselves and each other. A balanced alternation of direct, indirect and transmitted nature experiences develops thinking skills through detection, research and reasoning [8]. According to Moeed and Averill [49], students are also able to transfer the gained skills into a different context. All of these may lead to greater knowledge of the subjects and the environment and to the development of the environmental relationship.

### *2.5. Values behind the Environmental Relationship*

This study also explored the environmental values underlying the environmental relationship by evaluating the Mexican students’ writings that were linked to their landscape drawings. Value is a multidisciplinary concept. According to Niiniluoto [50], there are instrumental values and intrinsic values. Instrumental values are useful as a means to achieve a goal that is considered valuable, while intrinsic values are important due to their essential nature. Rokeach [51] notes that values have cognitive, affective and functional factors associated with them.

Environmental values are formed during early and middle childhood, and their development requires interaction with the environment [52]. On the basis of empirical studies, Kellert [30] developed a nine-level environmental rating system that can be used to examine the human relationship with the environment.

Kellert [8,9,30] described the development of environmental values through three phases. The first stage occurs before six years of age or during early childhood. During this phase, utilitarian, dominant and negativistic environmental values develop. The utilitarian environmental value emphasizes materialistic benefit. Nature is used to satisfy man’s own needs. The dominant environmental value means that, due to his own needs, man emphasizes his own existence at the expense of nature. Nature is thus considered subordinate to man. A negativist environmental value is related to a hostile or fearful attitude toward either an animal or a natural phenomenon.

The second stage is between six and twelve years of age when humanistic, symbolic and aesthetic environmental values develop. With the humanistic environmental value, human responsibility for

nature is recognized. The symbolic environmental value stresses that nature has a symbolic value. At the heart of aesthetic environmental value is the appreciation of beauty and seeing it in nature.

The third stage in the development of environmental values is from the age of thirteen to seventeen. At this stage, values are directed from local to global, and the stage is characterized by naturalistic, ecological–scientific and moral environmental values [8]. The naturalistic environmental value includes the appreciation of nature for the sake of nature itself. The ecological–scientific environmental value emphasizes understanding natural mechanisms and taking natural patterns of action into account. Dependency relationships are part of nature’s activity; the link between the conservation of species and the protection of habitats is important. The moral environmental value stresses that everyone should be treated as well as possible and that damage to others should be minimized. Nature should be protected and cherished. The primary point of view is the appreciation of natural order and harmony.

Eagles and Muffit [53] showed in their study that the most common environmental values among 12 to 14-year olds are the humanistic, moral, naturalistic and ecological environmental values. Girls show more moral value than boys, while no gender differences are observed in the other environmental values. According to Eagles and Demare [5], moral and ecological environmental values are most prevalent among children who discuss the environment at home, view nature documents and read environmental literature.

### **3. Study Design**

#### *3.1. Study Questions*

The first aim of this study was to find out what kind of landscapes the Mexican students want to conserve. The hypothesis was that the landscape which the students wanted to conserve would be important and valuable to them. The second aim was to determine what kind of environmental relationship and environmental values the students had.

The study questions were the following:

1. What kind of landscapes do Mexican students (1st–6th graders) want to conserve?
2. What kind of environmental values are revealed by Mexican students (5th–6th graders), and what do those values tell about their environmental relationship?

The first study question was related to nature, built and social landscapes as defined in environmental psychology [23], and the data included the Mexican students’ (n = 40) drawings and accompanying texts. The second study question was related to the 5th–6th graders’ (n = 152) landscape drawings with the accompanying texts. The variations in the content of the drawings were studied according to age and gender. The data were analysed and categorized using mixed methods.

#### *3.2. Participants and Material of the Study*

The participants were 1st–6th graders (N = 655) of an immersive English language private school in the city of Monterrey, Mexico. Mexico is one of the most diverse countries, culturally and economically, in Latin-America. The age of the students ranged from 7 to 12 years. Most spoke Spanish as a mother tongue, although the language of school was English, and were of high socioeconomic status. These background issues support students’ opportunities to travel abroad. The school was chosen based on collaboration connections and voluntariness. Data was collected by a Spanish–English bilingual postgraduate student who passed detailed instructions on data collection procedures to the principal. The school’s elementary school principal was contacted by email in 2010, through which the aims of the study and the data collection procedures were explained. The principal then communicated with the teachers, who participated voluntarily. Teachers asked their students to draw on an A4 white sheet ‘a landscape you would want to conserve’ and include a short text describing the landscape in the drawing. Pencils, including colored pencils, were used. The term conserve was chosen because it includes aspects of the future, and if we do not take action to preserve the environment,

it will disappear. Students were given one class period lasting 45 min to work on their drawings. Demographic information (name, age, gender, grade level and name of the school) of the students was also collected and students were asked to write them in English.

The first research question focused on the landscapes the Mexican students (N = 440 1st–6th graders' drawings; 49% girls and 51% boys) wanted to conserve. The students' texts supported the interpretation of the drawings. The 5th–6th graders' (n = 152) drawings and texts were chosen for further analyses to find out the answer to the second research question about students' environmental values and their relationship with the environment.

### *3.3. Drawings as Study Material*

Drawings have proven useful for studying children's environmental values, environmental relationships and environmental concepts [18,19]. Some advantages of this research method are that it avoids language problems and that children often feel comfortable drawing. Drawings are of special value for students that have difficulties expressing themselves verbally [54], and they can be helpful for those students who are shy or lack language skills [55]. When interpreting drawings, it must be taken into account that there are differences in respect to age and gender [56]. However, according to research on the development of children's drawing skills [56,57], students participating in the present study would be able to realistically describe the conservation value of the landscape.

There may also be some difficulties in using drawings as research data. According to Barraza [18], Backett-Milburn and McKie [58], Horstman [59] and others, the main drawback is the difficulty in analysing the drawings of young people in particular. In the present study, the drawings of the Mexican students were accompanied by explanatory texts which were used as additional support for the interpretations made on the basis of the drawings. Thus, versatile sources were used to understand the drawers' meaning-making [60] and to validate the interpretations (triangulation). To increase the reliability of the analyses and interpretations, two researchers analysed the drawings independently using mutually agreed upon criteria.

### *3.4. Study Method and Analyses*

The data was categorized quantitatively and analysed using qualitative methods. First, to get an overview of the landscapes students deemed worthy of conserving, the drawings and texts of all students (N = 655) were reviewed in general. Drawings were excluded if they were drawn on colored paper, contained text in Spanish or did not include the participant's age or gender. Thus, a total of 440 drawings remained for analysis (n = 161 by the 1st and 2nd graders; n = 127 by the 3rd and 4th graders; and n = 152 by 5th and 6th graders). About half of the drawings were drawn by girls (49%, n = 217). While the focus was on the drawings, the texts related to the drawings were only used in this analysis phase to support the interpretation. A chi-square test of independence was carried out to test if there was a significant difference in the frequency of the landscape types drawn by girls and boys.

Second, the drawings were classified into three main categories: nature landscapes, built environments, and social landscapes [23]. This categorization has also been used in previous studies [20–22].

Third, the texts of the 5th and 6th graders were analysed in more detail in order to determine what they conveyed about students' environmental values and what they would tell us about students' environmental relationships. The focus was on these grade levels because their texts were longer and clearer than those of the younger students. Further, it was assumed that the older pupils would have a wider vocabulary, and that they could better describe and present their thoughts compared to the younger students.

#### *3.4.1. Analysis of the Landscape Drawings of the Students*

The first research question focused on what kind of landscapes Mexican students wanted to conserve. First the drawings were divided into three main landscape categories [23] using deductive

content analysis [61]. A drawing containing a nature landscape without man or signs of human activity was classified as a nature landscape. If the drawing portrayed signs of human activity, such as a road, a bridge or a building, it was classified as a built environment. Landscapes classified as built environments could still include natural elements such as the sun and trees. Finally, if a drawing contained man, it was classified as a social landscape. For example, a drawing depicting a girl in a swing by a small cabin in the woods was classified as a social landscape, although it also contained elements of a nature landscape and of the built environment. Social landscapes represent Willamo's [29] view of the relationship with nature, in which man is seen as one with the environment and part of a landscape worthy of conservation.

Thereafter, the drawings were analysed by gender and grade level. Next, for the purpose of taking a closer look at what was occurring in each landscape type, the landscapes were further examined through inductive content-based analysis [61]. The contents of the drawings were described, and their main features were highlighted. For example, in the case of nature landscapes, it was examined whether the drawings included forest, water or beaches, and, in the case of built landscapes, it was noted which kinds of elements were depicted. The elements in the drawings were not quantified. Willamo's [29] work on relationships with nature was used to examine the landscapes worth conserving. The aim was to investigate whether the students placed human beings in the environment or not.

#### 3.4.2. Analysis of the Texts of the 5th and 6th Graders

The second research question focused on what environmental values were conveyed by the 5th and 6th graders' texts and what these values revealed about the students' environmental relationship. A total of 152 texts were analysed through a data-driven manner. At the end of the analyses, the environmental values that emerged from the data were reflected to the environmental values created by Kellert [30]. In terms of ethical consideration, the students' environmental relationship was discussed from the perspective of the individual, species, ecosystem and global levels based on Littunen and Lähde [28]. The theories did not form the starting point of the analyses and they did not direct the analyses of the written text. In addition, the results were compared with those of Loughland et al. [2].

First, the students' texts were read through. Thereafter, the texts were analysed using inductive content-based analysis [57]. The unit of analysis was thematic, consisting of one or more sentences expressing environmental issues or a student's environmental relationship [62]. The environmental values expressed by the students that corresponded with themes of environmental issues (see Section 2.5) were written down. Two researchers read through the texts one by one and recorded the themes that occurred in the material. The researchers performed the final thematic analysis together. The final decisions were made through discussions, which continued until consensus was reached and clear arguments were found. As such decisions always include elements of subjective interpretation, group discussions about each text were therefore essential. Researcher triangulation was an essential part of the process. Our research group consisted of experts from biology and geography education, environmental education, sustainable development education, educational sciences and language education, and two of the authors were experienced teacher educators and researchers.

Of the students' 152 texts, themes could be identified in 111 of them. The texts, which included only a list of what the landscape contained, were left out of the thematic analysis. Also, any landscape descriptions that contained contradictions were not included in the analysis. Thus, 41 texts were omitted from the analysis. Of the texts analysed, 63 were written by the girls and 48 by the boys.

From the data analysis, six different themes that described the students' environmental values were determined. After these themes were identified, new themes did not emerge, so the material was considered saturated [62]. Expressions describing each theme were categorized. For example, the texts expressing responsibility for nature were categorized under the theme of responsibility. There could be several themes in one text, and each theme was analysed separately. Thereafter, occurrences of a theme were counted, as well as the proportional percentages for the girls and the boys. The environmental values identified with thematic analysis were used to reflect on what environmental values could tell

us about the environmental relationship of the students. Subsequently, the theoretical background of the study was used to support the analysis. The aim was to study how the students' environmental values related to the environmental values created by Kellert [7,8,30]. In addition, the qualities of the students' environmental relationships were clarified by comparing them to the qualities identified in the studies of Littunen and Lähde [28] and Loughland et al. [2]. Two members of the research team first independently conducted the categorization and the subsequent analysis regarding students' texts in order to ensure the reliability of the process. The analysis process was dialogical in nature. The discussion continued until consensus was reached and clear arguments were found.

## 4. Results

In this section, the drawings and texts, according to the main landscape types and the school grade groups, and the differences in values and environmental relationships between genders are presented.

### 4.1. The Landscapes the Mexican Students Wanted to Conserve

In the Mexican students' minds, all of the three main landscape types—nature, social and built—were worth conserving (Table 1). The amount of drawn nature landscapes increased, and the social landscapes decreased, with age. A chi-square test of independence showed that there was no significant association between gender and the type of landscape drawn,  $X^2(2, N = 440) = 2.65, p = 27$ . The drawings were carefully made, and the descriptions attached to them clearly written. The students depicted a variety of different landscapes both from their immediate surroundings and from outside their homeland. Multiple areas and continents were mentioned beyond Mexico, including North America, Australia and Africa. In addition, the students valued both of the polar regions as worthy sites of conservation. Europe and Asia were not mentioned in any of the descriptions. The drawings were mostly done with coloured pencils, but there were also a few works made with crayons. The students drew primarily existing realistic landscapes and in nearly all landscapes—whether built or social ones—nature (elements) were present underlining the meaning and importance of nature to the students. A few of the drawings depicted mermaids or other fairy-tale creatures.

**Table 1.** The drawings (n = 440) classified into the three main landscape types according to the gender.

	Nature Landscape	Social Landscape	Built Landscape
Girls (n = 217)	138	48	31
Boys (n = 223)	125	58	40
Total (n = 440)	263 (60%)	106 (24%)	71 (16%)

#### 4.1.1. Nature Landscape

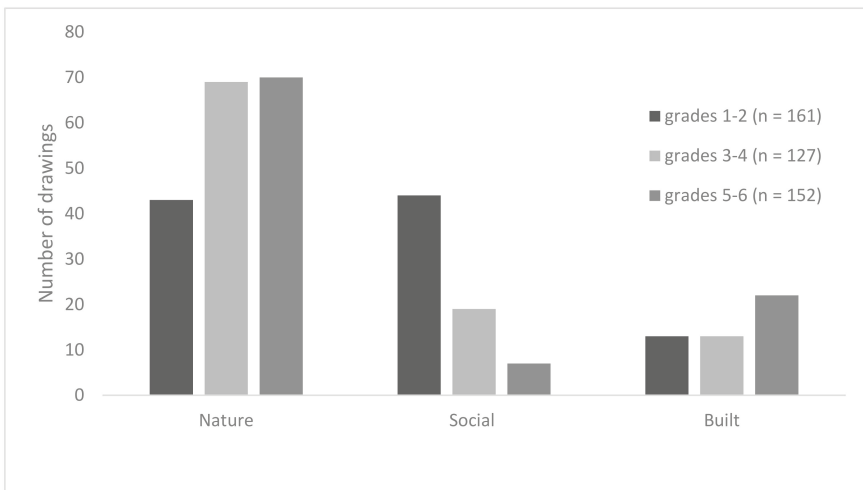
The landscapes which were comprised of natural elements only (Figure 1) were classified as nature landscapes. In these drawings, there were no people or traces of human activity. The majority of the students' drawings were nature landscapes (60%). The drawings depicted nature in various ways and included elements, such as mountains, aquatic environments, forests, glaciers, deserts and a wide variety of animals. Mountains, in particular, often appeared in the drawings, and some of the local mountains were named, most likely because the students were familiar with them. Beaches in the drawings were often named, such as Cancún Beach, which is the best-known beach in Mexico. Typical water environments were waterfalls, streams and rivers. The animals in the drawings were penguins, polar bears, whales, various fishes and domestic animals. The nature landscape was depicted positively and considered very important. Bright colours were often used in these drawings, which could be interpreted as expressing a positive relationship with nature.





**Figure 1.** Nature landscape drawn by a 10-year-old girl (left), a social landscape drawn by a 10-year-old girl (the girl with long hair behind the flowers is looking at what is going on in the environment) and a built landscape drawn by a 12-year-old boy (right).

Illustrating a pure nature landscape was more popular among the older students, 3rd—6th graders (about 70%), than among the 1st–2nd graders (43%) (Figure 2). This indicates that older students may be more appreciative of undisturbed nature than their younger schoolmates.



**Figure 2.** The drawings classified on the basis of the school grade groups and the three main landscape types.

#### 4.1.2. Social Landscape

Those landscape drawings in which humans were present were classified as social landscapes (Figure 1). This was the second most popular theme after the nature landscape. Social landscapes were pictured in total of 106 drawings, making up 24% of the material. Most students drew the social landscape mixed with both the built and nature landscapes. These mixed-theme drawings made up 79% (n = 84) of the social landscape images. The social landscape, together with the nature landscape, was depicted in a total of 19 drawings (18%). There were only two drawings depicting a social landscape combined with a built landscape and one drawing with people as the sole element.

The social landscapes often illustrated different leisure activities, such as people hiking in the wild, paddling, fishing, downhill skiing, surfing on a surfboard or camping in the wild. A social landscape was portrayed in 44% of the drawings made by the 1st and 2nd graders, which was much more often those by the older students. Of the older students, 19% of the 3rd–4th graders and 7% of the 5th–6th graders drew a social landscape. In a few of their drawings, people were pictured beside dams and polluted water pipes.

### 4.1.3. Built Landscape

Drawings which showed traces of human activity but not people themselves were classified as built landscapes (Figure 1). There were 71 drawings of this kind, 16% in total. Most (n = 67) of the drawings which had built landscapes also had nature depicted in them (Figure 1). Illustrating a built landscape was slightly more popular among the 5th–6th graders than in the lower grades (Figure 1). About a fifth (22%) of the 5th–6th graders drew the built landscape as worth conserving, while only 13% of the 3rd–4th graders and 13% of the 1st–2nd graders valued the built landscape.

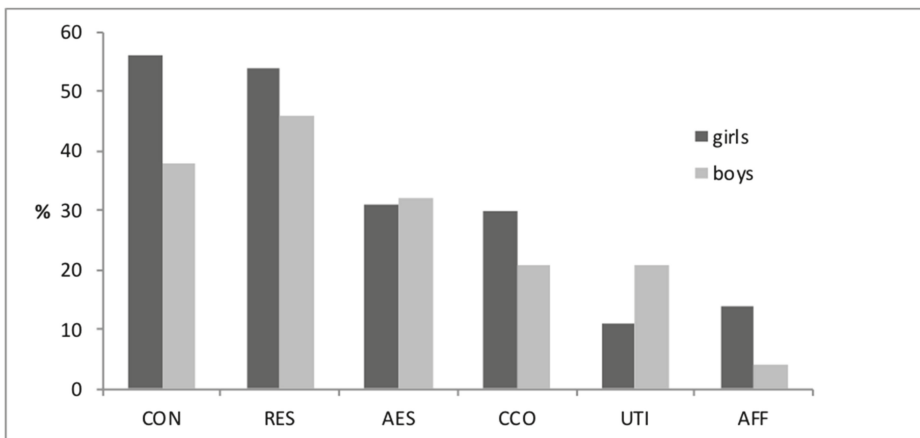
The built landscape was often drawn with a variety of different signs of human activity, such as cars, bridges, huts, parks and houses. Some of the 1st–2nd graders also drew other vehicles, such as airplanes and submarines. In the 3rd–4th graders’ drawings, there also were buildings, fences and a pyramid. One of the most special was the drawing of the Mayan Temple Chichén Itzá, an archaeological site in Mexico. In their drawings, the 5th–6th graders depicted, for example, a church (Figure 1), parks with swings, a Christmas tree and an igloo.

The theme of littering was apparent with all groups. The youngest students drew pictures depicting issues related to recycling, such as recycling points or recyclable bottles and cans. The 3rd–4th graders likewise pictured bottles and cans representing littering in the landscape and environmental pollution. In their drawings, people who littered were often shown. The same theme emerged with the 5th–6th grade students. These students drew trash, signs prohibiting littering and a plastic bag in water causing harm to the fish.

There were no statistical differences in the main types of the landscapes drawn by the girls (n = 217) and boys (n = 223). The boys drew slightly more built and social landscapes (56%, n = 40 and 55%, n = 58, respectively) than the girls (44%, n = 31 and 45%, n = 48, respectively). Likewise, the girls sketched slightly more wildlife (52%, n = 138) than the boys (48%, n = 125).

### 4.2. The Environmental Values and Environmental Relationships of the 5th–6th Graders

The student’s written descriptions of their environmental values depicted diverse relationships with nature and personal experiences related to landscapes. Multiple themes representing these relationships were identified in the data. These themes revealed their concern and affection for nature, and their texts often described causality and appreciation of aesthetics (Figure 3).



**Figure 3.** The environmental relationship of girls (n = 63) and boys (n = 48) with the landscapes they wanted to conserve. The percentage of respondents belonging to each thematic group is given. CON = concern; RES = responsibility; AES = aesthetic values, CCO = cause and consequences; UTI = utilitarian values; and AFF = affection for the landscapes.

In this section, thematic groups are used to represent the students' environmental values and environmental relationships. Themes are presented in order of frequency, so that the theme that occurred most often is shown first and the theme that was the least frequently mentioned is shown last. There were 124 themes mentioned in the girl's descriptions, approximately two themes per description. The boys had written about 77 different themes, having approximately 1.6 themes per description. Alongside the themes introduced, there are examples of the descriptions in which the theme was represented. Furthermore, in the theme analysis, attention was also paid to the possible differences between genders and the set of values concerning the landscape and environmental relationships of the Mexican students.

#### 4.2.1. Concern for the Landscape

The assignment was to draw a landscape which the students found worthy of conserving. In addition, the students were asked to write a description of what they had drawn. Descriptions in which the students expressed worry or anxiety about environment, or about things threatening the landscape or animal species, were classified as the theme of concern. The way the assignment was given may have affected the frequency of the expression of worry, because one of the most recurring themes was worry. Worry was brought up in 53 descriptions. Expressing worry indicates that the students have developed the ability to care about the landscape and that the landscape was experienced as being important. Expressing worry points out that the students at this age are already aware of environmental issues. Also, the girls ( $n = 35$ ) wrote about worry more often than the boys ( $n = 18$ ).

The expressed worry was focused likewise on the state of the landscape, as well as on animals. In some of the descriptions, worry was also focused on people, but people themselves were generally felt to be the main cause of the worry. In these descriptions, people were seen as a threat to nature.

The juxtaposition of good and evil occurred in the descriptions. Two different landscapes were described, one landscape including conceptions of the unpolluted landscape and another one describing pollution threatening the landscape. The students showed worry about the declining state of the world and were worried that the bad version would be realized. One girl expressed this worry:

*'I draw this picture that is divided in two parts the good, ecological part and the other part contaminated and polluted. We look like the bad part all contaminated and pollution everywhere. We should be the good ecological part. Let's change the world'. (Girl 356)*

The students were worried about the state of the world, and they were also aware of current environmental problems. They presented a wide range of concerns, such as pollution, extinction, deforestation and climate change. In connection with pollution, they mentioned water pollution, an oil spill in the Gulf of Mexico and littering. The oil spill also caused concern about possible harm to animals and the landscape. Factories, excessive use of vehicles such as cars, and high energy consumption were also mentioned in connection with pollution.

*There's an oil spill in the Gulf of Mexico, and it reached the shore line. It had been the worst oil spill in the U.S. history. It surpassed the damage of the Exxon Valdes that spilled 11 million gallons and this oil spilled more than 11 million. It's important to be removed because many animals had been damaged and it's a lot of work for the people to green (clean) them and it's too many that it already reached the shoreline'. (Girl 471)*

The previous description was classified as pertaining to the theme of worry, as the girl expressed worry about the well-being of the animals in the Gulf of Mexico and about the oil reaching the shoreline. Animals were mentioned in almost all of the descriptions of worry. This indicates that students are especially worried about animals and are prepared to act on behalf of nature and the landscape in order to improve the conditions of the animals. Extinction was often mentioned, as well as destroying the habitat of animals, for example, by felling a tree they live in. There was also worry about killing wild animals or catching them alive and then selling them. The students named several species of animals

in danger of extinction. A special concern was for big mammals. For the most part, the students were able to name animals in danger of extinction, such as polar bears and pandas. One girl wrote the following about her worry for the koalas and their habitat:

*'I chose to save this landscape because of the koalas. Koalas are small animals that are in trees. They are little and fragile and they need our help. This little guy is so cute and endangered (endangered). I love to help them and keep them habitat'. (Girl 417)*

The polar icefields were often mentioned. Both the girls and the boys wrote and drew many depictions of both the North and the South Poles and Antarctica. The boys mentioned mostly Arctic and Antarctic animals, but the girls also noted domestic animals they were worried about. The students wrote about the warming of the climate and the melting of the ice. The melting of the icebergs was connected to the disappearance of the habitats of the birds in the Arctic and Antarctic regions. Polar bears, seals and penguins were mentioned in this instance. It would be interesting to know why these topics were present in so many descriptions. Perhaps these topics had been discussed in school recently.

*'I want to preserve the north pole. Because of pollution the north pole is melting and animals are dying. Animals in there are being in danger. And it is all our fault. Because of using the energy in excess the poles are melting and the global warming is increasing ... ' (Girl 477)*

In some texts, the students also expressed their worry about the bad condition of the landscape and the effect of human's activities on future generations.

#### 4.2.2. Responsibility for the Landscape

Concern or worry was often accompanied by the mention of responsibility in the students' texts. This theme was chosen when human beings were seen as responsible for the described environmental disaster, or strong reasons for conserving certain things were given. Awareness of human's responsibility for nature was apparent in the students' writings. The theme of responsibility was also included in the students' writings when they gave advice on how to help the landscape and animals, such as 'Let's recycle!' or 'Don't throw trash!'. Also, writings about how human beings in general should act to conserve the landscape were observed. Many students wrote 'we', for example, 'We have to save the earth!' (Girl 421), thus underlining their understanding of our common responsibility for nature.

There were 66 remarks under the theme of responsibility, 34 of them written by girls and 22 by boys. There was no statistical difference between the genders: 54% of the girls and 46% of the boys brought out this theme in their writings. Both girls and boys named things humans should take responsibility for and protect. The girls wrote about the conservation of the sea or a distinct landscape for the benefit of future generations, such as their own children. The boys' texts reflected human's responsibility for even more distant landscapes and animals. The students' message was that our current lifestyle leads to the pollution of our surrounding landscape, and, as a result of our choices, the climate is warming up, which may have severe long-term effects.

*'My landscape is a river and a water falling the mountain. And I made it because I want to save fresh water'. (Boy 440)*

*'It represents all the nature around. Let's keep it like this! Let's save trees and the flora and fauna. There are also many trees and fresh water'. (Girl 453)*

In their writing, the students stated that they needed to take responsibility (I will, I have to), they needed to join the group that should take responsibility (we should, we have to) or that responsibility needed to be taken by human beings (people should).

#### 4.2.3. The Aesthetic Values of the Landscape

The aesthetic values of the landscape, that reflect its beauty and importance as a cause for conserving the landscape, were mentioned in 35 students' texts. Both the girls (32%) and boys (31%) valued the aesthetic nature of the landscape. They wrote about the beauty of the nature and of the landscape. In almost all of the texts that mentioned this theme, the aesthetic values were connected to the landscape.

The students often mentioned mountains, water environments, forests and deserts as beautiful places. In particular, such water environments as seas, ponds, rivers and waterfalls were mentioned. Many students wrote about distinct nature landscapes in Mexico. Also, many Mexican mountains were drawn by the students.

*'My beautiful landscape is found in Mexico. It is Cancun, Quintana Roo in Mexico . . . It is very clean without oil or many other trash . . . It is a beautiful sunset on it. I chose to save that landscape because it is very beautiful'. (Girl 410)*

The students wrote that there was no place for litter or pollution in their valued landscape—on the contrary, they appreciated the greenness of nature. Valuing a clean landscape was brought up in eight of the writings.

*'It represents the beautiful mountains without houses in it and the air is fresh and with a beautiful sunshine.' (Girl 368)*

There were only two texts endorsing a built landscape as a beautiful landscape. An example is where a boy wanted to bring out the beauty of a building sitting in the landscape.

*'This is a church in Arizona that is in a top of mountain. I wanna conserve this because is so beautiful.' (Boy 508)*

#### 4.2.4. Relation between Cause and Consequences

In the writings classified as relating to the theme of 'relation between cause and the consequences', the students often externalized themselves and talked about the mechanisms threatening nature or of those already realized as a matter of cause and effect. In the following text, a girl discussed climate change causing the melting of ice fields which causes a threat to the environment of polar bears:

*'Polar bears in danger of extinction. They live on the ice, and ice is melting because of global warming'. (Girl 360)*

This example also reflects the connection between the protection of the landscape and the conservation of species. The writer does not express her emotional affection to the landscape; rather, she describes the landscape as a bystander.

The students' writings were not presented scientifically using the terminology of the natural sciences. In these texts, a simplified view of the processes taking place in the landscape was expressed. The texts often discussed what happens and its consequences. Many noted the lack of an explanation for why something was happening.

The relation between cause and effect was mentioned 29 times, and more often in the girls' (30%) than in the boys' (21%) texts. In the following example, a girl noted how she wants to conserve all the lakes in the world to prevent the animals dying from the litter people throw. The text was classified as belonging to both the 'cause and consequences' and 'responsibility' themes. Responsibility is shown by her wish to conserve all the lakes, and cause and the effect by her description of the events, where throwing litter in the water causes the death of the animals.

*'I want to save lakes all over the world. With animals inside, because people throw trash in lakes so that makes animals to die . . . ' (Girl 463)*

#### 4.2.5. Utilitarian Values of the Landscape

This theme describes situations where the writer, or people in general, benefit from the thing mentioned in the text. In the writer's mind, its being useful to man would be a reason to conserve this landscape. The utilitarian point of view was brought up more often by the boys (21%) than by the girls (11%), totaling 17, which was only a fraction (9%) of all the themes (n = 201).

One of the examples of the benefits was a comfortable place in which one could quiet down or play sports. In this study, a mental advantage was also included in the benefits gained, in addition to material benefits, as one boy wrote:

*'Hills because you can do a lot of things there'. (Boy 355)*

Some of the texts stressed the importance of nature in maintaining life, and the preservation of trees was argued by some to be essential for the production of oxygen. Also, securing a supply of pure water was mentioned, since people need it to survive. For example, one student wrote:

*'I would like to save water. Because without water we can't live'. (Boy 491)*

Some of the texts emphasizing benefits described a chain of events or a natural process, for example, where a girl wrote about the importance of trees for the life of human beings and animals. In many of these texts, both 'cause and the consequences' and 'utilitarian' themes were present.

*'I want to save a tree because trees are very important in our lives, they give us oxygen, beauty, sometimes they even give us food. Trees are not only important for us they are important to animals to ...' (Girl 496)*

*'I want to save trees to give us oxygen to breathe'. (Boy 499)*

#### 4.2.6. Affection for the Landscape

Texts showing the students' affection for the landscape they had drawn were included in this theme. Personal affection for the environment was found in 11 texts only, nine of those written by girls (14%) and two by boys (4%). In most of the texts, the students expressed their personal affection with the word 'love', which showed their deep attachment to the landscape.

The students often explained what was so attractive in the landscape they had drawn. They accurately described what kind of effects this important landscape had on them. They wrote that landscapes can calm and relax you and that, while looking at them, all your troubles will be forgotten.

Affection was mostly felt for a landscape in the nearby surroundings of a student. Here is an example, where a boy describes a river, which runs by his friend's grandma's house.

*'I drew that because I went with [my friend] and I loved that place. We went to a river and we play and swim on the water. And we dive. That place was beside Enrique's grandmothers house'. (Boy 458)*

In addition to the nearby landscapes, affection was mentioned in regard to foreign landscapes, such as Australia and Hawaii. These may have become important to the students because they were places where their families spent their holidays. However, most of the places mentioned were in Mexico.

Affection for animals was often expressed. The students described the animals they had drawn into the landscape and brought up the importance and beauty of both domestic and wild animals. In their texts, the students often showed affection for a landscape because there were animals in it.

*'... I love this great big landscape. I chose to save this landscape because of the koalas ...' (Girl 417)*

## 5. Discussion

This qualitative case study focused on 7–12-year old Mexican students' drawings of landscapes they deemed worth conserving to determine the students' environmental relationship and environmental values. The participants were students of a private immersive English language school. The drawings were studied using deductive and inductive content analyses.

The first research question concerned *the landscape types* presented in the drawings of the Mexican students. The pictures were drawn according to instructions. The content was clearly drawn, and the attached descriptions were well written. The students drew all three main landscape types: nature, built and social. Built and social landscapes were often connected to the nature landscape [8]. Younger students (1st–2nd graders) drew more social landscapes than the older ones. The human beings in these social landscapes reflected the young students' own experiences with the nature, as was also the case in studies of Finnish and Swedish students [20,25]. These social landscapes indicated that students have a close relationship with the places drawn. This result was in line with one study of Australian adolescents who thought of nature as a place having meaning to them, especially regarding their psycho-emotional well-being [63]. The older students, the 3rd–4th and 5–6th graders, drew more nature landscapes than the younger ones. These results were also in line with previous studies [20–23,25].

Students drew their immediate surroundings, as well as foreign environments, for example, the North Pole. The landscapes the students wanted to conserve reflected positive things, such as landscapes with relaxing places or with biodiversity. The older students drew more remote places, and this result indicated that the students had environmental knowledge of various places on the globe. They also were able to connect the drawn places to global environmental issues. Animals were often present in the drawings and in the texts, and many of the texts encouraged humans to protect animals and their habitats. This differed in part from earlier studies [20,24] in which animals were rarely drawn in the landscapes but was in congruence with Gambian and Kenyan students' drawings, where animals were often present [64].

The environmental values conveyed by the 5th and 6th graders' texts related to the second research question. The students expressed their personal values, feelings, impressions and opinions, and they also described environmental threats. The same expressions were found in Finnish and Swedish students' drawings and texts [64]. However, for the first time, in this study, the environmental values were also categorized, and six different environmental themes were found. The most often recurring theme was concern, although some students also expressed anxiety, possibly reflecting general discussion of environmental disasters at that time or what they have learned at school. These students had learned about the Exxon Valdes oil spill in their reading class highlights. The students showed concern for the animals, environment, environmental problems and future generations. Being concerned and expressing worry about the environment showed that these issues are highly important to the students, in keeping with Kellert's humanistic approach [8,30].

More specifically, students were concerned about the state of the environment and the animals. The concern for the fate of animals evidenced in the material was not surprising, as it is typical for children and adolescents of this age to be particularly interested in the living creatures of nature. Students can emotionally attach themselves to animals very easily [8]. Concern for animals also emerged in the studies of Palmer [65] and Bonnett and Williams [43]. Large mammals were considered important in the environment, and the children indicated that they were emotionally attached to them. These results are in line with earlier studies [66–68] where children in their drawings focused on large mammals or were concerned about remote species, such as in Alerby's [19] study. Large mammals were most frequently mentioned in respect to distant species whose habitats are endangered. Attachment to large and endangered animals may be due, for example, to the presence of large mammals and the issue of their extinction in nature programs and documentaries. In these studies, the students wrote a lot about animals, and their lives were seen as valuable to humans. Similar results were obtained by Bonnett and Williams [37].

The Mexican students highlighted various environmental issues in their texts, such as global warming, pollution and the felling of trees. It is typical of 5th–6th graders to pay attention to the abnormality of natural phenomena [30]. Many previous research studies have shown that children can be worried about the loss of the habitats of animals [18,19,37]. In Barraza’s [18] study of British and Mexican children’s perceptions and concerns about the environment, the students also highlighted cause and consequences relationships, which described, for example, global warming and the loss of habitat for polar animals. Such relationships were also found in this study. The oil spill in the Gulf of Mexico received some mention. The students were aware of the damage it had caused and were able to provide very accurate information about the disaster. They were particularly concerned about animals suffering as a result of the oil spill. The students were able to discuss the oil pollution damage at school, but information was also available in local papers and through television news. In fact, a global examination of environmental problems indicated that the environmental relationship and ethical consideration of children are already at a high level [24].

Concern and *responsibility* for the environment were often mentioned together. The Mexican students were worried about their environment, and they were ready to act to protect nature. They also encouraged others to take environmentally friendly actions. This showed that they have an idea about humans’ responsibility regarding nature. The same awareness about responsibility was found in the studies by Alerby [19] and by Loughland et al. [2], where children knew the responsibility that humans have toward the environment. The students mentioned many global environmental problems, such as global warming, pollution and deforestation. According to Kellert [8], it is typical for students at this age to notice abnormalities in nature.

*Aesthetic values and affection* for the environment were mostly shown in the texts concerning the Mexican landscapes, especially the mountains. This result supports the observation of Eagles and Muffit [53] that, among 12 to 14-year old students, humanistic values are popular. According to White [17], children typically can be very emotionally attached to a familiar and comfortable environment when allowed to establish a genuine relationship with nature. The texts attached to the drawings also revealed the existence of the relationship between *cause and consequences* in the landscapes and *utilitarian* values. According to White [69], alienation from nature can transform children’s mindsets to see nature as being subordinate to human. However, the results of this study differ from White’s results. All the students showed a positive or neutral relationship with the environment, and nature was not seen as being subordinate to human.

The girls described their *relationship* with the environment in more varied ways than boys. They wrote longer descriptions of the landscapes worth preserving, and that is why their texts contained more themes than the texts of the boys. This may be because girls’ writing skills are better than those of boys [66]. The girls raised concerns especially about the environment. In a study by Eagles and Demare [5], girls were found to have a higher moral attitude toward nature than boys. It is difficult to gauge the level of morality in this study, but it is worth noting that the girls’ responses emphasized a high degree of moral responsibility.

Kellert’s [7,8,30] humanistic and moralistic attitudes among students were reflected via concern, responsibility and affection. And, finally, the student-generated material emphasized the nature-centred environmental relationship of the students.

## 6. Conclusions and Implications

This study provides an example of how teachers can determine crucial information about students’ interests and environmental values. More attention should be paid to the meaning that students attach to their everyday environments. This is important because schools play a key role in developing students’ environmental awareness and positive environmental values. It was noteworthy that Kellert’s [8] environmental values were also found in this study. Humanistic, aesthetic, moralistic and utilitarian values are closely connected to the themes of responsibility, worry, aesthetics and benefits. This reveals something about the universality of environmental values found in all kinds of cultures.



Recognizing the potential of culturally oriented education could strengthen the ties between content knowledge education and sustainability education.

As students showed concern about preserving nature, teachers should discuss with them about different ways to take action and make changes. Concerning, e.g., the environmental disasters, discussions are important in order to reduce students' anxiety which has emerged, for example, because of the climate change issue. Based on these results, humans' well-being in connection to the landscape and environment should be studied further in the future. Another future approach to be studied would be the effect of climate change: it has increasingly become an issue of global concern, and as children around the world have become involved in different types of activism, it would be important to see how this is reflected in children at the age of those participating in our study.

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Article

# Landscape as Experienced Place and Worth Conserving in the Drawings of Finnish and Swedish Students

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**Abstract:** Children explore their environment through experiences and each experience is meaningful in developing their environmental consciousness and identity. On the basis of the drawn landscape experiences, the present qualitative study set out to find out what landscapes the participating students deemed worth conserving. The data consisted of the drawings of 11- to 16-year-old Finnish ( $n = 311$ ) and Swedish ( $n = 246$ ) students. Deductive and inductive content analyses were used to analyse the data. The results showed that all three landscape types; nature, built, and social were presented in the drawings. Nature and built landscapes were the most frequent types, with the proportion of nature landscapes increasing and that of built landscapes decreasing with age. There were gender and cultural preferences: boys drew built landscapes more often than girls; and Finnish students drew summer cottages, a cultural phenomenon typical of Finnish landscapes, which was not found in Swedish drawings. Similarities in Finnish and Swedish data were identified e.g., in forest and water and “cultural landscapes”. Some of the students displayed a more distant, observing role, whereas others adopted an active one in relation to all three landscape types. The results are discussed in connection to the landscape theories and earlier findings of the drawn environments.

**Keywords:** environment; experiences connected to environment; inductive content analysis; landscape; students

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## 1. Introduction

The knowledge of students’ subjective world views [1], their environmental conceptions, experiences, and relationship to the environment are remarkable when developing sustainable education in schools. Media and information technology take over more and more of the youth’s spare time, and children have fewer experiences from nature and outdoor spaces than their previous generations [2].

The present study sets out to explore and analyse Finnish and Swedish children’s and adolescents’ views and experiences of landscapes that they deem worth conserving. The Finnish word of landscape ‘maisema’ and Swedish ‘landskap’ have a strong connection to the ‘bounded area’ or ‘region’ just like the German word ‘Landschaft’. So, they differ from the English word ‘landscape’ which covers more social aspects [3,4]. Instead the term ‘preserve’ we use the term ‘conserve’ because it includes the aspect of the future as the Finnish word ‘säilyttää’ and Swedish word ‘bevaka’ also do. The study was carried out as a country school project between Finland and Russia in 2003–2005, [5,6] organised by the Finnish National Board of Education. Drawings were chosen as data, as the researchers did not write or speak Russian. The project [5,6] provided an inspiration to explore the reasons why children want to

conserve nature, what kind of landscapes they want to conserve and what kind of differences there are between age groups. Since then, studies have been expanded and updated to include also drawings by children and adolescents in southwestern Finland [7,8]. Apart from our research, there are no studies on adolescents' views on landscapes deemed worth conserving in this research framework.

The qualitative data consists of drawings and written descriptions of favoured landscapes. The focus is on Finnish and Swedish adolescents' drawn and written experiences of the landscapes that they deemed worth conserving. Using deductive content analysis [9], the drawings were first divided into three groups: nature, built or social environment [10]. Then, the drawings and the accompanying written texts were interpreted using Wylie's pairs of tensions of the landscape [4], and analysed further in connection to the children's and adolescents' experiences regarding the landscape worth conserving. Below, the results are presented for countries, students' age (grade), and gender. The findings are discussed in connection to landscape theories and earlier findings of drawn environments.

## **2. Theoretical Background**

### *2.1. Core Concepts of the Study: Landscape and Environment*

Originally, landscape was used to refer to nature, but later on, human activity, such as man-made fields, and cultural artefacts, such as traditional houses, were included in the definition [11]. A landscape can consist of several environments and is formed mainly by visual experiences that embody the perceived landscape in one's mind. Thus, the landscape is a physical and mental entirety, which exists when a person observes the surroundings and forms her/his own experiences of the environment. The mental images are based on an individual's lifelong experiences, values, education, profession, mental state, and even on external matters like the season. Individual mental landscapes are unique, perhaps even products of imagination based on subjective or inter subjective experiences. Thus, the definition of a landscape also includes the way we interpret the environment [12]. Landscape can be seen as a dynamic synthesis of natural and cultural environments [13]. The concepts of landscape and environment can be used as synonyms, as does this study.

The environment is a complex concept that can be examined from a number of dimensions: as immediate, local, international, global, animate, inanimate, natural or constructed, physical or social phenomena [14]. Suomela and Tani [15] analysed it from three different aspects. The first, scientific and objective, aspect views the environment as something out there, outside and independent of man, formed from physical, chemical and biotic matters. The second aspect refers to an individual experience of the environment: my experienced environment—the environment is here. According to this view, every human being has her/his own environment, which acquires its meaning via thoughts, experiences and emotions of the individual. The third view refers to the environment formed by the community and society including the dimensions of power and responsibility. This view is represented by environmental politics, for example. The dimensions of power and responsibility can be seen in historical buildings and their surroundings, for example, which in Sweden and Finland are usually taken care of by the municipalities and also appreciated by the inhabitants.

In the phenomenological view, Tilley [16,17] endows landscapes a personal and social identity by defining landscapes "as perceived and embodied sets of relationships between places, a structure of human feeling, emotion, dwelling, movement and practical activity", Taylor [12] refers to subjective and personalized experiences. "Landscape is not simply what we see, but a way of seeing: we see it with our eye but interpret it with our mind and ascribe values to landscape for intangible-spiritual-reasons. Landscape can therefore be seen as a cultural construct in which our sense of place and memories inhere".

Wylie [4] views landscape as a topographic idea with surface and depth. He sees landscape as a tension between the perceiver, the subject, and the perceived, the object. According to Wylie, the term landscape refers to four pairs of tensions. The first pair involves the tensions of proximity and distance: the landscape is "here", or it is "over there". In our study, proximity refers to tactility; the landscape is described as something that is in the viewer's immediate environment, whereas distance refers to

a landscape that is viewed as a visual drawing object from a distance. The second pair of tensions views the person in relation to the landscape: s/he may be an observer or a part of the landscape. In our study, the students are considered observers if their drawings present only a set of observable material cultural artefacts, and they are regarded as part of the landscape when their drawings describe first-hand observations of the environment including meaningful practices and values that they have lived, touched, and explored. The third pair of tensions refers to eye and land tension: is the landscape real and not just a figment of imagination, is it just something we see or is it also a way of seeing? In our study, the landscape of the drawings is considered real if it is described as a solid, physical and palpable entity which can be surveyed, mapped, and described in a factual and objective manner and if the drawings in our study include a pictorial understanding of the landscape, that is, if they are pictures or images of the landscape showing that the students are able to look at the world around them in a special way. The fourth pair refers to the tension between nature and culture. If the students present the landscape from the environmental point of view the drawings are viewed as emphasizing nature but if they describe practices, actions, habits, events and other everyday things they emphasize culture. Wylie's [4] (2007) pairs of tensions were used as the key geographical ideas to analyse and interpret the drawings and identify the individual concepts of landscape. The tensions were also part of Suomela and Tani's [15] three different aspects of the environment in relation to man.

## *2.2. Man and the Environment*

As the major thrust of human geography is on the definition of the relationship between man and the environment [10], the original idea of the present study is based on this discipline. The nature of this relationship is also at the core in the interpretation of the results of the present study. Kaivola and Rikkinen [18] showed how environmental relations and images in space and place are created and how they are shaped by knowledge, experience and thinking. Feelings, sense of worthiness and attitudes also have an important role in building up environmental relationships and images. Created images of the environment may be absorbed in memories and entangled in meanings. They are highly subjective and are not available for investigation. The images and the relation between man and his environment is seen as important and unique and can become a lifelong environmental relationship. In human geography the environmental conceptions are also studied, and they reflect the basic understanding of the relationships between man and the environment. According to Loughland and others [19], there are two main categories of environmental conceptions: objective conceptions and conceptions representing a person's relational focus on the environment in a mutually sustaining relationship, which can be analysed.

Man and the environment can be connected to each other via experiences. The living environment as experienced surroundings constitutes students' physical and social environment [14]. For example, during a walk in the forest, one may physically feel being part of the environment or else feel connectedness to the environment via a social habit, such as a forest walk with one's friend. It can be seen through personal social responsibility as well as through the families, communities, and environment in which somebody is living and working [20]. The size of the living environment and the number of environmental experiences are connected to children's age [18]. An increasing number of environmental experiences with age was shown to broaden the range of Finnish and Russian students' landscapes that they deemed worth conserving; while younger students drew more yard and home environments, older ones drew more forest and water landscapes with many observed details, and also foreign holiday resorts [8,21,22].

Natural landscapes may hold a significant positive value to young people. Using drawings to visualize Swedish young people's thoughts about nature, Alerby (2000) found what she called "good world": nature was represented as pure and beautiful [23]. The same beautified picture of nature was reflected in the drawings of Finnish, Russian, Australian, and Nepalese children [8,22].



### *2.3. Landscape as An Experienced Place*

Children use and experience places based on their functions as environments for play and activity [24]. Traditionally, natural environments have been places for children to play and enjoy physical activities, and they have been found to show creativity in their activities in the natural environment [25]. However, modern societies seem to have neglected the value of such environments for the development of children and adolescents. Being a child in an urban area requires that children spot the opportunities for play in the landscape.

Play belongs to childhood, and the environment used for play is pivotal. The different types of contacts that children have when exploring their environment are meaningful in developing children's environmental consciousness and identity and in shaping the way in which children respond to the protection of the environment. Play has been shown to be a form of informal cognitive learning for children. It helps children to develop "flexible and divergent thinking" and provides children with the ability to solve real problems [26]. Outdoor play and experiences are important in creating connections between children and nature. Experiences of nature also help children (3–12 years of age) to shape conceptions and values [27].

There is less research into adolescents' landscape experiences as compared to children's play, but it is known that nature interactions and experiences are restorative [28] as well as beneficial for the general wellbeing for adolescents and adults [29]. For example, in their study of the functional properties and physical features of the environment, Woolley and Johns [30] found that skateboarding is a sociable experience for adolescents. It is a hobby in which adolescents gather to skateboarding places and meet each other.

## **3. Study Design**

### *3.1. Study Questions*

The aim of this study was to find out what kind of landscapes Finnish and Swedish 11- to 16-year-old students wanted to conserve. The hypothesis is that the landscape which the students want to conserve is important and valuable to them. Another research focus is how landscape drawings vary according to the age, gender, and country of the students. The age group was chosen, as adolescents' drawn experiences of landscapes they deem worth conserving for the future have not been studied in earlier related research.

The study questions are:

- What are the landscape types presented in the drawings and how are they described in the students' texts?
- What kind of relationship do the students have in connection to their own landscapes?
- What do the drawings reveal about the personal experiences of the students in relation to the landscapes they want to conserve?

The first and second study questions are related to nature, built, and social landscapes as defined in environmental psychology [10], and the data includes all of the Finnish ( $n = 311$ ) and Swedish ( $n = 246$ ) students' drawings and accompanying texts. The third study question is related to the students' experiences in connection to the landscapes that they want to conserve analysed in the framework of Wylie's pairs of tensions [4]. The data includes the drawings/texts of the students in southwestern Finland ( $n = 182$ ) and in Sweden ( $n = 246$ ).

### *3.2. Data of the Study*

This study includes two groups of adolescents (Table 1), one group of Finnish ( $n = 311$ ) and the other of Swedish students ( $n = 246$ ), in grades 5–9 (11–16 years old). Students ( $n = 557$ ) from two neighbouring countries were selected due to the similarities that the two Scandinavian countries share in terms of nature and culture. The participants of the study were recruited by e-mailing school

teachers in Southern Finland and Sweden, informing them about the study and asking whether or not they wanted to participate in the study. The teachers were also told that participation in the study is voluntary. Prior to the study, they were to inform the students and their parents about the study via a digital platform. The participating schools were located in both the rural and urban areas. The researchers visited the schools and gave the teachers instructions both in oral and written format. The teachers were guided that in case of confusion or misunderstanding they were allowed to clarify the word landscape to the students, explaining that landscape is connected to the environment. If the students needed further clarification, the teachers were allowed to ask the students to describe what there is in the environment. If the students' descriptions were scanty or limited to, say, objects in nature landscapes, such as mountains or water, the teachers were instructed to provide the students with a long list of objects contained in the environment to ascertain that the students develop a versatile picture of the concept. According to the teachers, the students were aware of the concepts at least in the basic level because only the word 'environment' was to be discussed and not other things on the list.

The students ( $n = 557$ ) were instructed to draw a picture of a landscape they would like to conserve. This instruction was given in Finnish (in Finland) and in Swedish (in Sweden). The students were given one hour at school to complete the drawings.

**Table 1.** Distribution of nationality, gender and grade of the Finnish and Swedish students ( $N = 557$ ).

Grade	Age	Finland			Sweden		
		Female	Male	Total	Female	Male	Total
5 and 6	11–12 years	69 (25)	67 (19)	136 (44)	50	47	97
7 and 8	13–14 years	60 (43)	51 (36)	111 (79)	39	45	84
9	15–16 years	36 (31)	28 (28)	64 (59)	25	40	65
		165	146	311 (182)	114	132	246

The Finnish drawings ( $n = 311$ ) were collected from Eastern Finland ( $n = 129$ ) in 2003 and from southwestern Finland ( $n = 182$ ) in 2011, and the drawings from the Swedish students ( $n = 246$ ) were collected in 2010–2011 from southeastern and southwestern Sweden. Due to the fact that the physical, built and social worlds have changed during the 8-year gap between the two datasets from the Finnish participants, the analyzed drawings were compared to the ones of our earlier studies. The data from 2003 and 2011 were studied, and it was shown that despite the changing world the students' views of a landscape worth conserving were uniform with the earlier data [6,21]. However, for clarity, the data of 2003 are presented separately from the data of 2011. In analysis phases II and III, only the drawings from southwestern Finland (2011) and Sweden (2010–2011) were analyzed.

### 3.3. Drawings as Study Material

Drawings by children and adolescents have been used as study material in several studies [e.g., 6,8,23] and their potential and challenges as research material have been discussed in earlier studies [6,21]. Students' drawings are important to get access to their ideas [31], or [32] in Fisher's (2005) words: 'Drawing is a wonderful way of making thinking visible' (p. 57). According to Reiss and Tunnicliffe (2001) [33], drawings are of special value for students that have difficulties in expressing themselves verbally. Drawings can also be helpful for those students who are shy or lack language skills, [34]. There are difficulties in using drawings and written texts as research data. According to Barraza (1999) [35], Backett-Milburn and McKie (1999) [36], and Horstman and others (2008) [37], the main drawback is the difficulty in analyzing the drawings of young people in particular. In the present study, the drawings were accompanied by explanatory texts, which helped the researchers to analyze the pictures. To increase the reliability of the analyses and interpretations, three researchers analyzed the pictures independently using mutually agreed criteria.

In the present study, the landscape is examined as the visual outlook of the environment in the students' drawings illustrating the landscape they want to conserve. The drawn landscape of the

environment “worth conserving” can be considered to reflect the mental images, where personal experiences related to the images of the environment are combined. [38]. They are comparable with the mental maps of living surroundings or wide environments [18]. The drawings of the Southern Finnish and Swedish students were accompanied by written comments which were used as additional support for the interpretations that were made on the basis of the drawings. Thus, versatile sources were used to understand the drawers’ meaning making [39] and to validate the interpretations (triangulation).

### *3.4. Study Method and Analyses*

The Finnish and Swedish students’ drawings of landscapes ( $n = 557$ ), were analysed by re-producing the visual contents of each of the drawings, one at a time, in written text. The written text and the background information were then exported to Microsoft Excel. The written descriptions were then analyzed in three phases (for detailed description, see [8,21] in terms of gender and grades). The three researchers analyzed the material independently and agreed in the vast majority of cases (93%), so the inter-rater reliability was high [40].

In phase I, the drawings were divided into three main landscape categories using deductive content analysis [9]. The analysis yielded drawings which presented (1) nature environments (no features related to the built or other human activity were described), (2) built and cultural environments (showing some indication of human’s activities, such as roads, fences, buildings, vehicles or cultivated fields) and (3) social environments (with human beings drawn as stick figures, showing the face only or as an angler in a boat, for example) [10].

A built environment is a human-made space in which people live, work, and recreate on a day-to-day basis [41]. The World Heritage Committee (2002) [42] defines a cultural environment as “a combination of nature and man and designed and created intentionally by man” and may be a relict or continuing landscape.

In phase II, the contents of the drawings were analyzed more carefully using inductive content-based analyses, and the prevailing contents as well as the details of the landscapes were further specified.

In phase III, the written experiences related to the drawn landscapes were analyzed using inductive content-based analysis [9]. The combined drawn and written experiences were analysed and classified using Wylie’s [4] pairs of tensions (Table 2). The ideas underlying the categories express the students’ “voices”, that is, the reasons why they want to conserve the drawn landscapes. Finally, eight categories were formed based on the students’ personal experiences (Table 2).

The drawings in category A were realistic copies of the environment “out there” and easily analyzed as nature experiences. The drawn details in category B, such as animals, flowers, gardening and other objects in the landscape showed the person’s relation to the environment in detail. Categories C to F represented experiences related to the city/town, holidays, summer cottages, and sport experiences. The last two categories contained descriptions of home/house (G) and “mental landscapes” (H).

**Table 2.** Categories of personal experiences connected to the landscapes drawn by the students—based on inductive content analysis.

Code	Category of Experiences	Content of the Drawing and Written Text
A	Experiences of nature	sea landscape with sun, sea with the horizon, sunrise/sunset, mountain landscape, forest landscape, the falls by a nature trail, tree or trees, fishing experience
B	Classical landscape as an experienced place	classical country landscape or lake landscape, lots of different kind of elements in the drawings
C	City/town experiences	big cities like Chicago or Amsterdam, the street landscapes in cities/towns, shopping centers and sales
D	Holiday experiences to the Mediterranean or similar places	the beach and warmness of tropical areas, warm places with palms, dolphins, Hawaiian Islands
E	Experiences in summer cottages	the surroundings of a summer cottage, lake landscape and a wharf, boats
F	Sport experiences	downhill skiing, football, floorball, tennis, golf, roller skating, dancing
G	Own house/own “nest”	own room + TV, home courtyard, beloved place in tree, built hut in tree or in ground
H	“Mental landscape”	being alone in a silent place-like on the beach or in the forest path, often listening to music

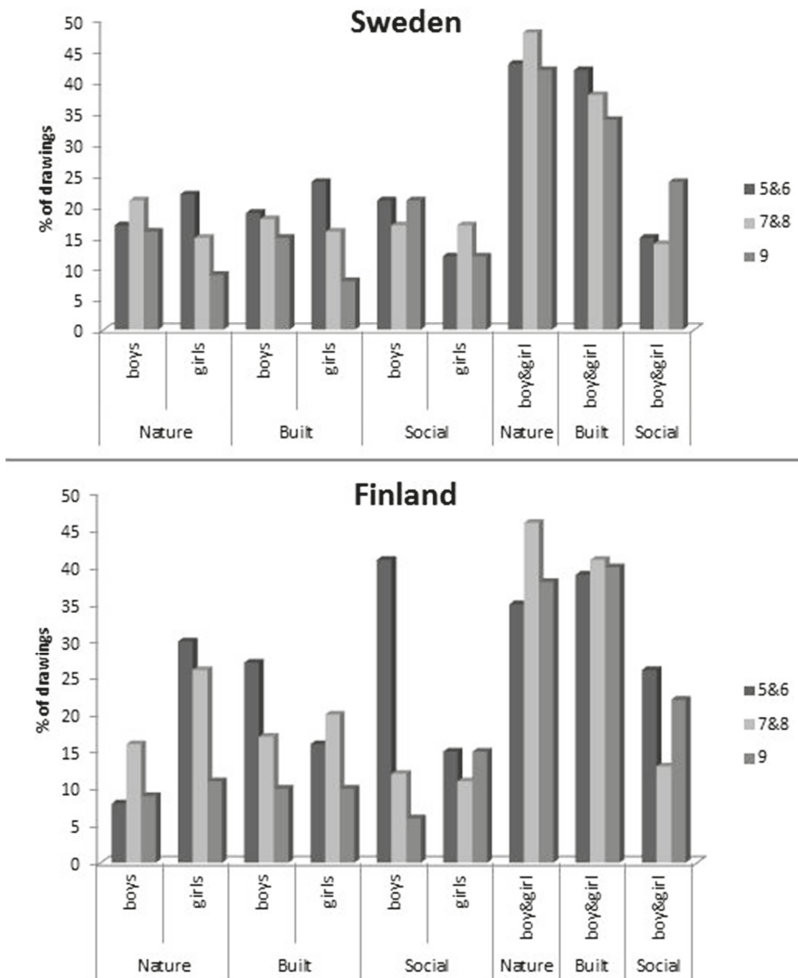
## 4. Results

### 4.1. Nature, Built and Social Landscapes in Drawings in Relation to Students’ Age and Gender (Analysis Phases I and II)

All three main landscape categories; nature, built and social environments were present in the data (Figure 1). Nature and built landscapes were the most, and social landscapes the least numerous in both groups’ drawings.

The proportion of natural landscapes increased, and the proportion of built landscapes decreased with the increasing age of the Finnish and Swedish students (combined, data not shown). Nature landscapes were the most favoured by the girls in lower grades in both countries. Built landscapes were favoured more often by the Finnish and the Swedish boys than the girls. Social landscapes were more evenly distributed among the different grades and genders in the Swedish than in the Finnish data, being especially common in the Finnish fifth- and sixth-grader boys’ drawings.

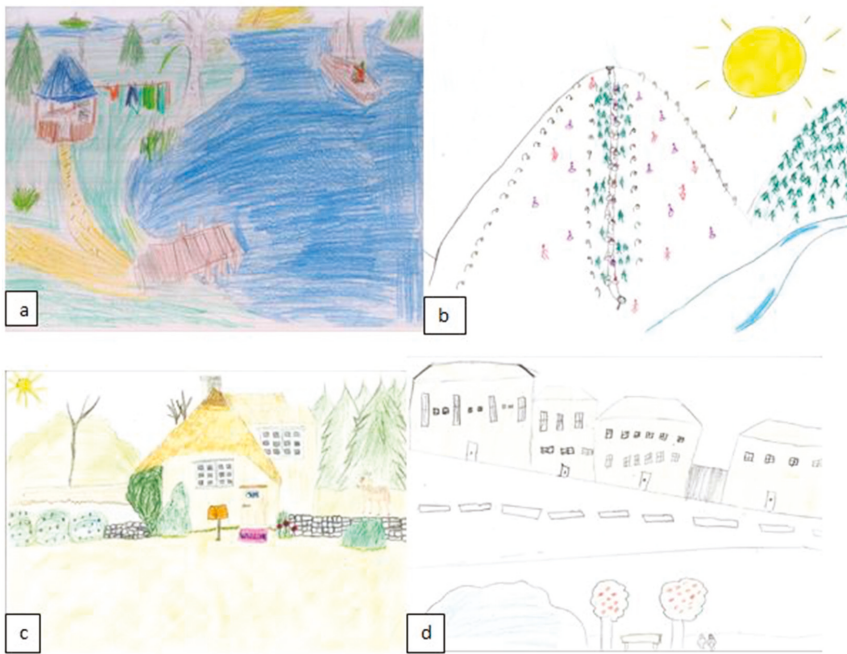
There were many similarities in the contents of the landscapes drawn by the Finnish and Swedish students. The Finnish ( $n = 311$ ) and the Swedish students’ drawings ( $n = 246$ ) typically represented a basic type of physical *nature*. Forests and trees (birches, pines, spruces, leafless trees and bushes), water (creeks, rivers, small lakes, lakes or the sea) and the sun were the most prevailing features. Water elements were particularly frequent in the girls’ drawings, but present in the boys’ drawings as well. In a number of drawings, both nature and built landscapes were represented, typically with the nature landscape gradually changing to the built one without the man-made landscape disrupting the peace of the nature landscape. *Built landscapes* and cultural landscapes (see picture c in Figure 2) were equally represented in the Finnish and the Swedish drawings. The prevailing features were man-made objects, such as wharfs, bridges or vehicles, (cars, tractors, and in the Swedish drawings also helicopters). Houses, streets or courtyards were also frequent. The Finnish students often drew summer cottages, which were not found in any of the Swedish drawings. Human beings were rarely part of the *social landscapes*; people were present only in 18% of the Finnish and 13% of the Swedish drawings. Man was drawn in harmony with the landscape, often as an active agent, for example as a person fishing on a lake in the summer (Finnish data).



**Figure 1.** The distribution of the Finnish ( $n = 311$ ) and Swedish ( $n = 246$ ) drawings by the girls and the boys in grades 5–6, 7–8 and 9 in the three main landscape categories: nature, built, and social landscapes.

Most landscapes represented summer sceneries in Finland and Sweden; there were only a few views with snow and winter activities. Some tropical environments were drawn, too, especially by the 7–9th graders. Boys in all grades drew more often various actions, sports and technical matters than girls. Girls and the youngest students drew animals, such as birds, horses, rabbits and fish. Boys drew mostly birds, but also fish, dogs, and even camels.

Although some of the boys’ landscapes represented schematic and diagrammatic drawings (baseline drawings included the sun, clouds, flying birds), they clearly showed views that they had seen and experienced (visual realism). The girls’ nature landscapes were more expressive and their drawings more versatile. Nature landscapes were often drawn as a scene in the far distance, they were landscapes “out there”.



**Figure 2.** Drawn landscapes as an experienced place (analysis phases II and III): (a) lakeside summer cottage drawn by a Finnish boy (11 years) (b) downhill skiing drawn by a Finnish girl (15 years) (c) classical country landscape drawn by a Swedish girl (12 years) (d) town experiences drawn by a Swedish boy (15 years).

#### 4.2. Personal Experiences Connected to the Drawn Landscapes (Analysis Phases II and III)

The drawings showed the students' personal experiences of the landscapes they wanted to conserve. The written text gave a deeper and more detailed picture of their relation to the environment describing what, how and why the students wanted to conserve the drawn environment. The students also expressed their personal feelings, impressions, opinions, values, and environmental threats. Thus, landscapes were clearly observed via emotions, senses and cognitions.

According to the drawings and texts, the experiences of the Finnish and the Swedish students were often related to "pure nature", classical landscapes with many details, and the built environment representing city/town, holiday and sport experiences. Experiences related to summer cottages were drawn only by Finnish students as well as being alone in a silent place (Figure 2), although silence and peace were also mentioned by Swedish students. Some landscape drawings by both Swedish and Finnish students (most by Finnish boys) presented a built hut or their own house.

#### 4.3. Experiences in Relation to Nature Landscapes

The most commonly drawn nature landscapes were water and forest environments. The experiences were related to the drawers' beloved places, holiday experiences, beauty of flowers or animals especially in the girls' classical landscapes (Figure 2). Many Finnish girls (grades 5 and 6) appreciated nature landscapes with silence, spending time with their parents at summer cottages, whereas Finnish and Swedish boys preferred sport experiences. A few boys from both countries also favored their own "nest" and own place in their drawings. Nature landscapes drawn by 7th and 8th graders typically represented a shore with water, palms and the sun. For Swedish students, such landscapes seemed to reflect freedom and outdoor living and dream landscapes for teenage girls.

The landscapes of the Finnish and the Swedish 9th graders were mostly environments “out there”, representing spruce dominated (mountainous) landscapes, the sea and sunset, and sunny holiday beaches. While the Finnish students drew beaches at summer cottages, the Swedish students drew sceneries of an outdoor recreation area (e.g., Stakedala). Ninth grader boys’ landscapes like the drawings in the 7th and 8th grades were scanty and simple. Their drawings had few elements, such as coniferous forests, winter with snow, night, seashore and a palm on a desolate island or a desert. The girls drew more detailed landscapes with rainbows, flowers and animals.

Examples of Finnish (FI) and Swedish (SE) students’ written descriptions in connection to nature landscapes (A-H refer to the categories of personal experiences in Table 2):

- “This tree is next to the home of my friend Atte, where we spend time together” (FI boy, 6th grade, G)
- “The sea landscape in the archipelago of Turku, where I sail” (FI girl, 8th grade, A)
- “Foreign destination, sunshine and waves” (FI girl, 8th grade, D)
- “My drawing represents harmony and peace. It is a forest landscape (the sun, water, two trees and big stones)” (SE girl, 8th grade, H)
- “The sunset in the mountains, it colors the snow lilac, You can see reindeer there” (FI boy, 9th grade, A)

The examples above show that the experiences of the students, especially the youngest ones, pictured in nature landscapes are related to places where the students currently lived or had lived with friends and relatives. The experienced environment represented greenness, harmony, silence and peace to some 5–9th graders. However, only the Finnish students wrote that they wanted to be alone in their silent place. For Swedish 5th and 6th graders the forest was a place for play and fun. They also wrote that greenhouse gases and rubbish should not be allowed to destroy nature, one student wrote about people having exploited the seas at an alarming rate and that the seas should be saved for the fish.

#### *4.4. Experiences in Relation to Built Landscapes*

The built landscapes drawn by the Finnish girls in the 5th and 6th grades represented most often summer cottages with surroundings at the lake- or seaside but also their family homes and yards. The surroundings of the summer cottage were usually drawn in detail; the pier, stony paths, the sauna, the well and a grill. The Swedish girls also drew sea landscapes with details, sun umbrella, sandals, sunglasses and a rubbish box with texts “all rubbish in here” and “keep the environment clean”. Boys in the 5th and 6th grades drew city environments, country landscapes with tractors, downhill skiing and the sea with a boat.

Half of the built environment in the Finnish girls’ drawings in the 7th and 8th grades represented summer cottages with piers. Other common landscapes in the Finnish and the Swedish data were cities with window sales and city life in general, whereas country landscapes or air pollution were rare. The Finnish boys (7th and 8th grades) drew mountain cottages, boats at the sea, piers at the summer cottages and a few pictures of city life or golf grounds. The Swedish boys also had detailed features in their landscapes e.g., piers, cars, boats, flowers and apple trees.

Built landscapes drawn by the Finnish girls in the 9th grade represented the sea and southern holiday beaches or summer cottages at the lake. Also nature reserves, shopping areas in the city and ice hockey playgrounds were drawn. The Swedish and the Finnish girls shared the same or similar features in their drawings, e.g., sea landscapes with boats, shopping areas and holiday sceneries with palms. The Finnish boys also drew ice hockey rinks, forests, summer cottages at the lake and terraced cultivated grounds, palms, mountain areas with bridges and high-rise buildings. The Swedish boys’ built environments often included a rock, cars, airplanes, trains and downhill ski-lifts.

Rubbish boxes and recycling bins appeared in the Swedish landscapes (but not in the Finnish ones) and some Swedish texts also mentioned the importance of keeping the environment clean.

Examples of students’ written descriptions in connection to built landscapes:

- “Our summer cottage at the lake, it is a silent place and that is the reason why it is my beloved place. There is also a sauna in my drawing” (FI boy, 5th grade, E).
- “My room with TV and play station” (FI boy 6th grade, G).
- “Sunny and silent morning in the center of the town” (FI boy, 8th grade, H).
- “Floorball playground (boy, 8th grade) or golf ground” (FI boy, 8th grade, F).
- “Island with palm trees in a warm climate and a treasure box” (FI boy 8th grade, D).
- “Landscape of the summer cottage and I am sitting on the shore of our summer cottage and I was looking at the sea when the sun was setting—best evening ever (music from the radio was on)” (FI girl 8th grade, E).
- “City life” (block of flats next to each other in the drawing) (FI girl, 8th grade, C).
- “Refrigerator, sale” (FI girl, 8th grade, G).
- “I have drawn a ski resort area, because I want to save the snow in the mountains so I can do downhill skiing in the future” (SE boy 9th grade, F).
- “House with peaceful atmosphere and the garden without any exhaust/emission and pollution (impurity)” (SE boy, 9th grade, G).

In the built landscapes, both the Finnish and the Swedish students frequently drew experiences related to nature (forest, sea) but experiences related to city/town, holiday, sport and family home were also drawn. Among the Finnish students the written text reflected experiences of being alone in a silent place and at summer cottages with relatives. The Swedish students connected their landscapes to freedom, outdoor living, hobbies and even to global environmental problems in their written texts.

#### *4.5. Experiences in Relation to Social Landscapes*

The social landscapes drawn by the Finnish boys in the 5th and 6th grades were related to hobbies, such as downhill ski areas in winter or fishing places in summer. The Swedish boys focused more on people, exemplified by a drawing of a man in the yard with fruit trees and an area with a rubbish box. The Finnish and Swedish boys described tidy environments, such as a family house with a man in the tree or football grounds. Two boys drew “motocross” cycling. Whereas the Finnish girls’ drawings had details: a girl sitting on a rock near home, girls walking or just lying down at a summer cottage, jumping from the pier to enjoy swimming, playing floorball in the sports hall, angling on the shore, reading in the hammock or letting the sled glide down the slope, the Swedish girls drew sceneries, such as a girl sitting in a park on a bench, ducks swimming on a little creek and a rubbish box in a tidy environment, or a girl sleeping in a hammock.

The social landscapes of the Finnish girls in grades 7 and 8 represented boating, children on a sandy beach and girls in the dancing hall, while the boys drew scanty landscapes with a team playing football, doing downhill skiing or people swimming in the sea. Some examples of the Swedish girls’ drawings are a seascape with a girl sailing in a small boat, a girl taking care of the horses in a stable or a girl mowing the lawn. The Swedish boys drew scanty and simple town landscapes.

The Finnish boys in the 9th grade drew hobbies, downhill skiing places or beaches with people on a summer day and classical country environments. The Swedish boys’ drawings represented their own houses, boys playing the guitar or cycling in the countryside. The Finnish girls’ social landscapes represented both summer cottage areas and winter environments with downhill skiing opportunities. The girls described the drawn places in writing as “relaxed and fun”, “my place”, “I relax in places where I can do things I like”. “I am with my friends, in good company and I eat good food.” The Swedish girls’ drawings included a shore with young swimmers, a girl in a summer scenery with flowers, and an African landscape with the text “nobody should suffer from hunger”.

Examples of students’ written descriptions in connection to social landscapes:

- “Tennis court, number 8. I play tennis with my Dad, exactly on this tennis ground number 8.” (FI boy 6th grade, F).
- “The Lapland mountain where Father Christmas lives and his reindeers” (FI boy 6th grade, A).



- “In my landscape one is to be able to go out and take a nice morning walk without garbage lying everywhere. The animals have a good life. One is able to swim in a river without getting stuck in a plastic bag. I think it should look like this in the future. A squirrel should not die because of a man throws a chewing gum” (FI girl, 6th grade, B).
- “The countryside cottage which I often visit in summer.” (vegetable garden in the drawing) (FI girl, 8th grade, B).
- “The downhill skiing area in a beautiful forest landscape” (several people doing downhill skiing with the drawer at the front of the picture looking at the others) (FI boy, 7th grade, F).
- “My landscape represents forest, humanity, vegetation, animals, knowledge, place to live, food and love. The globe and life on earth should be fine” (FI girl, 8th grade, B).
- “My future landscape” (country landscape, people working in the fields with different kinds of equipment, roads, a city with buildings, sea or lake with many people swimming and sunbathing) (FI boy, 8th grade, B).

In the social landscapes, human beings were drawn in an active relation (e.g., people doing something in the environment such as fishing) to the environment and they represented the so called “good world” (cf. [23]). for both Finnish and Swedish girls and boys. In addition to social activities, hobbies, images of places that the drawings and texts represented, future dreams were drawn. These included space travels or going to the summer cottages in summer.

## 5. Discussion

This qualitative study focused on Finnish and Swedish children’s and adolescents’ drawn landscape experiences with the aim to find out what landscapes the students deemed worth conserving. Their drawings were studied using deductive and inductive content analysis methods.

The first research question concerned the range of landscape types presented in the drawings of the students. The results showed that all the analysed types, nature, built and social landscapes, occurred in the data. The result is in harmony with the previous studies on landscapes drawn by a group of Russian and Finnish 7- to 16-year-olds [6] and by Nepalese and Swedish 7- to 8-year-old children [8]. The built landscapes were more often drawn by boys than girls in both countries. Built and social landscapes were often *clearly connected to the nature* [18], and in several drawings both nature and built landscapes were illustrated, with the nature landscape gradually altering to built and social environments (cf. [21]). These findings support other studies on drawings of the Finnish, Russian and Australian students [6,8]. The findings are also in harmony with *the classical concept of the landscape*, which consists of nature and built environments [13].

The drawings showed that the borderline between nature and built landscapes is gradually disappearing in the drawn pictures of the students [21,38]. As in earlier studies of Finnish young people [21] and of Finnish and Russian students [5,6], social landscapes were described in this study. The human being in the social landscapes indicated the close relationship of man and the environment, which is a central idea in human geography [43]. The present study confirmed this relationship for the Swedish students’ landscape perceptions, too.

With the drawers’ increasing age and educational experience, the drawings of nature landscapes with prevailing features of the water, forest, trees and the sun were enriched and detailed and turned to built landscapes, often to “cultural landscapes”. The advanced level of cognitive development may have turned the drawings of the older adolescents to be less concrete, more artistic and adult like.

The second research question focused on the students’ relationship to their own landscapes. Both the Finnish and Swedish students had drawn themselves as observers (looking at the environment), or as active participants (having an active role in their landscapes) or as people living in the environment (taking responsibility for it). These observations of drawn landscapes clearly reflected a combination of the definitions [4,12], and the result is in line with the findings of the previous studies concerning

Russian and Finnish students' drawings [5,21]. Environmental responsibility was reflected in the drawings or commented on in writing by the Swedish adolescents in particular.

The third research question asked what the drawings revealed about the personal experiences of the landscapes that the students wanted to conserve. Forests and water were most often included in the drawings of the Finnish and the Swedish students, which is understandable, as forests, rivers, lakes and the sea are easily reached by people in both countries. The result is in line with the previous studies [44]. Nature, classical landscapes, city/town, summer cottages, one's own house/own nest, sports and holiday landscapes were also described in the students' drawings. Nature landscapes were presented most often as landscapes worth conserving, a finding in line with Yli-Panula, Grönlund, and Eloranta (2012) [8]. As natural landscapes were more frequently valued in the adolescents' than the younger students' data, it may be that school-based outdoor activities have had an effect on students' memories (Chawla, 1999) [45]. The adolescents, more than the younger students, have been involved in environmental education conducted at schools. Both in Finland and in Sweden, environmental education and outdoor education are emphasized in the curricula [46–48].

Built landscapes were also seen as important, more often by the boys than the girls in both countries. A difference was that some of the Finnish students drew summer cottages but the Swedish students did not. This may be due to a Finnish cultural feature: Finnish families often have summer cottages, which provide opportunities for outdoor activities. Another cultural difference was the Finnish drawers' tendency to value silence and solitude in the favoured environment. The observed categories correspond to those reported in previous studies. Places such as homeplace and active places [48], restorative places such as sports/playgrounds settings [29], and places with significance or emotional memories, such as special holidays, were valued and considered worth conserving [49]. In these landscapes, children and adolescents have traditionally enjoyed their activities, and nature has been an inspiring source for their creation [25]. The built environment was represented by many students as "cultural landscapes" and man was drawn in harmony with the social landscapes. The drawn landscapes clearly showed views which the adolescents had seen and experienced (visual realism).

As far as the validity of the study is concerned, it was found that the drawing task was not easy for every student. Some students drew spontaneously on the paper what the concept of landscape brought into their mind. The resulting drawings represented stereotypical landscapes and were very meagre in content. Such simple landscapes were drawn by several students in the same classroom and represented the schematic stage of the drawer [21]. This was evident in some of the Finnish and the Swedish boys' drawings describing their activities on football playgrounds, for example. To draw one's favoured landscape is no easy task in the sense that it requires the control of at least two demanding cognitive processes, namely, selecting a memory of a valuable landscape among the (visual) memories in the existing knowledge storage, focusing on the visualization and reproducing the image on paper.

## **6. Conclusions and Implications**

Children explore their environment through experiences. Some of the students had taken the role of an observer in drawing the landscapes while others showed an active relation to the environment. Increase of nature landscape drawings with increasing age of the students shows that the task to build up an image of a valuable landscape worth conserving, and at the same time to draw a picture, require development of cognitive processes. These cognitive processes are based both on the knowledge and on the observations that students make in the environment. Therefore, it is important to visit the school surroundings during school days to study their role and possibilities to conserve their landscape and living there in a responsible way. The message for landscape planning is to create or survive multifaceted landscapes and green areas for children and adolescent to experience.

The social landscapes described in this study and the human being in these social landscapes indicated a relationship of man and the environment, which is a core idea in human geography. The drawings showed that the borderline between nature and built landscapes is gradually disappearing.

The built environment was represented in many cases as a “cultural landscape”, and man was drawn in harmony with the landscape in the social landscapes. The drawn landscapes illustrated views which the students had seen and experienced (visual realism).

To sum up, based on our research it seems that especially the nature but also the built environments are seen valuable to be conserved by the students in both countries. The social environment was not as often described. The natural and cultural heritages were not taken into account, although they play an important role in human development as a repository of knowledge, driver of economic growth, symbolic force for stability and conveyor of meaning. Their diversity and different forms should be emphasized more in teaching and learning processes because they are valuable common goods not only for creative innovation, well-being, dialogue, employment, income generation, reconciliation but also for sustainability [50].

To be able to provide a rich and versatile set of experiences of different environments to all students, in particular to those who have limited access to nature, it might be helpful to design virtual platforms with examples (films, pictures) of different kinds of landscapes, also environments that are more distant and unreachable, invite students to explore them, and help them to understand the concept of the landscape and the reasons why conserving nature for future generations is of prime importance.

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Article

# The Mystery Method Reconsidered—A Tool for Assessing Systems Thinking in Education for Sustainable Development

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**Abstract:** Influence diagrams, derived from the mystery method as its learning output, represent an externalization of systems thinking and are, therefore, valid to research; so far they have not been conceptualized in the research literature for teaching systems thinking in education for sustainable development. In this study, 31 of those diagrams are confronted with (1) three different expert references, in (2) two different ways, by (3) three different scoring systems to determine which evaluation option is both valid and easy to implement. As a benchmark, the diagrams' diameters are used, which allows statements about the quality of the maps/diagrams in general. The results show that, depending on the combination of variables that play a role in the evaluation (1, 2, 3), the quality of the influence diagram becomes measurable. However, strong differences appear in the various evaluation schemes, which can be explained by each variable's peculiarities. Overall, the tested methodology is effective, but will need to be sharpened in the future. The results also offer starting points for future research to further deepen the path taken here.

**Keywords:** education for sustainable development; systems thinking; data mining; mapping

## 1. Introduction

The complexity of today's major problems concerning sustainability requires a networked perspective on knowledge [1]. School teaching plays an important role in facilitating students' development of this perspective. To create learning environments that convey complexity and networking, teachers require an assessment that enables them to provide targeted support. In this article, the application of such an assessment tool, which is an expertise-based reference to the mystery method, or *mystery* for short [2,3], in a complex sustainability context [4], is presented. The reference will be used as a basis to evaluate learners' influence diagrams qualitatively. In this way, systems thinking, one of the central competences within Education for Sustainable Development (ESD), is assessed [5–7].

Many approaches to developing a system-related competence exist, including, among others, networked thinking [8], geographical system competence [9], and systems thinking [6,10], each with a conceptual overlap. In principle, such a competence is understood as the ability to describe, reconstruct, and model a complex realm of reality as a system and, on the basis of the model, provide explanations, make forecasts, and design, assess, and implement possible courses of action [11]. As noted previously, this is a central competence within ESD, along with *socio-scientific reasoning and decision-making* [12] and *Gestaltungskompetenz* [13] (approx. 'taking action'). The three competences

are interrelated [5] because one first has to gain systems thinking, which serves as a prerequisite for decision-making, finally leading to taking action. Therefore, acquiring systems thinking (and the other system-related competences) is a dominant goal for ESD and its implementation.

An essential pre-condition for teaching systems thinking is knowledge of its diagnostics. Competence models have been developed and tested accordingly. Concept mapping has been proven highly feasible as a valid assessment of systems thinking. Due to structural similarities between concept maps and the influence diagrams from the mystery method, the influence diagrams are presumed to be suitable for a diagnosis, which can take place in daily teaching practice [4]. Generally, as with concept maps, various methods can be used for evaluation [14,15].

Sustainability-relevant human-environment systems are associated with uncertainty and risk considerations due to their complexity [16]. This makes evaluating learning tasks' outputs difficult, as no clear solution can be defined. However, especially with the mapping techniques used frequently with systemic content, references are often used in assessment. But can there be a mapped reference if there is no clear solution for such maps? Benninghaus, Mühling, Kremer and Sprenger [4] were able to provide several references that can be used for assessment. To create the references, the authors constructed a mystery within a (non-)sustainable consumption pattern (water-intensive, export-oriented tomato cultivation in Almería, Spain). The layout of the mystery comprised 18 information cards. In class, the students constructed influence diagrams by connecting those cards with meaningful arrows. In this way, the students discovered interconnections between the information on each card. They analyzed the system of tomato consumption and externalized their systemic knowledge into influence diagrams, which, therefore, are valid for assessment.

This mystery, respectively its cards, were then used to create the references via data mining [17]. For this, the authors used experts, who determined if a connection between two particular cards existed. This was continued for every possible pairing of cards and thus followed the methodology of relatedness judgments [18]. The data gathering was conducted online, and the digital data were then processed into different references. They differed in the degree of experts' consent, since the experts did not decide for every pairing of cards equally. The consent ranged from complete unison (all experts agreed on/declined a connection) to connections drawn by only one expert. Based on this, the connections were weighted: connections agreed upon by many experts were given a high weight and could be viewed as 'certain.' The weighting allowed the production of different references with varying aspects for use in assessment. The references are described in more detail in the methodology section.

The objective of the present study is to analyze actual learners' influence diagrams using the references and adapting the method with a view toward meaningful use in teaching practice. The key question, therefore, is as follows: Which way of evaluation can provide the best results? There will be multiple variants of evaluation approaches based on the references (and other variables), which will be compared. For this, they will be correlated with the diameters of the students' influence diagrams. (The diameter is a point of measure on the diagram, which is explained in more detail in the methodology section.) The diameter allows conclusions about a map's/influence diagram's structural quality and is seen as a valid benchmark for evaluating our results.

The precise procedure for gathering and compiling data, using the assessment variants, and integrating the diameter is described in the methodology section, after the necessary theoretical backgrounds are presented, where the construct of systems thinking is in focus, as it is the main construct underlying the capability to deal with systems. This is followed by the theoretical consideration of mapping techniques, including a more detailed description of the mystery method, as well as an overview of possible evaluation methods for influence diagrams/cognitive maps. The concrete procedure of this study is described in the methodology section, followed by the evaluation of the data obtained and their interpretation.

## 2. Theoretical Background: Systems Thinking, Mapping Techniques, and the Mystery Method

As already described, conceptualizations of system competences are broadly diversified. They all originate from the field of research dedicated to dealing with systems but are based on different scientific approaches. In the context of ESD, the model of systems thinking represents an important contribution [6,7,19] and forms the theoretical framework for the work presented here.

### 2.1. Systems Thinking

Rieß and Mischo [7] summarized systems thinking as the ability “to identify important elements of the system and the varied interdependency between these elements. Other key aspects are the ability to recognize dimensions of time dynamics, to construct an internal model of reality, and to make prognoses on the basis of that model” [7].

These different areas of cognitive and action abilities indicate the need for a competence model. The model for systems thinking, according to Schuler, Fanta, Rosenkraenzer and Rieß [6], is divided into four sub-capabilities, with four dimensions formulated as hierarchical competence levels. Table 1 shows the dimensions and the corresponding abilities from sub-capability no. 3, which is crucial for structural mapping assessments, as the created structures from such an assessment may be understood as system models.

**Table 1.** Systems thinking dimensions and corresponding abilities from sub-capability no. 3 in descending order (authors’ depiction based on Schuler, Fanta, Rosenkraenzer and Rieß [6]).

Dimension	Sub-Capability (No. 3)
4: Evaluation of system models	Determining the validity of the application
3: Problem-solving using system models	Giving explanations, making predictions, and designing technologies based on qualitative system models
2: Modeling systems	Reading and understanding qualitative system models and constructing influence diagrams
1: Declarative/conceptual system knowledge	Knowledge of system hierarchies

Above all, the construction of system models and influence diagrams is important for externalizing students’ systems thinking. The connections we can find in the models or diagrams provide visuals for the students’ capabilities for systems thinking. They are of high value for researching systems thinking, and comparable approaches are found in most studies on systems thinking or similar constructs (e.g., in Kunz, Frischknecht-Tobler, Bollmann-Zuberbuehler and Groesser [11]; Fanta, Braeutigam and Riess [19]; Assaraf and Orion [20]; and Mehren, Rempfler, Buchholz, Hartig and Ulrich-Riedhammer [9]). Since the mystery method also represents a kind of mapping technique, a more explicit treatment of such techniques is necessary to develop the mystery method’s role in assessing systems thinking.

### 2.2. The Mystery Method as a Mapping Assessment

When investigating systems thinking, cognitive structures must be displayed visually. Operationalization is bound to suitable forms of representation that apply to all comparable concepts (see previous explanation). In many studies, concept mapping has proven to be a systemic form of representation [20–24]. Structural similarities between concept maps and influence diagrams, which emerge from applying the mystery method as the learning output, suggest that these influence diagrams also can be used for diagnostic purposes [4], because both concept maps and influence diagrams emerge as models of thought from the same process of modeling [25].

Influence diagrams from the mystery method are usually constructed during classroom teaching. The mystery method takes place in cooperative, small-group settings. The students answer to a mysterious (and motivating) key question by sorting, weighting, and networking information cards. The goal is to create an influence diagram with the information cards to become aware of and visualize the



interconnections within the content (e.g., tomato consumption, see above). As a result, the students will be able to provide a comprehensive answer to the key question from the lesson. The process of constructing influence diagrams involves internal modeling, in which reality (tomato consumption) is reduced to its essential elements and relations by the mystery's information cards and their interconnections, just like in concept mapping. This process symbolizes the ability of systems thinking. It produces a model of thinking that is externalized in the form of an influence diagram, which represents thought models and, therefore, is suitable for investigating systems thinking. Thus, it is reasonable to use the influence diagrams to assess systems thinking, which is presented later in this article.

We would like to refer to the influence diagrams, emerging from the mystery method, as *mystery maps*, as the basic principle of connecting the cards is similar to linking concepts in concept mapping. However, in the mystery used here, connections are limited to the cause-and-effect principle (by the test persons, as they were by the experts during the reference study), while the amount of information on the mystery cards represents more than a single concept in a concept map's node [4]. Therefore, concept maps and mystery maps are quite different, but at the same time related, and allow the use of equal assessment techniques, as will be shown next.

### 2.3. Structural Analysis of Cognitive Maps

Diagnostic work with cognitive maps is widespread and has become highly differentiated over time. For this reason, a concentrated overview is provided here against the background of reference maps and approaches largely from ESD and environmental education, as this gives a proper context for our study.

Diagnosis by reference generally is widespread in mapping [26]. For example, Rebich and Gautier [27] produced an expert map in the field of climate change and compared it with the maps of their test participants. According to the authors, the objective was not to evaluate the maps, but to determine in which areas of the construct (climate change) concepts and propositions actually were present. Thus, the reference was used as an orientation to locate the concepts and propositions expressed by the test persons and, thus, to derive focal points. Rice, et al. [28] worked similarly using an expert map to identify a set of concepts from the field of zoology that served as a kind of expectation horizon for the test persons' maps.

Sellmann, et al. [29] created and used a reference map in a different way; its purpose was to determine which individual propositions of the test persons were valid and which were not. The reference was created on the basis of a literature search and contained not only correct concepts, but also alternative ideas that were listed as such in the literature. Selection of the concepts themselves was carried out on the basis of expert maps from extant literature. It is noteworthy that the authors had group maps created with reference to Nesbit and Adesope [30], as this exerted a positive effect on the maps, also see [31].

The regulation of reference creation, including the number of experts involved, was not explained in the presented studies. In contrast, the references prepared for the study presented here were constructed using as many experts as possible to achieve a high degree of consent saturation in the connections, necessitated by the uncertainty inherent in the content (tomato consumption). Accordingly, this approach is necessary for all mapping procedures contextualized with uncertainty, which is not noted in the listed studies. The references used there are not to be regarded as incorrect, but they represent only a portion of the respective constructs. Therefore, cross-personal references are necessary to increase security [4].

## 3. Methods

For clarity, throughout this article and especially within the methodological explanations, the connections between the information cards from the mystery method are referred to as *edges*, and the cards themselves are referred to as *nodes* if an empirical background is involved. Otherwise,

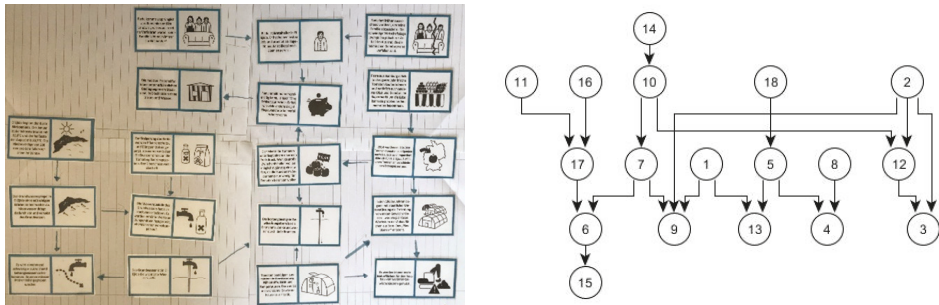
the teaching-method level maintains the terms *connection* and *information cards* so that the context is made clear.

### 3.1. Survey Participants

The test persons used for this study were grades 9 and 10 high school students (ages 15 to 17). For data collection, some students worked on the mystery alone, while others worked in groups of three. For practical purposes, selection and group composition were done on a voluntary basis under the teachers’ supervision. Data collection elicited 10 mystery maps from individual work and 21 from group work.

Data collection was embedded within a closed geographical teaching concept. The teachers used materials that were provided (content information, method explanation, introductory caricature, information cards) and were able to lead the entire lesson autonomously, as it would be done in a regular lesson. The learning units were scheduled for the usual 90 min, of which about 60 were spent working only on the mystery. This rather long period of time was necessary to enable participants to create a clear structure with the information cards and trace the connecting arrows in a clearly visible way. The participants were not trained in working with mysteries, but as it is a famous method, they may have recognized it from previous lessons. The influence diagrams were used only for the study and the class discussion at the lesson’s conclusion. No grading occurred; therefore, no performance pressure was exerted by this means.

All mystery maps were photographed and then digitized with the tool yEd Graph Editor into a text-based format (TGF) for further analysis. Figure 1 shows an influence diagram and its digitized graph. This resulted in a body of data that could then be explored using data mining approaches [17].



**Figure 1.** Influence diagram from mystery method and its digitized graph. Each information card received a fixed number to allow for comparing the diagrams. They are shown in the graph (authors’ photograph/graph).

### 3.2. Basics for the Derivation of Evaluation Technology

No structural analysis techniques for mystery maps exist in the extant literature. A self-imposed requirement for the evaluation technique, which was an objective of the present study, was that it must not be too complex so as to ensure that it can be applied in practice without difficulty in the context of diagnostics of systems thinking. To guarantee our evaluation technique’s validity, we correlated it with established methods of structural graph analyses. For this purpose, the measurement of the diameter (mentioned previously), for example, can be used: The diameter is defined as the longest shortest connection in the graph, i.e., the two points farthest apart, if the number of edges is taken as the distance measure and paths are not artificially extended. Graphs that comprise long chains, rather than many branches, tend to have a larger diameter. Maps that are ‘well’ constructed are expected to be more densely interconnected [32,33] and, therefore, will have small diameters. Finding a single value that carries valid information about the specific structure of a graph is difficult, as a single value

necessarily loses a lot of information that is present in the complete graph. The diameter is an example of such a value: its magnitude varies depending on the structure of the graph, and for a given number of nodes and edges, many different graphs with distinct diameters can be constructed. This property makes the value useful in analyses that refer to general structural properties of a network.

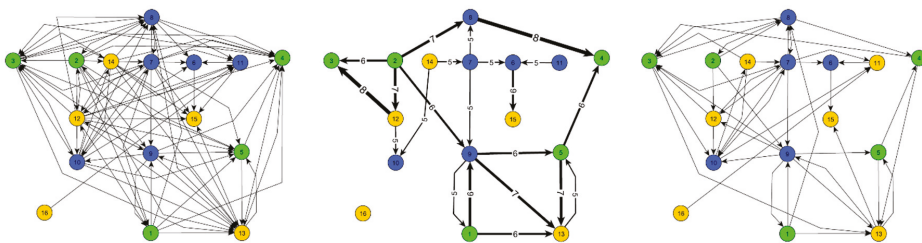
What constitutes a large or small diameter generally cannot be answered absolutely, but for strongly cross-linked graphs, the value remains constant, even with an increasing number of nodes, while for only weakly cross-linked graphs, it grows linearly with the number of nodes. Transferred to mystery maps, a mystery map that is considered well-constructed is more likely to have a small diameter, i.e., a solution with a small diameter is preferable to one with a larger diameter.

Although the process for measuring the diameter can be easily automated, it is relatively time-consuming to determine the diameter manually, as all the shortest paths in the network must be determined first. Since we were particularly interested in evaluation variants that can easily be carried out manually by teachers, we examined possible alternatives in this study. As a reference for the quality of such an alternative, we used the correlation with the diameter. For example, counting a map's edges or comparing edges with a reference can be done easily, and if an uncomplicated technique correlates with the complicated diameter, the goal of our research is reached, as our aim is to recommend a practical evaluation at the end. For this, we constructed a number of variants, each of which was then compared with one another and correlated with the diameter. Three different elements were available for the variants, which were combined to determine the technique that best meets our criteria. The following elements were varied: type of reference, type of connection, and type of scoring.

### 3.2.1. Type of Reference

*Reference* refers to the information obtained from expert data on the connections between the 18 mystery information cards, as described previously. Actually, only 16 cards were used for creating the reference, as two cards only contained information about the persona appearing and environmental setting prevailing in the mystery (see Benninghaus, Mühling, Kremer and Sprenger [4] for details).

The obtained expert data can be used in three different forms that differ in their degree of complexity. First, there is the complete reference (Figure 2a), containing all connections for which any number of experts indicated that a direct causal link exists. This was a comprehensive data set and, thus, was correspondingly complex. To reduce complexity, the second—and most reduced—variant only contained edges drawn by most of the experts (see Figure 2b, majority reference). Third, a slightly more complex network than the second one (the pathfinder network, or Pf-Net) was obtained using the Pathfinder algorithm [34] (see Figure 2c, Pf-Net) on the complete data set, as described in Benninghaus, Mühling, Kremer and Sprenger [4]. This process systematically removed certain edges for which better/weightier indirect paths existed. Both of the latter alternative diagrams had a reduced complexity and, therefore, would be easier to handle, should they yield comparable results.



**Figure 2.** References as a basis for the evaluation variants: (a) complete reference, (b) majority reference, and (c) pathfinder network (Pf-Net). Nodes represent the mystery cards based on the dimensions of sustainable development (green = ecological, blue = economical, and yellow = social) [4].

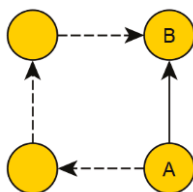
An evaluation scheme based on these three references can fall back on two structural characteristics: (a) the existence of a connection in the reference and (b) the weight of this connection. In the case of (a), one would like to make a specific yes-or-no decision for an edge and, thus, use either a majority decision by the experts or the existence of the corresponding edge in the Pf-Net as a criterion. However, the two variants are not equivalent, as the Pf-Net considers not only the weight of this edge when removing edges, but also the network's overall structure. For (b), in a concrete solution from the test participants, a drawn connection can be checked to see to what extent it is likely that experts would have drawn this certain edge. This information corresponds to the edge's weight in the reference.

### 3.2.2. Connection Types: Direct and Indirect

The edges between the information cards from mystery maps can be distinguished in comparison to a reference:

Direct connections in the mystery map comprised two cards, which were also directly connected in a reference. In this case, the experts saw a direct causal link that was also used by the learner creating the mystery map.

Indirect connections, on the other hand, are a link in the mystery map of a learner that existed in the reference not as a direct connection, but as an indirect path. In this case, the experts, in contrast to the learner, did not see a direct causal relation between the two facts, but at least agreed that the two facts were in some way related (Figure 3).



**Figure 3.** Direct connection (continuous arrow) vs. indirect path (dotted arrow) (authors' representation).

Direct connections are undoubtedly more valuable than indirect connections, and the scoring schemes in the next section reflect this idea.

### 3.3. Variants of Scoring and Evaluation Schemes

Based on the considerations outlined in the previous section, seven different evaluation schemes exist that were concretized by determining actual numerical values for the valuation, resulting in additional valuation variants (see Table 2). In the following section, the didactic-pedagogical considerations behind the variants tested are explained. In principle, the point system differed in various aspects: there were variants that contained negative points (a-variants) or avoided this sanctioning and assessed only positively (b-variants), the scores could be fixed (variants 1–6), or they could be based on the expert weights (variant 7), and the scheme could either consider only direct connections in the reference (variants 1, 3, 5, and 7) or also (positively) indirect connections (variants 2, 4, and 6). Consideration of indirect connections combined with expert weights again requires complicated manual evaluations, as one must determine the weight of a path from the weight of its edges. Therefore, this variant was excluded in line with the aim of our study (easy manual evaluation). Table 2 shows the resulting 14 variants.

**Table 2.** Evaluation variants with type of reference, type of connection, and type of scoring (x = relative weight).

	Type of Reference	Type of Connection	Type of Scoring Based on Rules of Evaluation	No.		
Pathfinder-Net (Pf-Net)			Edge present +1 Edge absent -1	1a		
			Edge present +1 Edge absent 0	1b		
			Edge present +1 Path present 0 Both absent -1	2a		
			Edge present +2 Path present +1 Both absent 0	2b		
		Majority reference			Edge present +1 Node absent -1	3a
					Edge present +1 Edge absent 0	3b
	Edge present +1 Path present 0 Both absent -1			4a		
	Edge present +2 Path present +1 Both absent 0			4b		
Complete reference					Edge present +1 Edge absent -1	5a
					Edge present +1 Edge absent 0	5b
			Edge present +1 Path present 0 Both absent -1	6a		
			Edge present +2 Path present +1 Both absent 0	6b		
			Edge present +x (0 to 1) Edge absent -1	7a		
			Edge present +x (0 to 1) Edge absent 0	7b		

### 3.4. Evaluation Schemes Based on Pf-Net

#### 3.4.1. No. 1a (Pf-Net, Direct, Negative)

The Pf-Net (Figure 2c) is a reference that teachers can handle well in practice, as it has relatively few connections. A simple evaluation gave one point for an edge that also appeared in the reference, while an edge that appeared in the mystery map and not in the reference was given one minus point.

#### 3.4.2. No. 1b (Pf-Net, Direct, Positive)

With variant 1a, total scores could fall below zero, if the performance was not adequate. In terms of pedagogical feedback to students, we prefer a score that should always remain positive. Therefore, all b-variants used different score values to avoid punishing wrong connections and only rewarded

correct ones. In this case, each correct edge was counted with one point and all incorrect edges were disregarded.

#### 3.4.3. No. 2a (Pf-Net, Indirect, Negative)

A somewhat more lenient evaluation resulted from the fact that an edge was no longer evaluated as wrong per se if it did not appear in the reference. Instead, a distinction was made as to whether the connected information cards were connected at least via an indirect path in the reference (cf. Figure 3). If this was the case, this edge was evaluated neutrally. Since thinking in causal interdependencies must develop first, and it needs a broad knowledge base from which to draw conclusions, it made sense from a pedagogical perspective to make a distinction here. Connections on the mystery map that neither directly nor indirectly occurred in the Pf-Net were still given a minus point in this variant.

#### 3.4.4. No. 2b (Pf-Net, Indirect, Positive)

Here, too, a counterpart exists without negative scoring. In this case, the 'only indirectly correct' connection was evaluated slightly positively to distinguish it from the 'clearly wrong' edge.

### 3.5. Evaluation Schemes Based on Majority Reference

The next four evaluation schemes are defined in the same way as the previous four. However, the reference used was not the Pf-Net, but the experts' majority reference (Figure 2b), in which a majority decision was made for each edge, and therefore, only edges with a weight greater than four remained.

#### 3.5.1. No. 3a (Majority Reference, Direct, Negative)

Points were awarded according to the same rules applied for variant 1a. Thus, one point was awarded for an edge that appeared in the mystery map and also in the majority reference, while one point was deducted for an edge that appeared only in the mystery map, but not in the majority reference.

#### 3.5.2. No. 3b (Majority Reference, Direct, Positive)

As with 1b, the evaluation is less strict here, in which no minus points were awarded based on the comparison with the majority reference.

#### 3.5.3. No. 4a (Majority Reference, Indirect, Negative)

As with 2a, this variant included indirect connections if a connection existed in a mystery map that was present in the majority reference as an indirect path. The allocation of points here corresponded to the negative orientation.

#### 3.5.4. No. 4b (Majority Reference, Indirect, Positive)

In this variant, an evaluation without negative points was carried out in the same way as the procedure followed for 2b.

### 3.6. Evaluation Schemes Based on Complete Reference

The following variants were based on the very complex complete reference (Figure 2a). The practical use of this evaluation scheme is very demanding, as numerous edges exist. However, the check based on the complete data set seems desirable. We also used these variants to evaluate if using the complete data set would yield additional benefits regarding validity.

#### 3.6.1. No. 5a (Complete Reference, Direct, Negative)

This variant worked congruently with 1a and 3a and awarded negative points accordingly. However, it used the complete reference as a basis.

### 3.6.2. No. 5b (Complete Reference, Direct, Positive)

In contrast to 5a, no negative points were awarded for this variant.

### 3.6.3. No. 6a (Complete Reference, Indirect, Negative)

As with 2a and 4a, indirect paths also counted in this variant. However, a negative evaluation was also carried out in individual cases.

### 3.6.4. No. 6b (Complete Reference, Indirect, Positive)

In contrast to 6a, a variant without a negative rating also was used here.

## 3.7. Evaluation Schemes Based on Complete Reference with Weighting as Score

By using the complete reference, it was possible for the first time to use the determined weight/certainty of an edge directly as a score. Instead of a fixed value per edge (as in 1–6), the edge's weights were added together. Therefore, a very unambiguous edge was considered to be more important than an edge for which uncertainty existed, even among the experts. To ensure that the scoring was independent of the absolute number of experts for the reference, the percentage value of the weight related to this number was used. Thus, a value of 1 meant that all experts had seen a certain compound as present; at 0.5, it would be half of the experts.

### 3.7.1. No. 7a (Complete Reference, Weight as Score, Negative)

To ensure symmetry with the previous schemes, a negative evaluation of wrong edges was carried out here. Since not all experts regarded an edge missing in this reference as a given, a value of -1 made sense here.

### 3.7.2. No. 7b (Complete Reference, Weight as Score, Positive)

Since a very strong tendency to the negative was to be expected for 7a, a neutral evaluation of wrong edges seemed most logical here. A zero was assigned if an edge was missing in the reference.

An evaluation based on indirect paths did not make immediate sense in scheme 7, as one would need to define a path's weight. This is usually defined as the sum of all respective edges' individual weights, whereby a longer path would be rated better than a shorter path. Appropriate definitions are possible (e.g., based on the minimum along the path), but as these are not very useful for practical work with an evaluation scheme, they were not considered in this study.

The evaluation variants can be seen as hypotheses. The next step was to clarify which correlated highest with the diameter and, therefore, would be accepted and which would be declined.

## 3.8. Statistical Evaluation of the Measured Values

Based on the analyses, each mystery map received 14 values for the evaluation variants from Table 2. To achieve this, the digitized graphs in the form of TGF-files were computed, based on the scoring rules from Table 2. The emerging data set allowed comparison of the schemes and variants. Also, the diameter was calculated, as it was the benchmark for the 14 variants.

On this basis, an analysis of the evaluation schemes' reliability was carried out first by different approaches, before presenting the correlation with the diameter as an argument for validity.

## 4. Results

This study's objective was to identify an evaluation technique that is as easy to use as possible. To this end, analytical steps were carried out to compare the various variants (see Table 2).

The 14 evaluation variants yielded the average results shown in Table 3 for all mystery maps as an overview. Listed are the mean values ( $\mu$ ) of all mystery maps per variant and the corresponding standard deviations ( $\sigma$ ).

**Table 3.** Mean value and standard deviation of the variants with respect to the achieved points ( $n = 31$ ).

No.	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b
$\mu$	-8.8	3.2	2.4	17.6	1.1	8.2	2.4	17.6	9.9	12.5	11.8	26.9	5.0	7.7
$\sigma$	3.0	1.4	1.9	3.8	4.9	2.6	4.5	5.1	4.5	3.3	3.7	6.0	3.5	2.0

First, the wide range of mean values, extending from -8.8 (1a) to 26.9 points (6b), is noticeable. In addition, the standard deviations also show relatively large differences, from 1.4 (1b) to 6.0 (6b). Overall, the b-variants (1b, 2b, etc.) of each scheme received higher mean values than the a-variants, as the negative scoring was absent from the b-variants. Particularly noticeable is the negative mean value of variant 1a, which can be explained by the (thin) reference (see Figure 2c, Pf-Net) with few edges and very strict scoring (see Table 2). The scattering of the values is particularly striking in variants 3a and 4a. Due to the rather low mean values and high standard deviations, many mystery maps with negative total scores were to be expected here as well.

4.1. Correlation of a- and b-Variants per Scheme

Although the variants from one scheme (e.g., 1a and 1b, 2a and 2b, etc.) functioned similarly, differences in the structural evaluations were to be expected. In particular, the use of negative points in the a-variants can lead to this. If the reference had only a few edges, then mystery map connections were marked wrong more frequently, as fewer ‘hits’ on the references’ edges could exist. This is then reflected in a more pronounced difference between the corresponding a- and b-variants of a schema. Thus, if the two variants were correlated for each scheme (1a with 1b, 2a with 2b, etc.), the correlation for the Pf-Net with few edges as a reference (schemata 1 and 2) could be seen as significantly lower than the correlation for the rather dense complete reference (Schemata 5, 6, and 7) (Table 4).

**Table 4.** Correlations of variants a and b per scheme ( $n = 31$ ).

No.	1	2	3	4	5	6	7
$r$	0.56	0.76	0.85	0.85	0.95	0.96	0.93

4.2. Correlation of a- and b-Variants with Each Other

The correlation of the seven different schemata with each other made the most sense in terms of content if one considers only either the a-variant or b-variant, as their scoring systems are similar. The results, together with the correlation of each variant with the diameter, can be found in Tables 5 and 6.

Checking the internal consistency with Cronbach’s alpha resulted in a value of 0.94 (standardized alpha) for all 14 variants, which clearly shows that all variants measured a similar aspect of the mystery structure. Divided between the a- and b-variants, a value of 0.86 was obtained for a, and 0.94 for b. This is further indication that the negative pointing of the a-variants leads to greater structural differences in the evaluation.

Numerous variants achieved medium-strong correlations with the diameter. Strong outliers were found with schemes 1 and 2. On the other hand, schemes 3, 4, and 7 appeared promising.

**Table 5.** Cross-correlations of the a-variants and correlation with the diameters (d) ( $n = 31$ ).

	1	2	3	4	5	6	7	d
1	1							0.18
2	0.56	1						-0.02
3	0.14	0.22	1					-0.48
4	0.12	0.26	0.98	1				-0.51
5	-0.1	0.60	0.49	0.56	1			-0.41
6	-0.15	0.62	0.37	0.43	0.97	1		-0.37
7	0.05	0.52	0.74	0.80	0.92	0.83	1	-0.47



**Table 6.** Cross-correlations of the b-variants and correlation with the diameters (d) (n = 31).

	1	2	3	4	5	6	7	d
1	1							0.01
2	0.75	1						-0.24
3	0.22	0.54	1					-0.55
4	0.27	0.62	0.98	1				-0.59
5	0.48	0.88	0.73	0.80	1			-0.40
6	0.53	0.93	0.65	0.73	0.98	1		-0.33
7	0.28	0.71	0.91	0.96	0.91	0.85	1	-0.56

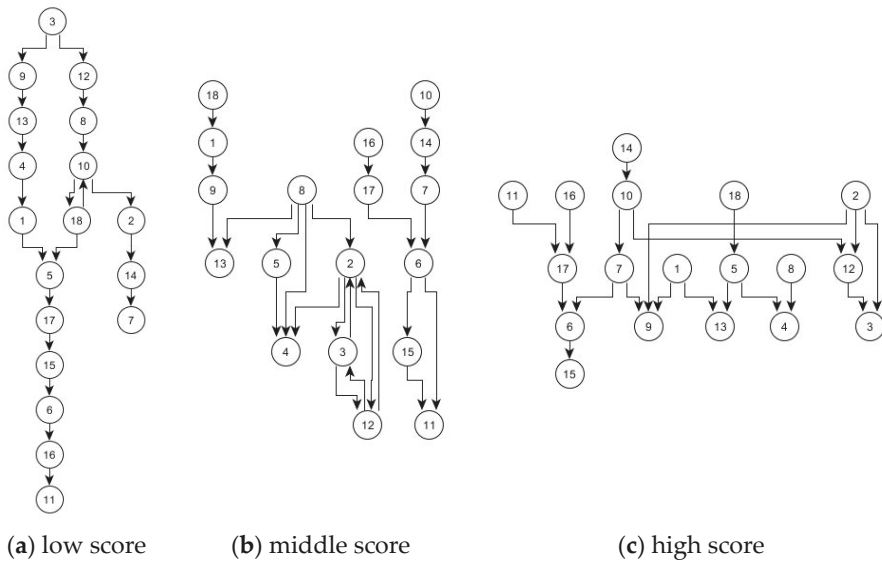
**5. Discussion**

The rank correlation of diameter and number of points for all variants have low to medium strength. Since all the variants achieve this level, it can be assumed that the evaluation schemes measure similar, but not necessarily identical, aspects of the mystery maps.

Since the diameter is an already-proven measure of the quality of graphs, the objective was to identify (highly) correlating evaluation variants (see Tables 5 and 6, last column). Based on the results, variants 3b, 4a, 4b, and 7b are the most promising, if -0.5 is defined as the minimum value of the correlation. Due to high internal consistency and consistently high correlations, a recommendation can be made on the basis of the variant that is easiest to handle in practice: 3b. Here, neither of the indirect connections must be considered, nor must negative points be awarded. Thus, the evaluation is purely a summation of the edges that correctly coincide with those identified on the reference with relatively low complexity (see Figure 2b, only edges with  $g > 4$ , a total of 23 edges).

In practice, the study presented here demonstrates that it is possible to approach the diagnosis of systems thinking in a complex context containing ESD using the mystery method. Although the ranking correlation of diameter and score seems to be medium strong, it is still clear which students are capable system thinkers and which are not. In the middle quartiles, the evaluation methods' selectivity still seems to be expandable. However, it should be noted that individual support is important in teaching and it must benefit weaker pupils. They can be identified with the method presented here. Figure 4 shows, for variant 3b, in (a) the map of the group with the lowest score (-10), in (b) a group with a score of 0 from the midfield, and in (c) the group with the highest score of all (11).

The illustrations in Figure 4 show, at first glance, understandable differences. Graph (a) is recognizable as the weakest graph, as it has a large diameter, which can be seen from the elongated shape, while (b) is different because more cross-connections can be seen here. However, on closer inspection, it is noticeable that the graph is divided, and the right part also provides a high (partial) diameter. However, (c) is very strongly cross-linked and shows a large width in this representation. It is also striking that (a) and (c) have 19 connections each, while (b) has 23. This is a further indication of the correct function of the methodology, because according to Kinchin [32], average mappers use many connections, while above average and below average mappers instead construct smaller maps, though above average mappers have more cross-connections. Variant 3b can reproduce these assumptions. It should be noted that the graphs are digitized and then automatically restructured mystery maps, which appear much more confusing in the original (Figure 1). The structures discernible here are not easily visible to a teacher in the course of a lesson, which is why evaluation technologies are needed.



**Figure 4.** Digitized and restructured mystery maps from different test persons sorted by score based on 3b (authors' representation).

## 6. Conclusions

This study's objective was to develop an evaluation technique for mystery maps based on various references [4] that should correlate with the diameter as an implemented quality measure of maps/graphs. The evaluation technique should enable teachers to evaluate mystery maps with little effort, with an emphasis on systems thinking regarding the complex networks and the construct of sustainability. Since no such method has been published so far in didactic contexts, the project represents a novelty.

Regarding the evaluation method presented here, it is necessary to create a tool for teachers that enables rapid evaluation of the maps for everyday use. The objective is to enable a quick entry of the connections, which then automatically generate a score for a map. In addition, strong deviations from the reference can be visualized, allowing for targeted promotion of these students.

In summary, it is possible to generate different references within a complex topic on the basis of a mapping technique, which then can be applied in an assessment. To sharpen the method further, more differentiating studies must be carried out. It would be worthwhile to integrate the methodology presented here with other approaches, such as videography, because an interesting conspicuity presented itself: there were no significant differences in the scores of single and group work (cf. methodology section). This difference was not relevant to this project and, as such, received no focus. Nevertheless, it would not correspond to the expectations of cooperative group work [30,35] and, therefore, represents an interesting facet for future research. Here, videography could show differentiated indications of individual and group differences and explain our observation.

Similarly, in combination with videography or other approaches, the methodology can be extended to other competences, particularly reading literacy, because the mystery used here has a high degree of text, which was preferred for reasons of uniformity between the information cards. Thus, influences from pictures or diagrams on the processing were avoided. Accordingly, the ability to read was a central requirement in this mystery and is certainly also an interesting aspect in the investigation of mysteries in general.

Further potential areas of application for the methodology presented here include other contexts and subject areas characterized by complexity and interconnectedness, in which networked or systemic

knowledge structures are the focus of research, as it is not only in the field of sustainable development that cross-links between dimensions are created [4]. For example, in the area of teacher training, networking between sub-disciplines [36] or areas of the teaching profession [37] are relevant. In the course of a well-founded teacher training program, the diagnostics of the interconnections are absolutely necessary. Whether and how mysteries can be designed and evaluated in this context are considered another exciting branch of research. A correspondingly adapted procedure, in any case, would be conceivable for determining the connections between the relevant areas.

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Article

# Education in Sustainable Development Goals Using the Spatial Data Infrastructures and the TPACK Model

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**Abstract:** Education in Sustainable Development Goals is a basic step in attaining its objectives, and, therefore, it has been undertaken by broad sectors of the teaching community. Nevertheless, the “sustainability curriculum” derived from the Sustainable Development Goals, in this case based on the data of the Spatial Data Infrastructures, in spite of its teaching and research potential, is something with which the teaching body is not yet familiar. The results of the fieldwork carried out (questionnaires and Delphi technique) prove this to be the case. For this reason, in order to educate geographically in reflection and collaboration with the aims of the Sustainable Development Goals, the viewing, in a GIS on the Cloud (WebGIS) of indicators of interest is proposed for the Sustainable Development Goals taken from the Spatial Data Infrastructures within the framework of the TPACK (Technological Pedagogical Content Knowledge) model. To facilitate all these learning objectives, a proposal for good practices in the classrooms of secondary schools and another proposal for university lectures have been designed, and the results applied and analyzed. These examples demonstrate empirically that, with adequate pedagogical tools, an education in geography for global understanding by integrating Sustainable Development Goals and Spatial Data Infrastructures can be achieved, which is what the TPACK model pursues.

**Keywords:** geographical education; Sustainable Development Goals; Spatial Data Infrastructures; TPACK; teaching competencies

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## 1. Introduction

The concept of sustainable development originates in the definition given by the Norwegian Prime Minister Gro Harlem Brundtland in the report “Our Common Future” (1987), which expressed the growing concern of society about the limitations of our resources and their inequitable distribution. Various initiatives have taken up this global problem, which remains unsolved (the 1992 Rio Summit, the 2000 Millennium Summit, the 2012 UN Summit on Sustainable Development Rio+20, Agenda 21, and others). In this context the UN takes the initiative in formulating 17 Sustainable Development Goals (SDGs) which, approved in 2015, should enter into force on 1 January 2016, with the aim of achieving them in fifteen years. This roadmap, which is known as Agenda 2030, includes 128 goals, a “plan of action for people, planet and prosperity. It also seeks to strengthen universal peace in larger freedom.” [1]. The SDGs seek a multidimensional model of development that would guarantee sustainability. This is a complex process of political and economic discussion, with no consensus and different viewpoints, which must also be addressed through education.

Nelson Mandela stated in one of his speeches that: “Education is the most powerful weapon to change the world”. In this is reflected the importance of acquiring knowledge, competencies, skills

and attitudes for transforming a more and more rapidly changing world. There is a broad array of different organizations that promote this line of work, one of whose main accomplishments being the proclamation of the United Nations Decade of Education for Sustainable Development (DESD), (2005–2014), approved in UN General Assembly Resolution 57/254 [2].

Various publications demonstrate how to implant these initiatives in classrooms, for example, the “Education for Sustainable Development Toolkit” [3] now built around education and innovation (“smart”) [4]. In the latter, only three short paragraphs are devoted to education, pointing out certain deficiencies to be corrected, formation being considered the fundamental base for sustainable development, as knowledge and good practices stimulate education for sustainable development (ESD). For this purpose, the tool of continuing education is offered. Other authors base the pillars of education on the SDGs dealing with the “sustainabilization” of the curriculum, a process whose aim is to educate for sustainable development by activating behaviors [5]. The Lucerne Declaration on Geographical Education for Sustainable Development [6], published by the Commission on Geographical Education of the International Geographical Union, lays the foundations of the transdisciplinary approach permitted by the SDGs, which are very appropriate in geographical education. Any professional of geographical teaching who analyzes and works in sustainable development can choose from the points of interest and treat them, using different scales, in search of an integrated development that would include the social (including political and cultural), environmental, and economic dimensions. The social aspects are related to the population. What is most important is the objective of ending poverty, which would be achieved by the distribution of wealth and the satisfaction of human necessities. The environmental aspect is concerned principally with the protection of natural resources, the alteration and degradation of the ecosystems and their diversity, climatic change, and the changes in the uses of the land. The economic aspect oversees the need to create wealth and to ensure the prosperity of the entire population.

## **2. Objectives and Method**

Educating in the Objectives of Sustainable Development entails pointing out the problems of the present-day world as compiled in the 17 Sustainable Development Goals, not only to reflect on them, but also to activate new behaviors. It is important to build bridges between the citizenry and education, taking advantage of synergies, making compatible what is learned in the classroom with the necessities that society demands. Thus, the working objectives are based on three pillars that constitute the aspects defended by the TPACK (Technological Pedagogical Content Knowledge) model: the first would be to show the problems of the present-day world from the SDGs viewpoint, using the information of the SDIs and to look for solutions by means of viewing this information on a WebGIS; the second would be to prepare the teachers in these problems and form technological tools as a key piece so that the student can make sense of the data; and thirdly, design and experiment with interventions (good practices) that should demonstrate that all the previous objectives are possible. For this reason, the teaching staff should know the content (SDGs) and the technology for collecting, using, analyzing, processing, and sharing data [7]; this is a useful methodology for students to learn about SDGs in order to fulfill the 2030 Agenda [8]. These three objectives are those that we will develop below, following the presentation of the results of the field work in which various questionnaires have been given to active and future professors for the purpose of studying their previous knowledge in the use of the SDIs (technology) in undertaking the SDGs (content).

## **3. The Wealth of Data of the Spatial Data Infrastructures for Addressing the Sustainable Development Goals**

The data, with its three main components—thematic, temporal and spatial—is the prime material for the territorial analysis of any phenomenon. This data located in the territory is called a geodata (georeferenced or geolocated data). For this reason, territory, which sustains the datum, emerges with

renewed importance, which the experts call neogeography [9], and whose enormous and growing volume causes many authors to speak of Big (Geo) data [10].

In this context, the citizen must learn to interpret spatial data beginning at school, and to acquire competences in using geospatial data. This is not possible without training the teachers in the use of the Infrastructures of Spatial Data (SDI). The official organisms make available the datum referenced in the territory (geodata) updated in real time, and with guaranteed inter-operability, in compliance with various harmonizing norms, standards, and specifications [11]. In this way, the “SDIs have emerged as an enabling platform that can also be applied to sustainable development challenges” thus supporting “the need to integrate geospatial information into sustainable development processes” [12]. These authors also suggested a National Geospatial Strategic Framework to integrate geospatial information into national sustainable development policies and strategies.

Obtaining data from the SDIs and integrating them into the Geographic Information Systems on the cloud or WebGIS is of great assistance for these objectives in education [13–18], because it is an excellent field for the active teaching of the use of collaborative working techniques, and it also leads to the benefits that the TPACK promotes. It has been shown that a WebGIS reinforces learning and is integrated into a novel educational current whose success in the classroom has been noted by numerous authors [19–27]. But this is not enough: in this world full of fake news [28], the students must learn as well to look for and evaluate the quality of the data, not only with respect to the precision of the location, of the attributes or of the logical consistency (relation between the layers and within the same layer), but also to the problems derived from the modifiable spatial unit.

#### **4. The Key Piece Is the Teaching Body**

##### *4.1. Analysis of the Previous Knowledge of the Teaching Body*

The evidence of the little or no knowledge of the SDIs has been made clear in a series of surveys and interviews with secondary school (Middle, Upper and High School/K7 to K12) and university professors in order to know whether or not they used the SDIs in their classrooms and lectures.

Various waves of different techniques have been applied. The first was a simple questionnaire that was answered before and after a summer course taught at the UNED and dedicated to teacher training (“Strategies for geospatial knowledge in secondary teaching”, Mérida, Badajoz, 10–12 July 2017). None of the 15 who attended claimed knowledge of the SDIs before the course began. The objective of the course was to use the open data of the SDIs on the WebGIS of the platform ArcGIS online TM, Esri® (AGOL). Consequently, at the end of the course these professors not only knew what an SDI is, but they also learned to integrate its data on a web map.

In a new survey conducted in primary and secondary schools of the Community of Madrid and in Ávila, with a universe of one hundred professors ( $n = 100$ ), 98% had no knowledge of SDIs. Only those who in their academic life received training in Geographic Information Systems (GIS) knew the initials, but in the informal interviews conducted, they stated that they did not use them in class because of certain problems of usability or of connection mentioned in various studies [29], in which the advantages are also pointed out.

The results of the Delphi technique, intended for professors and experts in SDI [30], showed a varied knowledge of SDIs and a certain skepticism in their use for teaching purposes, in spite of the fact that the majority of the existing geographic viewers on the Internet took their data from the SDIs.

For these reasons, we can state that the majority of the teaching staff is not familiar with the SDIs, even though they are used in many of the tools offered by geo-services or services based on geo-positioning and are very useful in employing the GPS for didactic purposes [31].

##### *4.2. The TPACK Model*

With these premises, we arrive at the TPACK (Technological Pedagogical Content Knowledge) model, designed by Mishra and Koehler [32], which adds a technological dimension to the model



previously created by Shulman [33] for knowledge of the pedagogical content (PACK). None of these three elements, pedagogy, disciplinary content and technology, in itself, would produce a satisfactory learning result. We can add that the interaction of these three elements bridges the gaps between content and professors, among professors, between professors and student and among the students themselves, which facilitates the collaborative learning defended by many professors who speak of Information and Communication Technology (ICT) [34,35].

There are different initiatives in its application to the formation of teachers at different educational levels [36–39], and in different disciplines, such as music [40], and also in geography [41,42].

The model does not attempt to enrich the content and the pedagogy implemented by the evolution of technology, but, rather, it defends the concept that technology requires new methodologies and new disciplinary concepts, and vice versa. This is a complex and weakly structured task [43], which in this case requires the teachers to integrate the following into their assets: disciplinary content related to the SDGs in all their dimensions (environmental or ecological, of economic and social development, as well as adequate governance); knowing how to teach them (geographic and pedagogic education), and being able to use the technology most appropriate to achieve both ends (open geodata of the SDIs integrated into a WebGIS). All this is for the purpose of promoting reflection from the point of view of sustainable development and of changing behaviors through the competencies of critical analysis and systemic reflection [5].

Below are shown examples of the evidence of the use of the SDIs in secondary school and university classrooms as an essential source of territorial information, demonstrating that knowledge of the content is the knowledge that the teacher has constructed on the discipline that he teaches, it being possible to integrate into the geographic themes the SDGs and the data from the SDIs viewed on a WebGIS within the framework of the TPACK model.

## 5. Good Practices Proposal in Secondary School Classrooms

The publication of UNESCO (United Nations Educational, Scientific and Cultural Organization) [44], Education for Sustainable Development Goals, shows how key pedagogic approaches for the Education for Sustainable Development center on the student, which gives him or her autonomy and requires the detection of his or her previous knowledge, which, in this case, we have done by means of a questionnaire in the *Kahoot* application, thus connecting with gamification.

The second approach emphasized is learning oriented toward action, which is resolved by using service learning. This responds to the idea of designing an action and carrying it out in order to learn with it. This is part of the Kolb scheme [45], which commences with a concrete experience in order to observe and reflect on it, form concepts that allow generalizations and apply these abstract concepts to new situations.

And finally, transformational learning, which begins with the students' comprehension of the world and invites critical and disruptive thinking and allows co-creation of new knowledge. In all these cases the teacher's role is essential as the facilitator in this learning environment.

The conviction of the need for formation in the school, in the challenges of over-exploitation and limitation of the Earth's resources and in the social and environmental problems that are generated (2030 agenda and SDG) motivate the new and good practices in the classroom set out below. The collecting of data is carried out using the SDIs, and for the collaboration in the goals of the objectives the service learning technique is applied.

The integration of these three elements, content related to the SDGs, application of pedagogical techniques like cooperative learning and service learning, some of them including technology such as flipped classroom (videos) and the Kahoot portal (surveys and quizzes), and technological instruments (data taken from the SDIs and viewed on a WebGIS, office automation) will lead to the achievement of the TPACK model.

The details of these good practices are:

- Title of the activity: Sustainable Development Goals through the Infrastructures of Spatial Data: from theory to practice
- Academic year: 2017–2018
- Material: Geography and history for the ESO (Obligatory Secondary Education) (ages 14–15)
- Students participating: n = 33. Percentage of boys and girls: 39% boys and 61% girls.

### 5.1. Objectives and Classroom Methodology

#### 5.1.1. Objectives

1. Know how to explain concepts related to the Spatial Data Infrastructures and the Sustainable Development Goals (SDIs, SDGs, geodata, types of poverty, types of migrations, etc.).
2. Know how to use a WebGIS with the ArcGIS Online tool to integrate the geodata obtained from the SDI services.
3. Know how to prepare a report commenting on the situation represented on the map and formulate questions related to geography and the sciences whose object is the territory.
4. Know how to communicate those solutions for the problems of the world and of their city and carry out those actions that are closest.
5. Know how to work in a team, with emphasis on distribution of roles within the group (spokesperson, secretary, coordinator, and time controller) and in making decisions.
6. Know how to debate and respect the speaking time of the spokesperson of each group.
7. Respect the work of others and one's own, as well as the effort, the social responsibility and the interest in themes related to the SDGs.
8. Respect the decisions of the group or class when it comes to carrying out a social action.

#### 5.1.2. Classroom Methodology

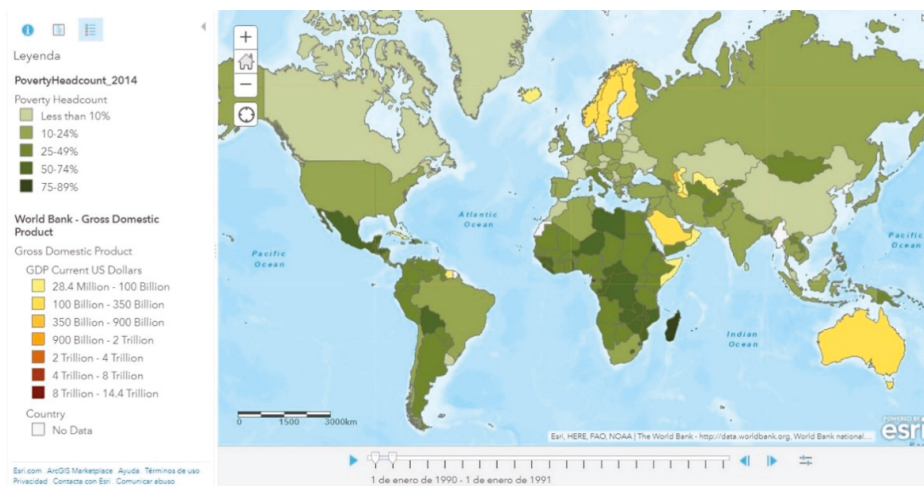
The following pedagogical strategies will be used to introduce and raise the awareness of SDGs numbers 1 and 2 (end poverty and zero hunger):

1. Flipped classroom technique, through the viewing of the following video: <https://youtu.be/nIdXZIJvXRM>, included in the EdPuzzle tool, which permits the introduction of open, true-false and multiple choice questions.
2. Individual reading of and reflection on the two SDGs to be studied in the didactic unit corresponding to "World, European, and Spanish population".
3. Cooperative learning in groups of four students, to be done in the IT classroom: creation of a map with the ArcGIS Online tool, using the SDI services provided by the web or free virtual dependable data repositories. The World Bank is recommended, but the students can select other SDI services, justifying the reliability of the geodata. After reviewing and correcting the maps, the students analyze and discuss the following map applying the outline below:
  - Introduction: brief comment on the data represented
  - Analysis of the data
  - Conclusions regarding the resolution of any problems or situations

Finally, each group prepares a reflection and smart questions for the debate on the subject of poverty and hunger. The spokesperson of each group is the one responsible for presenting the reflection and proposing the questions and possible solutions on a local and a global scale. In this case, the actions proposed that can be carried out in their city were to go to a social dining place and collect food in the "Kilo" operation. In this process they can investigate both the origin of the goods handled as well as their distribution and commercialization in the world as global elements that do not avoid the hunger and poverty that they observe locally.

The combination of individual and collaborative activities will be presented in a portfolio in which the following objects will be included:

1. A cooperative map with the variables related to SDGs 1 and 2, which include geodata from the SDI services (Figure 1).



**Figure 1.** Mapping of a variable related to Sustainable Development Goals (SDGs) 1 and 2. Source: A group of students from 3rd ESO (Obligatory Secondary Education) (K-9).

2. A report with the proposal of solutions to obtain the SDGs (1, 2). Analysis and commentary on the situations represented on the map, as well as reflection on the causes and consequences of poverty and hunger.
3. Proposal of solutions on a local and a global scale. Questions for the debate.

### 5.2. Results of the Learning Experience and Competencies to Be Acquired Through the Proposal

The basic competencies specified by Spanish educational legislation have been applied to the results of the learning experience (Table 1). In order to do this, the educational center itself has designed a program to facilitate the calculation of the measurement of the grading of the learning standards.

It was necessary to devise headings or indicators to measure achievements in each of the competences proposed by UNESCO [46], using the adaptation done by Professor Murga-Menoyo [5], which summarizes them in four competencies: critical analysis, systemic reflection, making collaborative decisions, and sense of responsibility toward the present and future generations (Table 2).

**Table 1.** Learning standards and key competencies, according to Spanish educational law.

	Learning Standards (LOMCE) <sup>1</sup>	Key Competencies <sup>2</sup>
B1.1.1	Locate on a world map the continents and areas most densely populated.	CSC, CAA, CD, CMCT
B1.1.2	Find on a world map the twenty most highly populated cities, deduce what countries they belong to and explain their economic situation.	CAA, CD
B1.1.3	Explain the impact of the waves of migration on the countries of origin and on the host countries.	CL, CAA
B2.6.1	Locate on a map, using appropriate symbols and legend, the most industrialized countries in the world.	CAA, CD
B3.3.1	Write a report on the measures that try to overcome the situations of poverty.	CL, CAA, CSIEE CCEC

<sup>1</sup> Ley Orgánica para la Mejora de la Calidad Educativa, is the current Spanish Education Law. <sup>2</sup> CL: Linguistic competence, CSC: Socio-civic competence, CAA: Learning to learn competence, CD: Digital Competence, CCEC: Competence in awareness and cultural expression, CSIEE: Competence in sense of initiative and enterprising spirit, CMCT: Competence in mathematics and in science and technology.

**Table 2.** Indicators of achievement of the competencies following UNESCO (United Nations Educational, Scientific and Cultural Organization) <sup>1</sup>.

UNESCO Competencies	Indicators of Achievement
Critical analysis	Ask oneself about geographic aspects (geographic questions) Identify problems of any type related to the territory Propose alternatives for improvement Do a constructive critique on the aspect observed
Systemic reflection	Understand reality at a global and a local level Interrelations among values, attitudes, knowledge, etc. Understand and reflect on the causes of phenomena, facts, and problems
Making collaborative decisions	Put into practice leadership skills and distribution of roles Participation of all the members of the working team Communicative skills to persuade or convince in arguments
Sense of responsibility toward the present and future generations	Understand the effects or consequences that an action can have in the short term and the long term Understand the consequences of inappropriate behavior that affect the present and future of the Earth Take care of intra- and intergenerational relations Contribute to the change to sustainability by adopting alternative solutions and proposing possible ones at different levels, a closer one, what can I do? Finally, a more global one, what should be done?

<sup>1</sup> Adapted by Javier Álvarez Otero from the UNESCO Competencies following Murga-Menoyo (2015).

### 5.3. Results of the Evaluation

In order to obtain the final evaluation, an evaluation at the beginning of the process is necessary (initial evaluation) in order to detect the students' previous knowledge and also a formative evaluation conducted throughout the entire process. In the initial evaluation a survey is conducted via the web application Kahoot, with seven questions (Table 3).

The majority of the students are familiar with the acronym of the Sustainable Development Goals (SDG) (81.82%), which can be attributed to the information provided in the media. They do not know the institution (UNESCO) that performed the tasks of defense, support and coordination of the worldwide action programs; many of them select the European Union as the mediator in these matters, an aspect that we could emphasize as owing to the Eurocentric view that our students have. The new date and the number of goals that have been proposed for the period 2015–2030 are not well known. We underline the fact that more than half of the respondents (51.52%) know the philosophy of the SDGs: “transform the world from any part of the world”. It should be stated that the phrase “any part of the world” corresponds to any geographical location and, therefore, two questions are proposed that are to be addressed during the preparation of the portfolio: “What can we do on a local scale

(my city, my neighborhood)?” and “What can we do on a global scale (the world)?” The majority of the students (72.73%) choose the correct option in the question on what objectives are included in the 2030 Agenda (end of poverty, quality education, and gender equality), which is related to the priority that they themselves accord to the problems they feel are closer. Finally, half of the students (51.52%) see themselves as protagonists of the changes that can be made to attain sustainability, both in their own cities and in the world, while other students have their doubts (45.45%) and there are even some do not feel capable of collaborating in these changes (3.03%).

**Table 3.** Summary of the results of the initial questionnaire done in the classroom <sup>1</sup>.

Questions Asked	Correct (%)	Not Correct (%)	Don't Know/Don't Answer (%)
What are the SDGs?	81.82	18.18	0
What is the institution concerned with the SDGs?	21.22	78.78	0
What is the philosophy of the SDGs?	51.52	48.48	0
Do you know what the new date is for attaining the SDGs?	12.12	87.88	0
How many SDGs are there for this new period 2015–2030?	12.12	87.88	0
Which of the following goals are included for the 2030 Agenda?	72.73	27.27	0
Do you, as a student, believe you could transform the world?	51.52	3.03	45.45

<sup>1</sup> Designed by Javier Álvarez Otero.

For the formative evaluation, the heading (Table 4) that completes the information from Table 1 is distributed, to be taken into account in the co-evaluation prepared among the students and the hetero-evaluation to be done by the professor. The measurement of attainment of the UNESCO competencies appears in the professor’s observation notebook, which will follow Table 2.

**Table 4.** Heading for the evaluation of the portfolio <sup>1</sup>.

Items	Degree of Achievement			
	4	3	2	1
Organization	Classifies, orders and files all the tasks	Classifies, orders and files most of the tasks	Classifies, orders and files some of the tasks	Does not classify, order or file any of the tasks
Presentation, order, and cleanliness	Presented very suitably, clean, and orderly	Presented suitably but with some defects in cleanliness and order	Presented, but with many errors in cleanliness and order	Presented with neither cleanliness nor order
Evidence of the learning experience	Contains all the evidence and objects	Contains some of the evidence and objects	Contains little evidence and some objects are missing	Contains neither evidence nor the objects.
Precision of the contents	Contents perfectly developed, with precision and good wording and spelling	Contents are developed normally, with correct wording and spelling	Contents little developed, with little precision and with spelling errors	Contents scarcely developed, with little or no precision and many spelling errors.
Final result	Is excellent and shows a great effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)	Is normal; shows relative effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)	Is acceptable and sufficient; shows little effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)	Is very bad or bad; shows no effort to acquire abilities and skills related to the competencies (LOMCE, UNESCO)

<sup>1</sup> Prepared by Javier Álvarez Otero to evaluate the portfolio.

The summative evaluation is the final average of the grades obtained by the student, which will consider:

- The co-evaluation from the valuation proposed among the working groups, based on the heading received and considering those aspects that could be improved for a future project or cooperative activity.

- The hetero-evaluation proposed by the professor, taking the heading into account.
- The individual objective test, consisting of using a WebGIS to integrate the SDI services, showing one of the realities and situations observed in the study of the SDGs.

The results obtained are shown below:

As we can observe in Table 5, all the students have obtained a grade higher than 7 over 10 (7.44), although we see certain differences between women and men, which can be explained by the psycho-evolutive differences of the students, whose basis is beyond the objectives of this article.

**Table 5.** Average grades for each type of evaluation and final grade.

	Women	Men	Both
Co-evaluation	7.52	7.32	7.42
Hetero-evaluation	8.26	7.39	7.83
Individual objective test	7.09	7.05	7.07
Final grade (average)	7.62	7.25	7.44

## 6. Good Practices Proposal in the University Lectures

Some professors are comfortable with the relation between the autonomy of the student and the orientation of the professor [47]; others see in TPACK an opportunity for distance teaching [48,49]. We have tried to integrate both views in order to incorporate the principles and values of sustainable development into the teaching project (curricular sustainability). This is a line of work promoted by the Conference of Rectors [50] itself, and which we have begun to incorporate into the university teaching (undergraduate and graduate students) in the Geography Department of the National Distance University (UNED).

To this end, various activities have been designed within the framework of the practical tasks that the students perform in some of the subjects studied at the National Distance University (UNED) (Table 6).

**Table 6.** Subject matter, degrees and tasks designed.

Name of the Subject	Degree (Department)	Task to Be Performed
Complements for training in the discipline of Geography	Master for professors (Geography and History)	Integrate aspects of sustainability and SDGs into the didactic unit to be designed
Human Geography	Degree in Anthropology (Philosophy)	Description of a cultural landscape to be integrated into a WebGIS with some SDGs
World Tourism Geography	Degree in Tourism (Economic Sciences)	Web map showing the sustainability of touristic destinations
Organization of Territory II	Degree in Environmental Sciences (Environmental sciences)	Web cartography of the environmental problems of the National Parks and an account of the contents of an article with Sustainable Development Goals.

Designed by Javier Álvarez Otero.

In the case of the students of the Master for professors, in the subject Complements for training in the discipline of Geography, the didactic unit to be done is the required work of the subject, and it should include aspects of sustainability related to the SDGs and the area of geography undertaken. The students whose final dissertations were directed in the academic year 2017–2018 have included aspects of sustainability. These students have shown their satisfaction at having been introduced to this line of work, which indicates that it is a correct approach.

The students of Anthropology, in the subject Human Geography, must do a complete description of a cultural landscape of their choice, which they must relate to the SDGs that they consider most relevant and must add a resume to a web map (using the Survey123 tool). The result will be a

collaborative WebGIS map to which will be added other layers of information from the SDIs in order to gain further insight into the relation between the phenomena studied.

The students of the Degree in Tourism, in the optional project for the subject World Tourism Geography, will use Survey123 to evaluate sustainability in the number of visits to great world touristic destinations, the result being a map containing all the information.

In the academic year 2017–2018, in the subject Organization of Territory II, the students for the Degree in Environmental Sciences did a study on the National Parks and the problems of sustainability detected in relation to the SDGs. In the 2018–2019 academic year a map has been created with the information on the parks available in the Infrastructures of Spanish Spatial Data (ISSD), to which the students will add their reflections on the environmental problems of these natural areas as they relate to sustainability and on actions for improvement of the SDGs. Given some of the problems encountered in the location, it was decided to use the Survey123 tool, which facilitates the creation of the layer of information by registering the data of the survey conducted at the site data that the student situates on the said map. Furthermore, the students will do a critique that they will review among themselves (double-blind pairs) on an article relevant to the organization of the territory and the SDGs from among a list provided by the teaching team.

Another area of application was the UNED summer course for professors given in July 2018 was flipped teaching and geolocalization for learning geography in the cloud. It included an obligatory activity in which the students had to present their surroundings to their classmates, making reference to some concrete element of sustainability. For this purpose, a questionnaire is used that permits georeferenced points to be included (Survey123), and makes it possible to show the results on a web map. In general, the students have been satisfied with the activity, which is still in the process of completion.

In the project those surveyed were to relate the WebGIS and the SDGs, reflecting on one of the subjects that are taught or will be taught in the future, with the idea of integrating into it the Objectives of Sustainable Development (SDGs). Also, there is a requirement to design a web map that can serve to improve the knowledge of these objectives, directed at looking for actions for improvement.

These tasks have attempted to cover at least the following goals:

1. An improvement in the work done by the students in relation to cartographic visualization and the contents related to the SDGs.
2. Create a form of working and of communicating the competencies, which encourage responsibility for future generations that the SDGs promote through the WebGISs.
3. Initiate a working model that can gradually be expanded and extended to other subjects.

In all these cases the aim is for the student to know the existence of the 17 SDGs, (although it may be impossible to address them all in just one academic year), and to reflect on some of them and to begin to understand the importance of sustainability, so that responsibility toward future generations may be fostered by means of a reflexive approximation to the territory through geography. In this process, it will be fundamental to invite the student to ask himself or herself questions from geographic science that could foment the creation of a critical spirit along the lines of what the 2030 agenda should achieve through socio-economic, technological and educational advancement, for example: how to feed the 8.563 million people who will constitute the planet in 2030 in a context of climate change, economic and financial uncertainty, and increasing pressure on natural resources.

The indicators that will serve to evaluate the results will be:

- (a) The level of satisfaction of our students, who will answer a question on it, and will progress in themes of cartographic visualization, in which probably, according to the replies of former years, around half of them will not have worked before.
- (b) The level of satisfaction of the professors, who will thereby obtain a better integration among teaching teams and tutoring professors.

- (c) Knowledge and awareness of the need to attain the goals of the SDGs, which will be observed through the tasks performed.
- (d) Transmission of the knowledge acquired to their own students and/or other students.

## **7. Discussion of the Results**

The results ratify the need to improve the territorial knowledge on which are based the goals of the SDGs as well as the importance of using reliable, up-to-date sources such as the services offered by the SDIs.

The professors must face the challenge of the ICT and take advantage of them in benefit of more efficient teaching. Beyond incorporating them into what was being done before, a transformation is proposed that integrates the three aspects indicated: disciplinary, pedagogical, and technological, into the acquisition of disciplinary (CK), pedagogical (PK) and technological (TK) knowledge which integrates pedagogical disciplinary knowledge (PCK), technological disciplinary knowledge (TCK) and technological pedagogical knowledge (TPK). All of them participate in the construction of TPACK, which permits disciplinary objectives to be attained with the proper use of the integrated pedagogy and technology.

Thus, new knowledge is created that will help the students in their development both professional and as citizens. In this study it has been applied to a better knowledge of the SDGs, which it is possible to do by using the geodata of the SDIs viewed on a WebGIS.

Of the suggestions on aspects to be introduced in the formation of professors that permit good practices of this kind in the classroom, one is integrating aspects of geolocalization and SDI related to the SDGs and the contents of the curriculum in a natural way, as has been shown here for secondary and university education.

Although the proposal is still in the early stages, it has been considered perfectly feasible in the University Master in Formation of Professors of Secondary Education of the UNED and other universities; it could even be applied to the permanent formation that the active professors must complete. In this way, it would easily reach the secondary school classrooms and promote the university–secondary school relation, very necessary because of the valuable retro-alimentation it provides. Furthermore, with this proposal we are contributing to two areas of priority action of UNESCO [51]: “Transform the environment of learning and formation” and “Create capacities among the educators and trainers”.

## **8. Conclusions**

Our proposal of educating in the Sustainable Development Goals as a means of collaborating in their advancement merges with the TPACK (Technological Pedagogical Content Knowledge) model, bringing together the intrinsically interrelated disciplinary, technological and pedagogical content.

We consider that this proposal is innovative in its disciplinary aspect because it is a new way of approaching content and reflections on the Sustainable Development Goals; in its pedagogical aspect because it requires new methodologies, some of them collaborative; in the technological aspect because it uses Spatial Data Infrastructures and a technology available since 2012 (WebGIS of ArcGIS Online). In this study there are examples proposed of the classroom in relation to secondary school students and also to university students, and in addition, the difficult topic of the formation of the professors is treated, a key matter for the transformation of teaching necessary for the citizenry of the 21st century.

TPACK and Spatial Data Infrastructures join for the purpose of favoring territorial knowledge and improving the competencies of the students, future professors, living together in a technological environment and a society ever more demanding of up-to-date data, within the phenomenon known by all as Big Data; in this case for a better knowledge of the Sustainable Development Goals and the initiation of actions in order to reach the proposed goals. The usefulness of cartographic language in a WebGIS to express the Sustainable Development Goal has been demonstrated, based on the needs and motivation of our students.



What has been achieved is that the student knows and is involved in achieving the Objectives of Sustainable Development, using the data of the Spatial Data Infrastructures viewed in a WebGIS, and contributing good classroom practices extendable to other places and centers. An important feature is the use of a variety of pedagogical strategies and techniques, such as the proposals that permit the student to be the protagonist of his or her own teaching–learning process from the beginning, with an experiential focus (flipped classroom), passing through practice (learning based on problems) and proposing solutions to what he or she is familiar with, thus providing a service to his city (learning-service).

**Author Contributions:** J.Á.O. designed, executed and analyzed the results of the questionnaires for professors and the application to the secondary school classroom as part of his doctoral thesis. M.L.d.L.y.T. coordinated the team and conducted the research. Both developed and agreed on the existing literature.

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Review

# If a Tree Falls: Business Students Learning Active Citizenship from Environmentalists

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**Abstract:** This article presents and discusses student assignments reflecting on the documentary film *If a Tree Falls*, written as part of the Business Ethics and Sustainability course at The Hague University of Applied Sciences. This article follows two lines of inquiry. First, it challenges mainstream environmental education, supporting critical pedagogy and ecopedagogy. These pedagogies, which advocate pedagogy for radical change, offer a distinct and valuable contribution to sustainability education, enabling students to critically examine normative assumptions, and learn about ethical relativity, and citizenship engagement from environmentalists. The discussion of “lessons of radical environmentalism” is pertinent to the question of what types of actions are likely to achieve the widely acceptable long-term societal change. While this article focuses on student reflection on a film about radical environmentalism, this article also discusses many forms of activism and raises the question of what can be considered effective activism and active citizenship in the context of the philosophy of (environmental or sustainability) education in connection didactics and curriculum studies. Second, this article argues for the need for reformed democracy and inclusive pluralism that recognizes the needs of nonhuman species, ecocentrism, and deep ecology. The connection between these two purposes is expressed in the design of the student assignment: It is described as a case study, which employs critical pedagogy and ecopedagogy.

**Keywords:** democracy; critical pedagogy; ecopedagogy; sustainability; radical environmentalism

## 1. Introduction

Protected areas are the foundation of biodiversity conservation, safeguarding nature and cultural resources, improving livelihoods and driving sustainable development [1]. However, protection of nature has never been as controversial and even dangerous, with hundreds of environmental activists (and citizens defending their homes from displacement) being attacked and even murdered, and many more jailed, mostly in developing countries [2]. In recent decades, hundreds of environmental activists have been murdered in South and Central America [2,3], particularly in Colombia [4] and in Brazil. Many anti-logging campaigners who have been murdered are members of indigenous groups [5,6]. In Africa, environmental activists became better known since the execution of Ken Saro-Wiwa and other Nigerian protestors against the oil industry [7], and there is a continuous suppression of grassroots groups [8]. The largest death toll in Africa includes conservation workers and park rangers killed by poachers, illegal (or legal!) loggers supported by corrupt officials [9–12]. Asia has also been a dangerous place for environmentalists, including incidents of environmentalists’ persecution in Vietnam and China (e.g., [13,14]). In Cambodia, the anti-logging campaigner Chutt Wutty was murdered, without fair investigation completed [15], with three other deaths in 2018, reportedly by poachers, still being investigated [16]. Campaigners from the NGO *Mother Nature Cambodia* face trials on suspicion of economic disruption [17,18]. Activists’ concerns and efforts to challenge the status

quo should be taken seriously, as an estimated 20% of the Amazon rainforest has been cleared in the last 60 years [19]. In other areas too forests are drastically cleared to make way for agricultural activities, including animal agriculture, which plays a significant role in deforestation, biodiversity loss, soil degradation, and water pollution [20], constituting an estimated 26% of anthropogenic greenhouse gas emissions [21]. Production of animal products is estimated to double by 2050 [22], with currently an estimated 70 billion land animals killed each year for food (excluding sea animals) [23]. Environmental protection and animal rights issues are thus increasingly interconnected.

Simultaneously, not just defense of the environment but individual animals are increasingly persecuted, and animal rights activists have been declared terrorists and incarcerated for animal liberation acts throughout Western Europe and North America [24]. The persecution of environmental and animal rights activists is becoming a global problem, with increasingly more governments adopting legal measures to silence and imprison activists [25].

One of the least publicized types of environmentalism is associated with groups labeled as “radical” by governments or the media [26,27]. The US government has applied the term “terrorist” and “radical” to the Earth Liberation Front (ELF), and Animal Liberation Front (ALF) [28–30] and the label “ecoterrorist” or “ecoterrorism” has fueled the persecution of animal and environmental activists. The term was coined in the 1980s as a response to the rapid and bold growth of environmental and animal rights movements and has been used by the industry to shift the public dialogue and frame activists as terrorists [24,31,32]. At the height of the “Green Scare”, the FBI labeled “ecoterrorism” as its number one domestic terrorism threat [25] but has since downgraded it to “one of the most serious domestic terrorism threats” [33].

Both ELF and ALF strive to cause no harm to humans and nonhumans as a core principle guiding their actions and instead use tactics such as arson and economic property damage to draw attention to corporate and government compliance in environmental destruction (Harden 2006) [34]. They disrupt activities that cause suffering and death of animals, for example by targeting animal testing laboratories [24,32]. It is important to mention that the tactics of animal rights activists are varied and diverse, from leafleting, nonviolent protests and demonstrations, public education, school visits and importantly carrying out undercover investigations that aim to make public the practices animal exploitation industries go to great lengths to hide [24,34]. Undercover investigations have resulted in actions against animal industries, including the prosecution of laboratory staff (e.g., [35]), and shutting down slaughterhouses (e.g., [36]). However, in efforts to persecute activists and protect “animal enterprises”, ag-gag laws have been proposed and passed in some US states, criminalising whistle-blowers and undercover activists [37] and the Animal Enterprise Terrorism Act is a legislation protecting “animal enterprises” and using “vague and overly broad” legislation to criminalise activist actions [38,39] Similar legal measures have been passed in other countries, including the UK, where protection of animal testing facilities have received increased protection while making it easier to prosecute animal rights activists (Serious Organised Crime and Police Act 2005). Since Donald Trump’s presidency, the US government has intensified the persecution of environmental activists [40].

The case described in the documentary *If a Tree Falls* dates back to the pre-Trump arrests of environmental activists and raises questions about the role of citizenship and citizen’s ability to engage in legitimate action for change. Pertinent to the case of environmental education, this article inquires what “lessons” can be learned from environmentalists, government action and framing of terrorism and radicalism.

## 2. Active Citizenship, Critical Pedagogy and Ecopedagogy

Active citizenship education is based on an educational model known as “Action Research for Community Problem Solving”, which stimulates students to become actors in, for and with their communities [41]. Education for active global citizenship, addressing worldwide environmental and social issues, combined the focus on plural and democratic education with a sense of clear purpose and direction, instructed by the challenge and urgency of resolving the problems [42,43].

This approach to education was inspired by Paulo Freire's seminal book, *Pedagogy of the Oppressed* (1997). In examining this book, Anthony Nocella stresses the importance of "striving for an engaging educational experience in the classroom or even learning about the revolutionary/liberation groups, societies, and collectives" [30]. The shortcoming of Freire's ideas has been highlighted by Corman [44], who aptly critiques his perpetuation of "a deeply anthropocentric and speciesist understanding of animals," highlighting the responsibility of critical educators to attend "to the particular and overwhelmingly negative constructions of nonhuman animals throughout the text." The main objective of eco-anarchists is to subvert all forms of political, economic and scientific monologist that is present both in the market ecology or green capitalism and in the ad hoc environmentalism of the social-democracies [45]. In the case of animal rights, speciesism, the underlying ideology that excludes nonhuman animals from the sphere of moral concern and legal protection [46], creates a category of billions of the oppressed, largely un- or misrepresented in education [47–49]. In their advocacy of 'revolutionary' pedagogy McLaren & Houston [50] "informed by a dialectics of ecological and environmental justice that highlights the situatedness of environmental conflict and injustice toward nonhuman nature" (p. 166), advocated defense of convicted ELF activists as they were seen as challenging the mainstream capitalist status quo.

However, the Marxist critique of capitalism has its shortcomings. Ecosocialism has been especially critical of naive narratives about finitude, scarcity, and conservationism [45], thus criticizing mostly social inequality in the distribution of wealth and not challenging the very mechanism of how this wealth is created – through the appropriation of natural resources. It must also be noted that Socialist or Communist countries do not have a better environmental record than capitalist ones, as their economic systems are still predicated on a growth paradigm and industrial development [51]. Nor do countries such as Vietnam or China (e.g., [13,14]) have a better record in the treatment of environmental protests as noted in the Introduction. While green Marxism rightly criticizes the capitalist system of industrial production, its (sometimes implicit) support for socialist or communist systems of organization fails to take into account the fact that contemporary industrial production systems, however socially ideologically organized, are still predicated on the exploitation of natural resources. What is significant in ecopedagogy is not so much its "red" origins in Marxist thought, but a call for a revolutionary different method of addressing the excesses of industrial development and anthropocentrism

In a similar way, the Animal Liberation Front (ALF) can "teach" students about the value of animals—not as objects, but as beings who have intrinsic value [27] and help overcome the misconceptions about ALF as a violent group that is perpetuated by the media by using a rhetoric of terrorism [52]. Nocella [52] argues that critical pedagogy can be used to understand ALF and "their history, culture and mission," which is "rooted in a concern for the suffering of nonhuman animals and peace." By bringing animal issues to the forefront of critical pedagogy, Gunnarsson Dinker & Pedersen [49] question what can education become "when humans are not regarded as the only subjects," laying the foundations of the growing field of critical animal pedagogy [53]. This provides an intersectional approach to the examination of social justice issues and oppression, highlighting the necessity to tie theory to action. Saari [46] notes that speciesism, dependent on its reproduction, normalizes exploitation of nonhuman animals and human-nonhuman animal hierarchy through conventional environmental education and welfare education. In fact, "although many educational proposals have been mobilized in response to the urgent need of social and environmental challenges, they have done so without the will to assume the transforming depth of ecocentrism, or understanding that the urgency of such responses could be complicated by the seemingly "cumbersome" discourse of the "civilizational and paradigm changes" [45]. In addition to critical animal pedagogies, other promising frameworks addressing "the impacts of current cultural habits that perpetuate the abuse of the world's ecosystems" include EcoJustice Education, which aims to help educators "facilitate the exploration, development, and implementation, of habits that support diverse, democratic and sustainable communities" [54].

Various forms of environmentalism each rest on "assumptions, judgments, and contentions that provide the basic terms for analysis, debates, agreements, and disagreements" [55], but particularly eco-

bio- or zoo-centric viewpoints are important for a united critique of anthropocentric thinking [27,30,47]. Education that involves these viewpoints reaches far beyond what education for sustainability, environmental education, and particularly education for sustainable development have so far achieved. The relevance of a genuinely ecological, “deep” or “dark green” environmental education, as noted by Molina-Motos [45] is that this alternative ecopedagogy “assumes the singular contributions and dialogue between deep ecology, ecofeminism, social ecology, the land ethic” that, in consort, provide robust foundations for the paradigm shift. While deep ecology [56] highlights the intrinsic value of nonhuman beings and the environment, it is shallow ecology, recognizing human dependency on the environment and stressing its material value for human prosperity, that is more prominent in mainstream environmental education and education for sustainable development [47,57]. Molina-Motos [45] reflects that to address deep ecology, environmental education should “produce new knowledge from the uniqueness of pedagogical thinking and the essential role it plays in the knowledge production of our societies”. Pedersen [48], Saari [46], and Spanning [58] argue that the hierarchical status quo is not challenged but supported by the notion of the *humane* use of nonhuman animals, pertinent to welfare education, traditional forms of environmental education and education for sustainable development. The status quo needs to be challenged by education, aptly argued by Pedersen [48], who calls for a cessation of relating to animals through our narcissistic preoccupation with animals-for-us. Exploring such trajectories in ESD and beyond, across subject-specific curricula and in age-appropriate manners, implies making the immanent critique a foundation and condition for political and environmental engagement in human-animal relations. It could even imply the practice of a different kind of critical pluralism, in the sense of opening education to multiple unthought possibilities of unlearning and re-learning our being in the world as standing with, staying away, and stepping aside.

The different kinds of critical pluralism, as Pedersen [48] suggests, is different from the common discussion of pluralism prevalent in the environmental education field, as this pluralism (sometimes referred to as democratic) refers to a single dominant species’ decision-making. By contrast, inclusive pluralism [57] would refer to multispecies stakeholders, involved in decision-making through the process of eco-representation through human proxies [59]. Posthumanist scholars have also questioned traditional notions of democracy, which systematically exclude animals and call for a rethinking of what democracy means and who or what can be part of public [60,61].

Borrero [62] argues that democracy in real practice has been transformed into mere mechanisms for the legitimization of the business-as-usual by governments, with elections stimulating the competition among groups of elites, with common voters treated as consumers for a political market. Rozzi’s [62] concern is that, as currently practiced, the democratic mechanisms make the impression of broad popular participation, while in reality the decisions are made by small but powerful economic minorities, mirrored in the case of education by Davis and Bansel [63]. They argue that educational institutions are constantly at risk of indoctrination into neoliberal values through corporate sponsorship, but also through a common curriculum that aims to develop certain “useful” skills in students, shaped by the dominant ideology of economic growth as a prerequisite of social development [63].

However, caution needs to be exercised here, as there are few pragmatic solutions offered to how commonly held elective practices can be “government of the people, *by* the people, *for* the people” and how they can avoid being subordinated to the interests of the “elites”. Another concern is how human elections can take the interests of non-human species into account, as common democracy tends to be anthropocentric [55,59], and the interests of nonhumans are often overlooked due to a myriad of other social and economic interests recognized in democratic societies [64]. The “democratic” environmental education and education for sustainable development has come to signify plural and open opinions, questioning authority, in some cases even to the exclusion of expertise [64], resulting at times in the kind of “anything-goes-relativism” [42].

In fact, supporters of pluralism in education, as discussed by Wals [42] and Kopnina and Cherniak [57], branch out into those who promote openness of opinions as a panacea for neoliberal

ideology, and those that are skeptical of *all* ideologies, including that of education *for* sustainability as it is potentially seen as authoritative and indoctrinating.

### 3. Methodology

There were 290 bachelor students of International Business enrolled into the Business Ethics and Sustainability course between January and May 2019 at The Hague University of Applied Sciences. The assignment presented in this article was one of five assignments, aiming to introduce students to general ethical theories, including environmental ethics and business ethics. The course is described in the syllabus: “Ethical and sustainable management requires a blending of social, natural and financial capital to create a business model for the future. Business Ethics and Sustainability course recognizes opportunities for innovation and impact at the intersection of ethics and environmental, economic and social systems”.

The documentary *If a Tree Falls: A Story of the Earth Liberation Front* was shown to students. The ELF carried out a five-year wave of arson and economic sabotage attacks from 1996 to 2001, which caused no human victims but resulted in an estimated \$23 million in damage to lumber companies, a ski resort, meat plants, a wild horse “processing” factory, and federal ranger stations [34]. A multi-agency criminal investigation known as Operation Backfire coordinated by the Federal Bureau of Investigation resulted in convictions and incarceration of several ELF and ALF group members in 2002 [34]. One of the activists committed suicide in prison in 2005 [65]. The documentary follows Daniel McGowan, one of the ELF activists, who was arrested with other activists after a series of arson, property destruction, and economic sabotage attacks. The documentary culminates with McGowan’s trial charged with terrorism and subsequent sentencing to 7 years in a special high-security prison.

After watching the documentary at home (available on YouTube), the students were asked to write a 1000-word reflection using a six-step approach:

- Step 1: Film details: title, name of the director, etc.
- Step 2: Purpose of the film: what is the message the director wants to convey?
- Step 3: Prior knowledge: did you know anything about the topic before watching the movie?
- Step 4: Synopsis: the main events.
- Step 5: Personal comments: Reflect on the movie from your perspective, validating your comments with relevant arguments and specific details/scenes from the movie. Argue critically what you did and did not like about the movie. Do you think the director achieved his goals in terms of getting the message across to his audience? What did you learn in terms of morality? Do you think this movie is effective in informing and convincing the audience about the ethical issues involved? Will you recommend it to friends?
- Step 6: Application of ethical theory and relevant chapter materials: reflect on the ethical issues on relevant topics, e.g., human rights, social and ecological justice, animal rights, abuse of power, etc.). Discuss which ethical theories can be applied (consequentialist, non-consequentialism, etc.) within the context of the movie.

A random selection of four reflections of assignments submitted in reverse chronological order that the students have submitted their assignments is presented below. While this is a small random sample, the choice of four essays presented in full was made due to the fact that the presentation of qualitative data is space-intensive, and the authors have chosen for a more complete presentation of results rather than an abridged and schematic presentation of almost two hundred essays. While choosing for this type of qualitative research presents some challenges, as the data are collected from a few cases so findings cannot be generalized to a larger population, they can still be valid in a sense of being “an accurate representation of the phenomena they are intended to represent” [66] and transferable to another setting.

Some segments were abridged (shortened) in cases of wordiness, repetitions or redundancies, and the researcher for clarity edited some segments. All the areas in the text that have been edited are



indicated in square brackets. The editing strictly involved readability (comprehension), most of the original grammar, spelling, and style (aside from cursory Grammarly program check) were retained. The essays were analyzed using the content analysis method.

#### **4. Case Study: Student Reflections on the Film *If a Tree Falls***

##### *4.1. Student 1*

The purpose of the documentary is to question whether terrorism can be described as an action where someone is making property damage in a way, which is not causing any injury or death for innocent people. The director also wants to make people determine the phrase of “eco-terrorism” and what would be the actions that can be prosecuted in the name of “eco-terrorism”. Furthermore, the director’s message to the audience is that these people had a normal childhood with a normal background instead of judging them instantly as a terrorist because they did not commit these crimes as a basis of vandalism but rather with reasonable motives against companies which were abusing native forests.

My prior knowledge about arsons was very confined. All I knew before was that people who are committing arsons are either looking [for] excitement or [for] payback for something that they are seeing or finding as injustice actions.

When U.S. Attorney started their investigation against ELF, they gave a chance for defendants to start co-operating with the investigation to walk away from charges if they can help for bringing ELF cells down. However, McGowan had decided that he will stick to the plan, which was not to snitch about other members of the group. Nevertheless, it turned out that some of the defendants took the deal and turned their back to others. I find this extremely unethical and against my morality. Bill Barton, of the Native Forest Council, has worked many years as a logger, gave an interesting interview about radical environmentalists. According to him, companies tend to state these arsonists as eco-terrorist even though companies themselves are the ones who have cut 95 percent of native forests. Barton argues that companies, which are only thinking about the profit, which they gain for logging trees, are radical and not the people who are trying hard to save the last five percent of remaining trees. I share the same way of thinking with Barton. When ELF burned the horse slaughterhouse to the ground, the very same company was never again able to continue its business operation. Local people had tried over ten years to have a different kind of demonstrations against the company without success. The point is that I don’t agree with the arson actions by any means but I am still amazed how powerful arson is to get something to do. I don’t either accept the actions, which the police were using; when they crossed the line by using away too much pepper spray and violent actions against demonstrators. In my opinion, they could have just taken those people into custody for 24 h and then release them with the condition not to commit any further demonstration. One old woman, who was participating in the World Trade Organization protest, stated: “Vandalism is vandalism. Destruction is destruction. Whether it’s of lives or property, it’s not acceptable”, and in my view, this is the baseline of extermination. The only distinction comes when some actions are more violent and fierce than others and therefore, vandalism and destruction judgment should be different and always dependent on the case. This documentary did not change my understanding of ethics even though my comprehension of arsons is broader now.

Ed Begley Jr. stated that “I don’t understand why when we destroy something created by man we call it vandalism, but when we destroy something by nature we call it progress.” This quote sums up very well the whole ideology behind [ . . . ] ELF. Radical activists such as ELF tend to justify their actions [believing] that without illegal actions against governments and companies the life on earth ceases to exist eventually.

The ethical theory of consequentialism can be applied [...] The idea [ . . . ] is that morality is something that concerns the consequences of human action and not the actions themselves. However, [ . . . ] some actions that are made in the name of consequentialism can be very dreadful.

#### 4.2. Student 2

The film is made to create conscience about a topic that [ ... ] until today is [ ... ] very important in society. Also, it [ ... ] shows that a group with good ideas [can] be terrorists because of their unethical way of acting as well as the bad handle of the government and authorities. It shows important environmental and political issues. The message here is that ideas should be manifested but not getting into vandalism or violence, should be more peaceful otherwise, you can be harming the property and good of good people and that should not accept. Also, like the Lumberman said: "I need trees to continue with my business, I'll not go and cut every[thing] because I'll lose the business ... ". The director wants to get everybody to think about this complicated and important matter and grow an opinion about the concern of the Earth.

I didn't know anything about the ELF groups and all the movements in the United States for protecting the planet and how far it got, to violence and prisoners. [ ... ] I did not imagine that there was a group considered to be terrorists because their ways of manifestation, burning properties (according to Daniel there was never people inside). [ ... ]

The moral arguments were not that moral after all, the ELF was thinking about the wealth of the planet but forgetting the wealth of people, doing vandalism in the streets lead the citizens to feel threaten and scare. In my opinion, you cannot act with an incomplete image of all the consequences you can produce in innocent people.

Personal Comments: A few years ago, in Peru, we had a situation like the one shown in the movie, the famous movement against the mine called "Conga" that was going to destroy a lake to extract all minerals. The people of the place start manifesting that basing their arguments in the contamination of their principal source of water, this conflict got that advance and violent, some people died. I think that a country to grow it is necessary to use the natural resources, the competitive advantage, but these resources need to be used with care and responsibility, something that will not happen if the government is not strict about the laws. In the scenario of ELF, I don't agree with their way of acting towards the conflict and government, I don't think violence and vandalism can lead to good solutions that can everyone benefits. Also, I do not agree with the way of how the government acted, they just turned against the ELF group without considering the argument that there is maybe been some bad use of resources [ ... ]; many times, interests and politics lead the actions of the government. For the other side, I do agree with some of the ideals of the ELF, there is the need for a politic change, I can relate this to my country so much because we are not advanced at all in sustainability and ethics, starting for the government; corruption is the mother of failure. I do think the director achieved his goal of open the eyes of the audience and achieve to show the message completely. I learned that moral ethics can be very different for each person due to their different ways of thinking. This video, it's an example of how a conflict should not manage, both sides, the police, and the ELF; so I do think it's a good way to show the public about all the ethical issues, its really a film that I would recommend.

In terms of moral and ethical issues, we have seen many different approaches. I think is impossible to established on universal moral code of ethics because there is not a strict definition of good or wrong according to everyone thought [ ... ] In this video I think that the ethical issue [ ... ] is the abuse of power, because the government never gave ELF the opportunity to be heard and just consider them terrorists and treat them like those, being also violent. In the context of the movie, the ethical theory that it can better be applied is the consequentialist because they know that violence and vandalism are not a moral thing, but they thought that the consequences of the results would be positive, that's why ELF saw vandalism and violence as an option.

#### 4.3. Student 3

With this documentary, Marshall Curry tries to show the audience all sides of the story behind these so-called "eco-terrorist attacks". On the one side, he wants to inform the public of the background of the attacks as well as the planning that goes into them in order not to endanger any human life. On the other side, we also get insight from several people within the police and FBI as well as,

sometimes innocent, victims of the crimes. The film aims to get people talking about this issue again and in a greater scheme of things about all of mankind's interaction with Mother Nature. The viewer gets insight on both sides of the spectrum and should be able to formulate his own opinion on the issue upon viewing.

Before watching this great documentary, I must admit that I had close to no prior knowledge of the existence of the Earth Liberation Front. The issues of deforestation and a general lack of care towards the environment have been things I was familiar with, however, the extreme steps a single group of individuals would take to protect the environment and incriminate themselves while doing so were news to me. I used to be under the impression that environmentalist groups were reserved for peaceful protesting instead of such radical actions as undertaken by the ELF.

The main issue is the definition of the term "terrorists", especially when taking into consideration that no human life had been harmed during the multiple attacks, and the questioning of the effectiveness of traditional peaceful protests. The moral argument of the ELF was that peaceful protesting had been ignored and undermined by authorities for too long, so they realized to change the world, they had to change the rules first. This lets the viewer understand that these were not random acts of terrorism but rather carefully planned attacks against the system. After finishing the documentary, you can still be opposed to the group's actions, however, you cannot claim that these attacks were chaos for the sake of chaos.

I very much enjoyed the movie because of the unbiased stance it took on this issue. Marshall Curry is not trying to manipulate people. He is merely informing the public and letting them form their own opinions. I very much believe that the director got across the message of the film very well while not pushing it too directly into the faces of the audience. Is this terrorism? Can peaceful protest change anything effectively? If you ask these questions to people that saw the movie, I believe, you will get lots of different answers. As well, that is good because there is no simple answer to these problems. There are just too many factors that must be considered when it comes to the environmental challenges that this generation is faced with. When I watched the movie, I changed my opinion on these topics from minute to minute. At first, I could not believe that I have not heard of this radical and dangerous group before but after getting to know their motives and themselves I began to appreciate their courage to try and change the system we live in. In the end, I still do not think that their approach to the issue was the right one, but I am having a hard time labeling a group of people with good intentions that have not harmed a single person with their actions as "terrorists". I think this quote from the movie describes my feelings towards this issue perfectly:

"I'm okay with cutting down trees. I'm not okay with cutting them all down. The industry tends to call the environmentalists radical. The reality is that 95% of the standing native forests in the United States have been cut down. It's not radical to try and save the last 5%—what's radical is logging 95%!"

This movie is a great example of an effective way to inform the public better on important issues that have been oversimplified by mainstream media. It gives great insights on both sides of the story and is an enjoyable, yet somehow depressing, watch with friends and family that gets your brain cells working.

We can see the ethical dilemma with the emotivist actions of the ELF. In the minds of the group they acted within the means of consequentialism, meaning their actions themselves are not good but due to the consequences of there being one less "evil" company in the business, they accept them as ethically correct. Another ethical issue is the acting of the companies that were attacked. They get targeted due to their lack of corporate social responsibility and general anthropocentric way of business. Lastly, something that has shocked me very much was the abuse of human rights by the police in violently shutting down peaceful protests. These scenes might not have taken center stage in the movie, but police brutality remains a major issue during environmental protests.

#### 4.4. Student 4

Before watching the movie, I have already heard about it. When I saw that choice in the syllabus, I certainly selected that documentary. Then, just before seeing the movie, I did a quick research about *If a Tree Falls*. I collected some information about the Earth Liberation Front and Animal Liberation Front. I also read the comments from some movie critics [ . . . ] ELF was trying to make people aware of the companies, which had cut the 1000-year-old trees, destroyed the forests, nature and biological habitats of animals so ELF was protesting according to these dynamics. Without leaving any hint and evidence in their actions, they enforced the FBI. ELF [ . . . ] split people because of the lawsuits for their members. Some of the people thought that these members were terrorists and the other part of the people thought the opposite. Also [ . . . ] members of ELF who were tried and convicted by the Federal Jurisdiction (US) just like the people that were convicted for the September 11 attacks. In that period, people were intimidated by the harshest punishments by the government. Whatever the result, they raised awareness about protecting nature and taking actions against the system and it is an undeniable fact.

Earth Liberation Front and Animal Liberation Front were both in a very critical and special political point, which would make the definition of “violence” suspiciously, queried. When I learned the aims of actions and stories of activists, I can say that I have queried the definition of “violence” naturally. That is why there is a discourse of ecological terror in some capitalist countries, which think the most fundamental reason for existence is the imposition of the right of dispossession under the definition of the freedom of ownership.

I may say that we do not have a right to have all-natural and use it. We, as humans, do not have a right to destroy the habitats. Although, the law secures the opposite. By implication, this documentary is a call, which points the responsible. *If a Tree Falls* says that our world is being destroyed, that the people engaged in civil disobedience actions [ . . . ] are nam[ed] “radicals” and “terrorists”.

To sum up, *If a Tree Falls* is a masterpiece because of its special story which revolts against the human power [over] nature [ . . . ] It is crystal clear to see that there is an attack on human rights and ecological justice. The behavior of policemen to the people and the moments they lived in jail are unacceptable. The companies had destroyed the 1000-year-old trees, forests, animal life, habitats, and nature. As it has mentioned about this situation in Chapter 4 of our book, *Sustainable Business “Key Issues”*; it is stated that normally economic growth usually requires the extinction of animal life and actions in opposition to this growth by the anti-pollution activists of the Earth Liberation Front (ELF) in the US was identified as terrorism during the 1990 s. As Ed Begley Jr. has stated: I don’t understand why when we destroy something created by man we call it vandalism, but when we destroy something by nature we call it progress. It is so clear to see what has happened and how it affected the world objectively. In this case, the period that they had are worldwide events and everyone’s issue. In Chapter 2, *Environmental Challenges*, it has also been stated by Arno Naess that the world health, issues about inequalities and social justice, equitable apportioning of wealth, intergenerational justice, human rights and the obliteration of poorness are the important parts of altruistic worries; while environmental advantages and disadvantages such as describing species and habitats as “[re]sources” [are] the concerns of shallows ecology. In the second explanation, saving the beneficial regions is just for the obtaining of raw materials, farming, city parking and ecotourism. [ . . . ]

According to these definitions of ideologies, it can easily be understood that which side has adopted which view. Consequentialism can be defined as an ethical theory that is mostly taken up seriously by non-religious people and it explains the results of human activities while it gives lessons about what people should produce the hugest amount of decent results. Consequentialism [ . . . ] is the most suitable theory within the context of the documentary.

## 5. Results

In the context of Business Ethics and Sustainability, students' comments relating to normative assumptions and ethical relativity are particularly relevant. Student 1 reflected on how definitions of terrorism and radicalism are ambiguous, especially as the motives for certain actions were dictated by the belief or experience that they are more efficient in achieving certain aims than alternative actions (student 1 noted: "When ELF burned the horse slaughterhouse to the ground, the very same company was never again able to continue its business operation. Local people had tried over ten years to have a different kind of demonstrations against the company without success." Student 3 wrote about actions that occurred because of "questioning of the effectiveness of traditional peaceful protests"). This raises the question about what can be considered "effective" activism and active citizenship-how can narratives like these be used to open up discussion on the problems presented in the film and discuss how do we create change in society. Student 1 found certain perspectives presented in the film that were not voiced by the environmentalists, but by people like Bill Barton, who has been employed by the Native Forest Council as a logger (student 2 called him "the Lumberman"), quite revealing of alternative vision of what radicalism is ("Barton argues that companies, which are only thinking about the profit, which they gain for logging trees, are actually radical and not the people who are trying hard to save the last five percent of remaining trees"). Student 1 also argued that actions and motives need to be understood and judged in context ("vandalism and destructions judgment should be different and always dependent on the case"). Student 3 is also impressed by Barton's exclamation about the remaining trees: "It's not radical to try and save the last 5%—what's radical is logging 95%!"

For student 2, vandalism needs to be understood in the context of planet and people, and this student finds that the ELF went too far "thinking about the wealth of the planet but forgetting the wealth of people". In this context, terrorism – or terror, fear, is indeed related to "vandalism in the streets lead the citizens to feel threaten and scare". On the other hand, like student 1, student 2 felt that they could agree with some actions or beliefs of ELF, as "there is the need for a politic change". Student 2 also felt that the situation or moral standing needs to be seen from different sides ("I learned that moral an ethics can be very different for each person due their different ways of thinking" or "impossible to established on universal moral code of ethics because there is not a strict definition of good or wrong according to everyone"), some of the lessons of the film and the activists could be applied to his own (developing) country, as this student writes: "I can relate this to my country so much because we are not advanced at all in sustainability and ethics". It is significant to note that as discussed in the introduction, corruption and lawlessness in developing countries leads to violent deaths of many environmental protectors, as noted by the Global Witness Report (2018) [2]. Like student 1, student 2 thought that consequentialism explains, if not justifies ELF's actions: "consequentialist because they know that violence and vandalism is not a moral thing, but they thought that the consequences of the results would be positive". Similarly, student 3 notes that the ethic can be seen as both as "emotivist" and consequentialism, writing: "meaning their actions themselves are not good but due to the consequences of there being one less "evil" company in business".

Three students' in the sample understanding of environmental activism are linked with US politics and discussion of state's disputable authority on violence, while, as discussed in the introduction, environmental protest and suppression are global issues. One of the students raises a similar concern about Peru. Also, all students reflect that the issues that environmentalists confront are not specifically American, but have to do with the power of corporate or political organizations, with student 3 emphasizing the global nature of the issues in "a greater scheme of things about all of mankind's interaction with Mother Nature". Student 3 particularly emphasizing that the nature of the protest was peaceful and that the label of terrorism is questionable in this context. The same student also notes that the reaction of the police was disproportionate to the nature of government response and that one can speak of "abuse of human rights by the police in violently shutting down peaceful protests".

Student 4 also emphasizes the violation of human rights, as well as mentions ecological justice ("there is an attack on human rights and ecological justice"). A larger vision of "the system" (industrial,

controlled by powerful political and corporate interests) is emerging even in this small sample of assignments. Student four reflected that the actions of ELF and ALF were “very critical and [made a] special political point, which would make the definition of “violence” suspicious”. Student 4 also explicitly mentioned this critique about capitalist countries, “which think the most fundamental reason for existence is the imposition of the right of dispossession under the definition of the freedom of ownership”. Student 4 also demonstrates some background knowledge of the difference between shallow and deep ecology, referring to Arne Naess’ writing, that “the world health, issues about inequalities and social justice, equitable apportioning of wealth, intergenerational justice, human rights and the obliteration of poorness are the important parts of altruistic worries; while [ . . . ] describing species and habitats as “[re]sources” [are] the concerns of shallows ecology”.

## **6. Discussion**

Student views do demonstrate at least the beginning of a certain shift in consciousness, or what Molina-Motos [45] describes as a vision that questions “many of the basic pillars of the belief system that sustain the anthropocentric morality of our time”. In education, critical pedagogy and ecopedagogy could help students explore the importance of representing non-human others, as well as critically discussing the practice of democracy in its conventional form. Critical thinking and dialogue are core tenets of the approach advocated in this paper and including various perspectives are essential to eco-literacy. Educations transformations can be possible if “our foundational assumptions” based on anthropocentrism are “made explicit, interrupted, and shifted” and “we learn to think differently about our relationship to each other and the natural world” [54].

As discussed in the Introduction, in political and societal discourse this has been known to lead to opinions presented as facts and found equally legitimate, because they are democratic. Doubts about, for example, climate change science are being replaced by doubts about the motives of scientists and their political supporters [67]. In some cases, the wisdom of a true people’s democracy (if such a thing existed) can be perhaps questioned in terms of the outcomes of reliance on the rule of the majority that might be uninformed, but even more importantly, unmotivated to act to solve global environmental challenges such as climate change [64]. Also, the public’s understanding of environmental challenges often lacks complex time-scale, as global issues such as climate change, “need to be understood within time spans of some hundred years or more” [68], and thus long-term thinking is required. This long-term thinking is not guaranteed by simply assuming that democratic or plural systems will challenge short-term economic or neoliberal thinking.

One could certainly argue that without political hegemonies and economic power players that influence democratic processes, the people (collectively) will be caring and well-informed and will make the “right” (or the “good”) decisions that would profit the environment and the most vulnerable people, but the discussion of the inherent goodness and wisdom of people and their ability to rule themselves go back to the classic philosophers such as Aristotle and Plato, or more recently, Hobbes and Locke, some trusting the populace to rule themselves (to some degree), some not, and is far from being resolved. So far, no living democracies or, for that matter, autocracies, have shown much ecological wisdom, at least as far as consumption practices are concerned. Still, to recall the maxim often attributed to Churchill, democracy is the worst form of government, except for all those that have been tried before. In the context of this article, that democracy that does not persecute its citizens as radicals but is open to dialogue, allowing them to have a say in actual decision-making processes, might be the best kind. While this type of permissive democracy may indeed protect some environmentalists, however, it still might fall short of eco-representation [59].

This is especially problematic as, in the context of ecopedagogy, we can speak of environmentalists as potential revolutionary “teachers”, experts on critical thinking and forceful and active instructors [27]. In cases when all opinions are treated equally, however, the influence of corporate marketing, self-serving media, and disinterested government on shaping public opinion that climate change is a hoax [67] is under-estimated. The public might not find it important to resolve biodiversity crises because the

same media ignores the issue, or because the destruction of habitat is not seen as having a direct impact on one's purse. This shared public ignorance or compliance might easily come into conflict with any teacher who says that species extinction or climate change is real and we need to act to resolve it. In reflecting upon the controversy about shooting wolves in Canada's Yukon area, Jickling [69], employed at the time as a teacher in a local school, felt that advocating for wolf protection would be "neither practically viable nor educationally justifiable" (p. 92). Jickling mentions the fact that some of the parents of students in this community were hunters but explained his reluctance to take a pro-wolf stand, as a teacher he felt he needed to stay neutral to teach students democratic and open values and avoid indoctrination. This, we should note, is an example opposite to what ecopedagogy suggests. Ecopedagogy implies that we should be critical of claims that teaching is "neutral", as opting not to include pro-wolf arguments as Jickling does might not be an example of neutrality, but of conforming to the status quo. The documentary about radical environmentalists have shown, at least in this small sample, that students can learn about the possibility of confronting ecological injustice by critically evaluating options and limitations for legitimate and effective action.

## 7. Conclusions

Documentaries can be a useful tool to introduce activist narratives and raise the question of what can environmentalists (and animal rights activists) teach us about active citizenship. As seen in the student reflections, the documentary raises questions of what can be considered "effective" activism to create systemic change in public perception and challenge anthropocentric values. The various opinions presented in the documentary offer students an opportunity not just to demonstrate the importance of critical thinking but also to reflect on their positioning as business students, as active citizens, and as individuals with the stake in the future. As noted in the documentary, one reason for the downfall of ELF was differing ideas of how to create change and what tactics to use. George [70] proposes that for transformational change to happen, it is important to use critical dialogue to build effective alliances "that pave the way to cooperative existence," which in turn can "help us discover new possibilities for mobilization, inclusion, and justice" [70]. The reflection on the viewing of the documentary provides students with an opportunity to assess these possibilities, and make a start in the direction of evaluating how a category of "radicalism" is constructed. Despite the anthropocentric and speciesist bias of traditional critical pedagogy, it nevertheless offers useful tools worthy of consideration and serves as foundational tools for alternative approaches including ecopedagogy and critical animal pedagogy. As discussed here through the case of student assignments, while critical pedagogy and ecopedagogy promote active citizenship, and encourage students to be critical and active participants in decision-making, it also stresses knowledge and motivation. Ecopedagogy supports eco-literacy, as well as an understanding of broader social processes that are responsible for the creation of anti-environmental, economy-centered perspectives. Deep ecology and ecopedagogy demonstrate the need to reform democratic processes to include nonhuman voices and perspectives. The problematic role of language in the vilification of activists is highly pertinent today with the climate crisis, which requires urgent action and for us to question what is radical-trying to save the last tree or making a profit.

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