Article

Integrating Education for Sustainable Development Competencies in Teacher Education

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Abstract: The aim of this study is to provide a comprehensive overview of the publications focused on integrating education for sustainable development (ESD) competencies into teacher education during the last decade, in an endeavour to identify which competencies have been considered in the literature as key competencies for reorienting teacher education towards sustainability as well as explore the suggested assessment tools and approaches to integrate these competencies into teacher education programmes. The results show increased attention during the last decade to develop a set of ESD competencies for teachers, which reveals the absence of a unified framework for teacher competencies for ESD. However, the extent to which these competencies are effectively integrated into teacher education remains an undiscovered area. This paper highlights the progress and gaps in the research related to mainstreaming ESD competencies in teacher education, providing evidence from the literature that can inform policy and strategy improvement in higher education institutions.

Keywords: education for sustainable development (ESD); sustainability; competencies; teacher education; systematic literature review

1. Introduction

Education for sustainable development (ESD) has become one of the most predominant research areas since the United Nations General Assembly has proclaimed in its Resolution 57/254 the period from 2005–2014 as a UN Decade of Education for Sustainable Development, in order to emphasise the critical role of education in moving towards a more sustainable world, recalling chapter 36 of Agenda 21st, on promoting education, public awareness and training, adopted at the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil, in 1992.

ESD is defined as 'an emerging but dynamic concept that encompasses a new vision of education that seeks to empower people of all ages to assume responsibility for creating a sustainable future' [1]. Thus, the overall goal of the DESD is to integrate principles, values, and practices of sustainable development into all aspects of education and learning [2]. This does not mean merely adding some concepts to the curriculum but rather applying a holistic approach that enables transforming knowledge, skills, and attitudes towards sustainability [3].

This vision of education has been reflected explicitly in SDG4.7 of the 2030 agenda, which stated that by 2030, all learners should be empowered to "acquire knowledge and skills needed to promote sustainable development" [4]. The same aspiration is stressed in priority action three of the global action programme (GAP) 2015–2019 [5], as well as in ESD beyond 2019 framework, which reaffirmed that "building capacities of educators and trainers" remains a priority [6].

Therefore, UNESCO advocates a shift in education systems to allow for essential changes in the teaching and learning paradigm in order to facilitate the integration of ESD especially into pre-service and in-service teacher education [5], and provide learners and

educators with intrinsic opportunities to acquire necessary ESD competencies to assume their role as agents of change [7].

1.1. Key Competencies for Sustainability

Sustainable development (SD) competencies have been identified in the ESD literature as a set of knowledge, skills, and values that are fundamental to ensure students' capability to adapt to the complexity and uncertainty of sustainability issues [8].

Consequently, ESD intends to enable students and educators to acquire the necessary competencies and empower them to contribute to sustainable development [5], which means that specific competencies are required including theoretical background, methodological capabilities within a discipline or area of practice, as well as values that controlling behaviours and influence decision making [9].

There is a long-standing debate in ESD literature to identify which key competencies should be fostered and integrated into education programmes [10–14]. Evidence demonstrates that many frameworks have been suggested in the literature to clarify core competencies for ESD, as offered by Wiek et al. [15,16], Rieckmann [13], Lambrechts et al. [17], and Lozano et al. [11], as well as the significant framework of UNESCO 2017 [4] that comprehends other competencies in the literature. Table 1 consolidates sustainability competencies in the selected literature.

Table 1. Key competencies for sustainability (authors' own elaboration based on the literature).

Reference	Sustainability Competencies
[15,16]	Systems thinking competence; anticipatory competence; normative competence; strategic thinking or action-oriented competence; interpersonal competence and integrated problem-solving competence.
[13]	Systemic thinking and handling of complexity; anticipatory thinking; critical thinking; acting fairly and ecologically; cooperation in (heterogeneous) groups; participation; empathy and change of perspective; interdisciplinary work; communication and use of media; planning and realising innovative projects; evaluation; ambiguity and frustration tolerance.
[17]	Responsibility (values, ethics, reflection); emotional intelligence (transcultural understanding, empathy, solidarity, compassion); system orientation (inter-disciplinarity); future orientation; personal involvement (self-motivation, motivating others, learning); and ability to take action (participatory skills).
[18]	Work in an interdisciplinary environment; acquire interconnections, interdependence and partnerships; flexible visions, cross-cultural understanding and cooperation; participatory competence; planning and implementation; empathy, sympathy and solidarity; personal motivation and among others; and understanding competence of distinct behaviour and cultural vision.
[11]	Systems thinking; interdisciplinary work; anticipatory thinking; justice, responsibility, and ethics; critical thinking and analysis; interpersonal relations and collaboration; empathy and change of perspective; strategic action, personal involvement; tolerance for ambiguity and uncertainty.
[4]	Systems thinking competency; anticipatory competency; normative competency; strategic competency; collaboration competency; critical thinking competency; self-awareness competency; integrated problem-solving competency.

1.2. ESD-Oriented Teacher Education

While it is crucial to identify core competencies needed to enhance the capabilities of learners to act as agents of change towards sustainability [5,19,20], it is also indispensable to explore how to integrate these competencies in different educational settings [21] and how to empower educators to nurture sustainability competencies in themselves and their students as well [22].

The integration of sustainability competencies within educational programmes requires transforming teaching and learning practices [16] in order to shift from knowledge-based education to competency-based education [23,24].

From this point of view, teachers should no longer be mere transmitters of knowledge, but rather, they have to act as a catalyst for the acquisition of ESD competencies [15,16]. Therefore, the emphasis to achieve ESD goals is placed on the training of teachers [25] and urging efforts to integrate ESD in teacher education [5,7]. Nonetheless, evidence shows that prospective teachers lack the necessary competencies to incorporate ESD into their future teaching work [26,27], and the same deficit was observed within the university teachers with regard to adapting their teaching practices and content to be competence based [14,28].

Although a gradual shift has been observed in higher education institutions towards integrating sustainability into their programmes [18], to date, the extent to which these programmes are reoriented towards sustainability remains a question [10,14,19,29,30]. In addition, according to the final report of the implementation of the UN DESD, efforts to reorient teacher education towards ESD are still insufficient [2] (P.32); consequently, a comprehensive educational transformation is required in order to prepare professionals to handle sustainability challenges [6,15] and enable them to embed ESD in their teaching practices effectively [21].

The last few years have witnessed a growing attention to educators' competencies [10], and a number of competency models have been developed and tested; therefore, reviewing the literature can provide a comprehensive overview of the latest developments and/or deficiencies in the field and consequently inform decision making and planning for improvement.

To our knowledge, so far, there is no systematic literature review regarding the integration of ESD competencies in teacher education, while there are a number of previous studies that attempted to synthesise the literature on sustainability competencies in higher education in general rather than be devoted to teacher education. Mindt and Rieckmann [31] carried out a systematic literature review to explore the state of the art concerning teaching–learning approaches and methods in higher education for sustainable development (HESD) and HEE higher education for entrepreneurship.

Lozano and colleagues [11] undertook an extensive literature review that served as a basis for the formulation of twelve sustainability competencies in addition to connecting these competencies to certain pedagogical approaches in an endeavour to help educators update their courses and practices to be sustainability oriented.

Similarly, Evans [32] built on the work of Lozano et al. [11] and Wiek et al. [16] in addition to other frameworks in the field to identify a set of five competencies for the sustainability field and suggest potentially effective pedagogies for teaching them.

Additionally, Cebrian et al. [33] conducted a systematic literature review of the recent literature on sustainability competencies' assessment in higher education in order to inform the EDINSOST research project, which aims to create a unified framework and standards for mainstreaming sustainability competencies, learning processes, and assessment tools into the Spanish universities.

Finally, Pacis and Wynsberghe [21] sought to explore the benefits of key sustainability competencies for education for sustainability, through reviewing literature with a specific focus on Harold Glasser's 2018 proposal to use the tree as an analogy and metaphor for KSCs in order to inform the creation of an adaptive tool for the design of curriculum, pedagogy, practice, and assessment structures.

Against this background, the current review of literature intends to close the aforementioned research gap through providing a comprehensive overview of publications focused on integrating ESD key competencies in teacher education during the last decade.

A noticeable emphasis on sustainability competencies can be observed starting from 2011 onward; this may be attributed to the momentum imposed by the UN DESD (2005–

2014), which was about to enter its final phase. Therefore, a number of competency frameworks have been suggested.

The year 2011 witnessed the emergence of two pioneering ESD competency frameworks: namely, learning for the future competencies [34] and Wiek et al. [16], which have guided the subsequent works in the field; thus, it is permissible to say that these two leading frameworks were a significant milestone, whereby most of the works that came after these two frameworks were influenced by them in one way or another.

Accordingly, this study deals with research published from 2011 to 2021, revealing the research trends and focus as well as compiling the proposed ESD competencies for teacher education. In addition, the study sought to identify the assessment tools that have been suggested or tested as well as the propositioned approaches to integrate sustainability competencies into teacher education programmes.

It is worth mentioning that the terms sustainability and sustainable development have been used interchangeably in this study.

2. Materials and Methods

This study is based on a systematic review of literature concerning the integration of ESD competencies in teacher education. A systematic literature review can be defined as a methodology to synthesise the existing body of literature in a field [35], in order to provide a systematic, replicable, and transparent search and analysis process; it is a type of evidence synthesis for informing policy and practice in any discipline [36]. Therefore, this systematic literature review sought to synthesise the evidence with regard to integrating ESD competencies in teacher education during the last decade from 2011 until 2021.

The selection of the studies went through a systematic and transparent process in several phases; the authors established inclusion/exclusion criteria to guide the selection of articles to be included in the study in order to eliminate any potential bias in data collection.

The emphasis placed on all research articles focused on the integration of sustainability competencies into teacher education, whether through proposing a framework or developing assessment tools to examine the development of these competencies, with the aim of exploring how ESD competencies have been addressed in the literature, highlighting the research trends in this field, regardless of the geographical distribution of the articles, which, despite its importance, is not the focus of the current study, so that it can form a good basis for a comprehensive stand-alone comparative study.

More specifically, studies had to meet the following inclusion criteria to be included in the review:

■ Studies published in academic journals between 2011 and 2021.
■ Studies should be written in English.
■ Studies must present clear measures towards the integration of sustainability core competencies into teacher education rather than being general studies, thus;
■ Descriptive papers including conceptual and theoretical discussions; and attitudinal studies, technical reports, dissertations, conference proceedings, book chapters or unpublished evaluations, were excluded, as the search was limited to academic journal databases.
■ The title or the keywords should include the following: education for sustainable development (ESD) or sustainability, competencies, and teacher education or initial teacher education, or pre-service teacher training or higher education.

Therefore, the initial search was conducted through the Near East University database with the following key words: education for sustainable development or sustainability, and competences and teacher education, including all research articles published during 2011–2021 in the English language. The search yielded five hundred and thirty research articles n = 530; after duplicates were removed, the number retracted to four hundred and thirty seven articles n = 437.

Screening for the purpose of including/excluding articles was accomplished based on specific criteria through three phases (Figure 1):
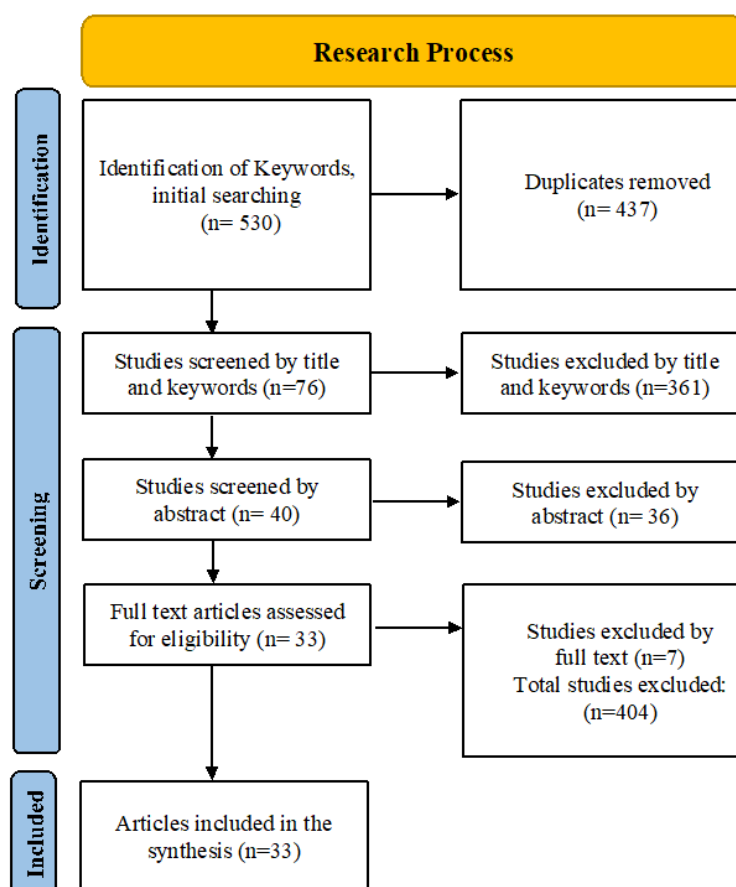
Figure 1. Diagram of the research process (authors' own construction).

Phase 1. The first phase aimed at reviewing the title and keywords in each article, as it should include the aforementioned keywords. As a result, seventy-six papers were identified. N = 76.

Phase 2. In the second phase of the screening process, abstracts of those seventy-six research articles that were identified in the first phase were reviewed, in order to determine the articles that proposed or presented a framework for ESD competencies and discussed how to operationalise ESD competencies to be integrated into teacher education. The resulting number of articles was Forty. N = 40.

Phase 3. The full text of all articles identified in the second phase was read, in order to ensure their conformity to the specified criteria, whereas articles that offered a framework or model to integrate ESD competencies in teacher education were included, while other articles that dealt with the topic theoretically (e.g., policy analysis) or analysed programmes or curriculum without any mentioning of how to mainstream these competencies into teacher education were excluded. The final output of this stage was thirty-three papers that were included in the analysis, N = 33.

However, the authors acknowledge that the inclusion/exclusion criteria entails some limitations of the study, such as excluding studies written in a language other than English, or other types of publications, such as books and conference papers. In addition, relying mainly on the Near East University database may lead to the exclusion of some research and consequently missing some data, which may has affected the results of this review.

Lastly, the data analysis includes descriptive statistics for yearly distribution of articles and the most frequent journals, in addition to thematic content analysis employing the inductive approach to analyse content, identify common themes, and interpret results, with the aim of answering the following research questions:

Q1: What are the categories of publications on ESD key competencies in teacher education from 2011 to 2021 in terms of year of publication, methodology, and purpose of the study?

Q2: What ESD key competencies in teacher education were identified in the research published from 2011 until 2021?

Q3: What are the approaches and the assessment tools that have been proposed in the research published between 2011 and 2021 to integrate and to assess ESD key competencies in teacher education?

3. Results and Discussion

This section presents and discusses the results of the systematic literature review with regard to the three research questions. First, we provide a general overview of publications focused on ESD competencies in teacher education in terms of year of publication, methodology, and purpose of the articles. Second, teachers' competencies for ESD found in the literature are outlined. Third, we introduce the proposed assessment tools to evaluate the development of students' ESD competencies, finally elaborating the suggested approaches to integrate ESD key competencies into teacher education programmes.

3.1. General Overview of Publications Focused on ESD Competencies in Teacher Education

The review reveals that thirty-three research articles were found with a focus on ESD key competencies in teacher education between the periods of 2011 and 2021.

The distribution of articles based on the year of publication (Figure 2) shows an escalation of ESD research in teacher education after 2016, which culminated in 2019 with the highest number of publications. It is worth mentioning that the GAP (global action program), which is considered as a follow up of the UNDESD aimed at urging actions towards achieving target 4.7, came to an end in 2019 [7]; therefore, it is possible that the increased concentration on EDS in teacher education is a form of response to the objectives that GAP strived to achieve.
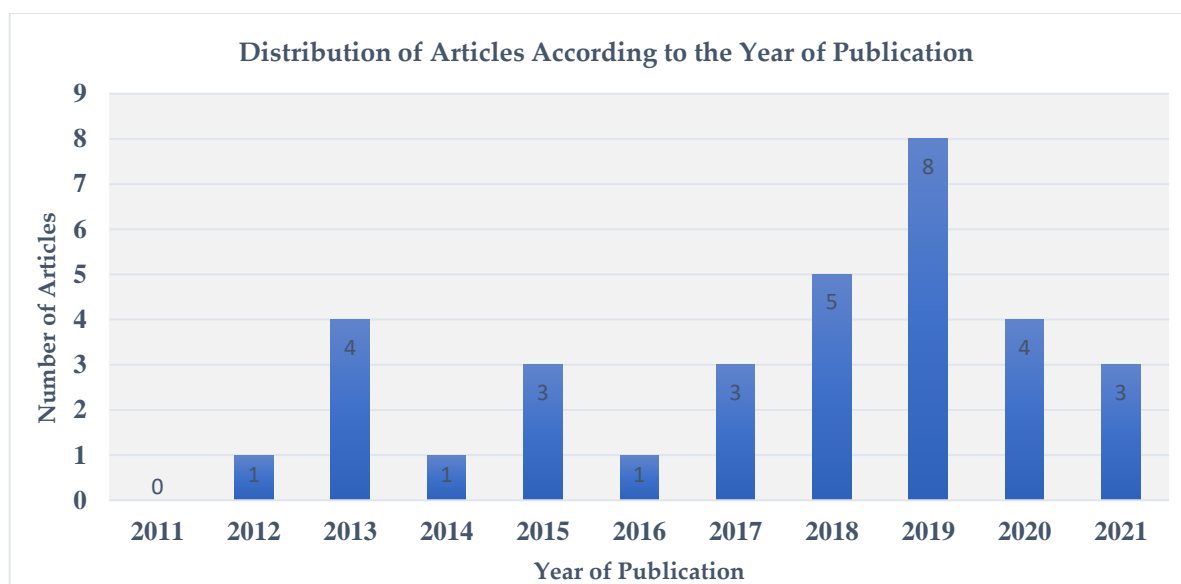
Figure 2. Distribution of research articles based on the year of publication (created by authors).

On the other hand, the limited number of publications between 2011 and 2014 corresponds to what was mentioned in the DESD final report that efforts towards reorienting teacher education are still insufficient, and it called for further focusing on ESD in teacher education [5].

Regarding the distribution of the articles by journals (Figure 3), evidence shows that the journal *Sustainability* has dominated other journals with approximately 30% of publications, which can be attributed to a number of special issues in 2019–2021 (e.g., "Competencies in Education for Sustainable Development" and "Sustainability in Teacher Education" etc). This is consistent with the findings of Avelar et al. [37], who noticed that *Sustainability* has produced the largest number of articles. The scope of the journal is cross-disciplinary environmental, cultural, economic, and social sustainability.
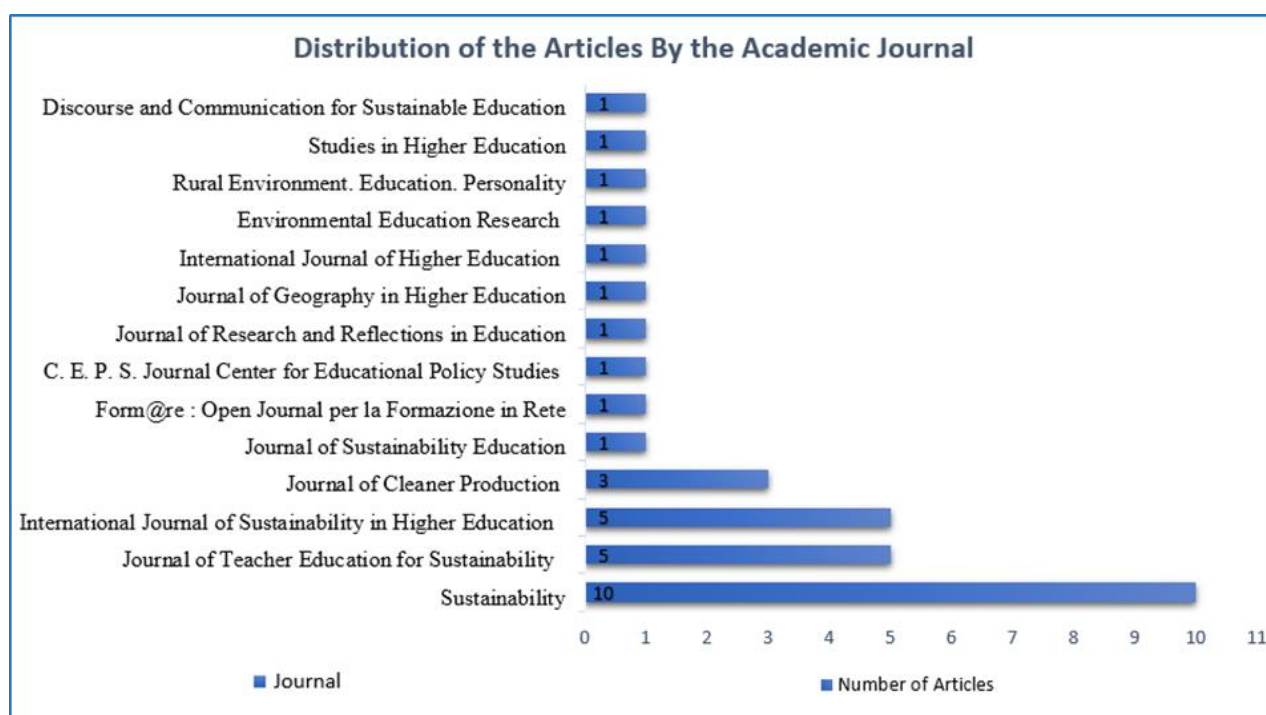

Figure 3. Distribution of articles based on the journal (created by authors).

The following highest number of publications is observed in the *Journal of Teacher Education for Sustainability* with 15% of articles; the journal focuses in general on research related to teacher education, programme evaluation, case studies of practice, action research reports, and reports on teaching practice or techniques. Likewise, the *International Journal of Sustainability in Higher Education* has a similar proportion of articles at 15%; the journal deals with a variety of topics in sustainability within a higher education context, for example, environmental management, environmental policies, curricular innovation, planning and design of campuses, staff and student initiatives.

In addition, 9% of the analysed articles have originated from the *Journal of Cleaner Production*, which attracts research in different topics relevant to sustainability, such as cleaner production and technical processes, sustainable consumption, environmental and sustainability assessment, sustainable products and services, social responsibility, education for sustainable development, and policy for sustainability. Meanwhile, the rest of the articles were scattered among diverse journals covering a wide range of subjects pertinent to sustainability: for instance, school innovation, technology in teaching and learning, special education and inclusion, lifelong learning, education policies, teaching social sciences and humanities, arts teaching, higher education and adult education, teacher education, higher education policy, social, natural and life sciences, geography learning and teaching. In conclusion, the journals generally target common sustainability topics; however, the emphasis of 47% of these journals is sustainability in higher education, including one academic journal dedicated for teacher education and sustainability, which may indicate a growing trend to focus on teacher education among other areas of higher education [33,38,39].

Additionally, looking at the methodological approaches demonstrates that different qualitative methods were applied in 52% of the articles (Figure 4); this has been indicated in other previous studies [40–43], where case studies [9,19,44], content analysis [27,45], and expertise dialogue [46] have emerged among other qualitative methods as more reliable on than other methods in studying education for sustainable development in higher education in general, and teacher education in particular, which may assert the idea that knowledge of the subject is still being constructed, and therefore, exploratory and descriptive qualitative approaches are more appropriate [47].
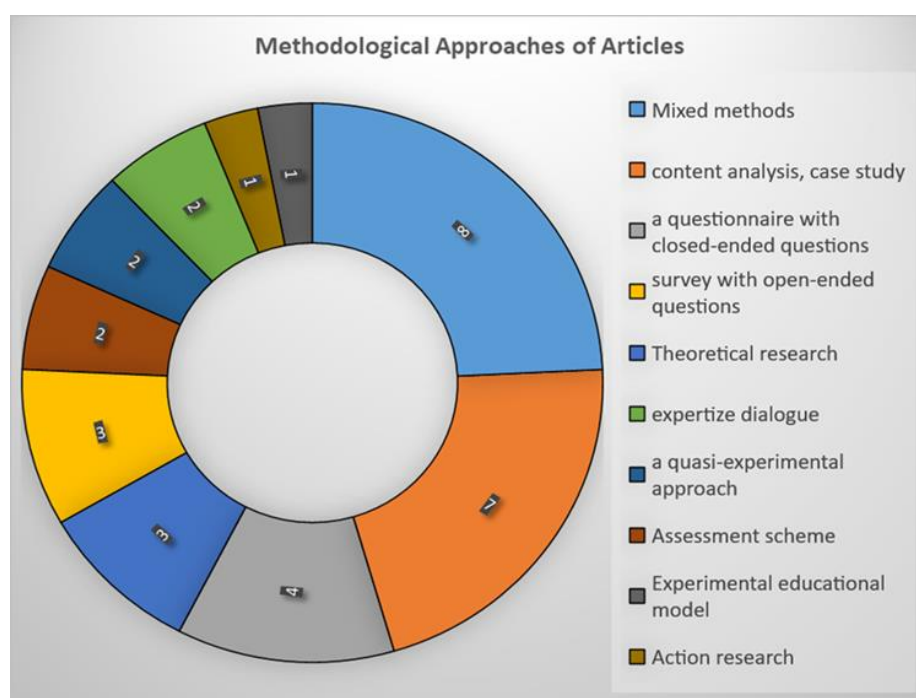
Figure 4. Methodological approaches of articles (created by authors).

On the other side of the spectrum, a remarkable tendency towards using mixed methods in sustainability research can be observed, especially those published from 2015 onwards [30,48–50].

In addition, investigating the purpose of the published articles and their contribution to the ESD research repertoire can provide evidence on the trends in ESD research and the changes in these trends over the last decade.

Analysing the objectives of the articles revealed that although most researchers highlighted the importance of integrating ESD competencies into teacher education, 36.4% of articles aimed at presenting or proposing competency frameworks, whereas nearly 24% of articles attempted to introduce an assessment tool along with the competency framework or pedagogical approaches [3,9,30,44,46,51–53], while approximately 12% presented a competency framework only without assessment tools [45,49,54,55].

Exploring perceptions on ESD competencies is another common objective in 21.2% of articles [19,41,56–60], which is in line with the notion that reflections and self-assessment are among the effective techniques for promoting the acquisition of competencies and drive to the desired change [58].

Such techniques assume that student teachers possess the competencies in ESD and they can assess their own competencies [57]; other authors argued that revealing student teachers' awareness of ESD competencies provides a strong indication of the extent to which ESD competencies are incorporated in teacher education programmes [10,19,42,56], whereas a lack of knowledge, awareness, and pedagogical knowledge on SD are perceived as a major barrier to ESD implementation [59].

Moreover, 18.2% of articles targeted the assessment of a training programme or a specific course in terms of its effect on students' competency development, e.g., [50,61], in addition to 15.2% of articles focused on studying the status of ESD in teacher education in a country [62–64], while nearly 9% of the articles reported on a research project related to mainstreaming ESD competencies in teacher education [65,66].

Furthermore, linking these objectives to the year of publication (Figure 5) highlights a remarkable shift towards focusing on the assessment of ESD competencies and connecting them to different pedagogical approaches, especially starting from 2015.

Figure 5. Connecting objectives and year of publication (created by the authors).

This is consistent with Cebrian et al. [58], who highlighted that the assessment and evaluation of sustainability competencies, skills, and outcomes have been strongly emphasised in the literature, which may be a result of the global call by the end of the UNDESD and the inception of the GAP for concentrating on the assessment of ESD in teacher education programmes in terms of their impact on student teachers' competence development, and prioritising it in research, policy, and practice [2,5,67–69].

With this in mind, it is crucial to focus on bridging the research gap in operationalising sustainability competencies [15] in order to facilitate their integration in all forms of education, and consequently enable the acquisition of these competencies as well as assessing the effectiveness of the integration.

3.2. Competencies for ESD in Teacher Education

As stated by UNESCO [2], it is a paramount to enhance the capacities of educators by mainstreaming ESD into pre-service and in-service teacher education programmes, and this remains a priority in "Education for Sustainable Development Beyond 2019", which emphasised that teacher education should offer more opportunities for educators, to strengthen their capabilities as facilitators of learning that lead to transformation [2]. This review brings to light the importance given to ESD competencies in the literature in the context of teacher education.

Dlouhá et al. [9] used the normative and transformative dimensions of UNECE [34] to analyse the UNESCO [4] competence framework in order to identify elements of the eight competencies. Meanwhile, Vare [66] reported on a small-scale action research project in the

UK called a Rounder Sense of Purpose (RSP), which built on the UNECE 2012 and other frameworks in the literature to develop a concise set of twelve competences for educators in education for sustainable development with learning outcomes spread across three dimensions (thinking holistically, envisioning change, and achieving transformation) and four degrees of engagement (Integration, involvement, practice, and reflection).

Garcia et al. [44] proposed the CESC competency framework in Education for Sustainability from the perspective of Complexity accompanied with a methodological approach to assess these competencies based on Sleurs [70] and the UNECE 2012 domains. These domains were used in the work of Biasutti et al. [48] to develop an assessment tool to evaluate the infusion of ESD principles in the curriculum as well as measuring the presence of them as general competencies in students' outcomes.

CRUE is another reference framework that consists of the core competencies in sustainability proposed and approved by the Conference of Rectors of Spanish Universities; those generic competencies formed the basis of a rubric or what was called a competency map for education degrees and postgraduate studies, which was developed within the EDINSOST research project [3]. The rubric defined three levels of competency acquisition (knows, knows how, shows and does) based on Miller's pyramid [50].

The EDINSOST competency map has been used in a number of research studies, some of them targeted at certain teaching methodologies (e.g., project-oriented learning, problem-based learning) to examine their appropriateness for enhancing students' acquisition of sustainability competencies [3,50].

Tejedor et al. [53] tried to connect each competency of CRUE sustainability with the pedagogies of the EDINSOST project as well as proposing and elaborating a didactical approach to deliver each one, while Cebrián et al. [58] developed a questionnaire through defining the different levels and units of sustainability competencies based on CRUE's sustainability competencies' framework and used it as a self-evaluation tool to identify students' perceptions of the development of sustainability competencies.

Moreover, the EDINSOST assessment scheme served as a tool to analyse the presence of sustainability in the curricula of sixteen Spanish higher education institutions [63,64].

Another leading work in the field is offered by Bertschy et al. [54], who presented an ESD-specific professional action competence model for teachers in kindergarten and primary schools [54], which distinguishes two aspects of competency that should be considered when designing teacher education programmes: knowledge and ability including content knowledge and pedagogical content knowledge; the other aspect is motivation and volition, which refers to convictions/values, motivation, and self-regulation.

Brandt et al. [30] attempted to operationalise the framework of Bertschy et al. [54] through perceiving the competencies as learning outcomes, formulating them from a pedagogical perspective as actions expected from the teacher.

The analysis demonstrated that Wiek et al. [16] is one of the most cited frameworks in the literature [47]; in addition to informing UNESCO's 2017 eight competencies for sustainable development [66], it formed the foundation for a number of subsequent frameworks [32].

Warren et al. [55] translated the general key competencies into ways of thinking that can help students think profoundly about the content from various perspectives, visualising different scenarios for the future, and analysing systems in order to strategise how to bring about change in society.

Similarly, Giangrande et al. (2019) [46] suggested a competency framework drawing on Wiek et al. [16] with the addition of seven more interpersonal competencies and proposed a purposeful process to assess these competencies through providing a variety of evaluation questions.

Bentham [45] proposed an action competence framework based on the literature and policy analysis, which was presented as a pedagogical approach that may promote ESD. The author emphasised the main elements of ESD education by breaking down the

competencies into categories: teaching and learning approaches, skills, knowledge, and values; then, they identified the themes and competencies under each category.

In addition, the KOM-BiNE competence model that was developed as part of a large-scale EU project offers a set of competencies related to individual aspects within four fields of actions: "knowing and acting", which refers to subject-matter knowledge, and methodological knowledge "know-how", in addition to "valuing and feeling", along with both externally oriented activities and more individual areas [65].

Moreover, Cebrián and Junyent [19] suggested a theoretical framework to explore the competencies that student teachers would prioritise in a school project in light of a theoretical framework of professional competencies in ESD proposed by Cebrián and Junyent 2014. The results showed a significant gap between these theoretical frameworks and student teachers' awareness, and there is a dire need for more integration of ESD competencies in teacher education.

This idea may lead many researchers to focus on how to assess the development of sustainability competencies [10]; the DAP (Dispositions, Abilities, and Behaviours) framework was developed as a guide to measure learners' sustainability competencies in higher education, where learners' dispositions refer to their sustainability competencies in "Learning to be" and "Learning to live together", and their abilities to engage with sustainability relevant to their sustainability competencies in learning to know and to do, while learners' behaviours to enhance sustainability can be connected to their sustainability competencies in "learning to transform oneself and society" [51].

Marcote et al. (2015) [71] identified five key competencies based on the literature (systems thinking, anticipatory competence, normative competence, strategic competence, interpersonal competence) and examined the impact of an experimental educational model on the development of sustainability competencies, and their findings proved that students' active participation in seeking solutions for socio-environmental problems can significantly nurture students teachers' competencies as well as fostering sustainable lifestyles.

Ghorbani et al. [49] developed a framework with fourteen professional competencies for the "learning to be" approach based on the literature and findings of the interviews with a number of experts and in-service teachers. They argued that teachers' abilities such as the ability to promote students' self-esteem, self-confidence, self-awareness, and self-belief, as well as supporting them to set valuable goals for their lives, are critical for realising UNESCO's third pillar of learning "learning to be" and should be integrated into teacher education programmes.

Table 2 combines the most common ESD competencies in the literature in the three aspects of competency: the first one is related to knowledge, whether content knowledge or pedagogical content knowledge, the second is pertaining to the core life skills, and the third aspect concerns values and behaviours, in the sense that these aspects of competency are an integral whole, where ESD knowledge forms the context and foundation of learning, while the core life skills are the means to enable converting ESD knowledge into desired behaviours and practices.

It is worth mentioning that the literature abounds with discussions about these core life skills for teachers in different contexts; they might be referred to as soft skills, which focus on the personal traits of teachers and learners and can influence their quality of teaching and student achievement [72]. Some scholars linked soft skills to the development of digital competence [73], which is fundamental to promoting lifelong learning and facilitating innovation in educational practices [74]. In summary, this systematic literature review on ESD competences in teacher education provides increased attention to develop a set of ESD competences particularly for teachers; however, it also shows the intricacy of agreeing on a unified framework for teacher competencies for ESD [10]. In addition, the extent to which these competencies are integrated in teacher education remains an undiscovered area, and further research is needed to assess the effectiveness of that integration [10,14].

Table 2. ESD competencies in teacher education (authors' own elaboration based on the literature).

Aspect	Competencies	Example Articles
Knowledge (Content and Pedagogy)	Acquiring general knowledge of the content of sustainable development and education for sustainable development	[45,57,58,64]
	Connect and contextualise society, economy, ecological environment, local, and global problems	
	Understanding interdisciplinarity and transdisciplinarity of ESD	[19,45,66]
	The ability to apply SD knowledge and develop methods for this application	[49,65]
	The ability to develop and provide efficient learning opportunities	[30,54]
Core Life Skills	Critical and creative thinking	[9,44,54]
	Systemic thinking	[45,46,66]
	Future thinking	[9,65,66]
	Work and live with complexity	[44,49]
	Interpersonal competence, communicating, and networking	[30]
	Strategic competence	[46]
	Collaboration in decision making and problem solving	[9,19]
	Self-awareness, manage emotions and concerns	[9,19,46]
Values and Behaviours	Promote sustainable use of natural resources	[50]
	Promote social tolerance and equity	[45,49,66]
	Optimism towards contributing to ESD	[54,57]
	Responsibility for environmental problems	[57]
	Acknowledgment of the importance of the idea of SD as a task for society as a whole	[54]
	Acknowledgment of the role of education as a resource for tackling of this societal task	[54]
	Normative and cultural competence	[9,46]
	Application of ethical principles related to the values of sustainability	[3,53,63]

3.3. Approaches to Integrate ESD Key Competencies into Teacher Education Programmes

The current review demonstrates that there are a number of proposed approaches to integrate ESD competencies into teacher education, which can take various forms whether interdisciplinary [57], transdisciplinary [53,60], or as cross-curricular competencies [3], through a holistic [45] and transformational education [45,46], which attests the approaches mentioned in the previous literature and by international bodies [42,75].

The most popular approach is to offer customised courses that deal with ESD content and competencies, accompanied with appropriate pedagogies [9,19,30,51,54,56,57,61].

Meanwhile, many other suggestions emphasised the notion that ESD competencies are learnable but not teachable [10,70,76], which highlights the importance of teaching methods to provide diverse learning opportunities for students to develop their competencies; consequently, engaging students teachers through innovative pedagogical approaches [58] in

an interactive and open learning environment [3,46,53] with adequate assessment methods can facilitate their acquisition of ESD competencies [49,60].

Moreover, other researchers argued that ESD competencies can serve as standards [54] for curriculum development and could be infused into the programme descriptors [19] whether as educational goals [9] or learning outcomes [48,63,64]. In addition, ESD competency can be addressed as a new indicator within the existing teacher competency model [52].

Considering these proposals in light of the purposes of the analysed articles discloses that so far, most of the attempts have taken the nature of limited research initiatives that, despite their importance, lack sustainability. Additionally, while it is heartening to see these endeavours in several universities worldwide to integrate ESD competencies into their programmes in different ways, this pinpoints the urgent need for a common framework, at least at a national level, for the integration, as well as a unified framework with specific indicators to evaluate the effectiveness of that integration.

3.4. Assessment Tools Proposed or Used to Assess Competency Development for Sustainability

The analysis shows that there are a variety of assessment instruments (Figure 6) that can be useful in assessing the development of ESD competencies within student teachers, whereas students' self-reflection is the most reliable tool; this is in congruence with the findings of some previous studies that indicated the frequent use of self-evaluation surveys compared to other assessment tools [40,77], while other authors pointed out the limited use of self-assessment tools [58].
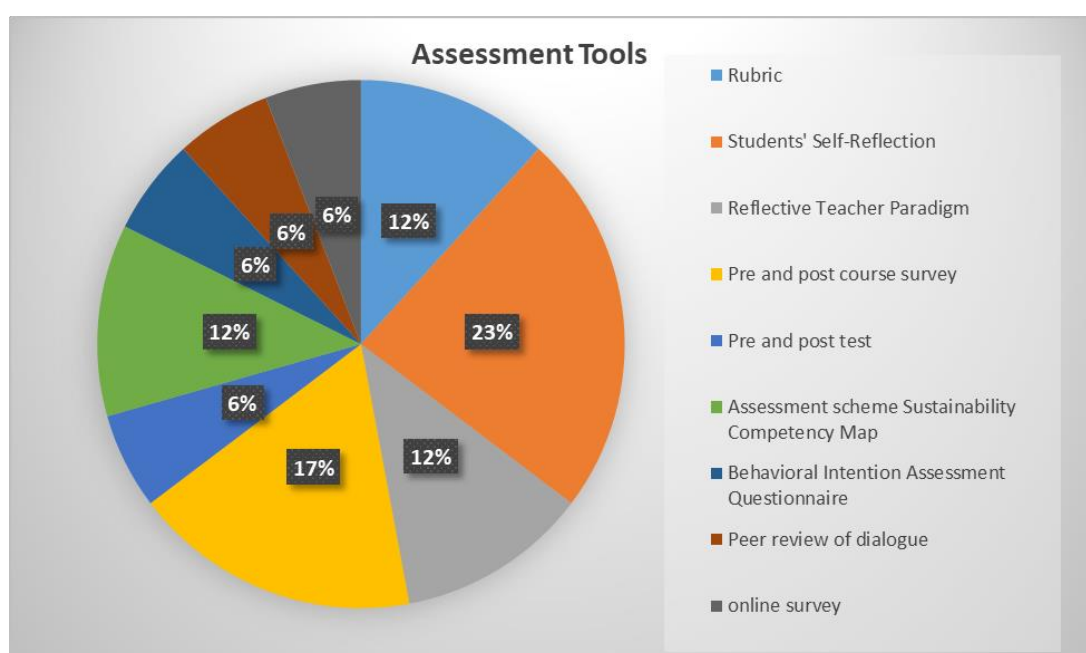
Figure 6. Assessment tools for assessing competency development (created by authors).

The next popular tool is pre/post-course survey, whilst other tools such as rubrics and a reflective teacher paradigm are introduced less frequently.

Nevertheless, all the proposed tools are presented as having the potential to enable competency assessment, which may reflect on one hand the importance given to monitoring and evaluating competence development, and on the other hand, it can be an indication of the absence of a common competency assessment framework [51], and further research is needed in this area [58,78].

4. Conclusions

This systematic literature review reveals a growing interest in the last decade towards ESD research in teacher education especially from 2016 onward; the analysis demonstrates the emergence of different research trends concerning ESD in teacher education, notably, exploring the perceptions on ESD competencies and assessing a training programme or a course as well as detecting the status of ESD in teacher education of a specific country; however, the last decade has witnessed increased attention to develop a set of ESD competencies particularly for teachers, which may indicate the complexity of agreeing on a unified framework for teacher competencies for ESD.

Moreover, a tendency can be observed especially starting from 2015 towards focusing on the assessment of ESD competencies and connecting them to different pedagogical approaches. Therefore, various assessment instruments were presented to be useful in assessing the development of ESD competencies within student teachers, which reflects on one hand the importance given for monitoring and evaluation of competency development, but on the other hand, it pinpoints the need for a common competency assessment framework. Furthermore, the emphasis was on assessing competency development at an individual level rather than examining the integration of sustainability competencies in teacher education system as a whole, whereas seeking systematic and comprehensive approaches to assess the integration of ESD competencies into teacher education is so far an unaddressed topic.

It is noticeable that qualitative methods dominated the majority of articles, indicating that knowledge about ESD and its applications in teacher education is still evolving and thus, exploratory and descriptive qualitative approaches are more appropriate. However, an increasing trend of using mixed methods can be observed in recent publications.

Although numerous approaches have been proposed in the literature to integrate ESD competencies in teacher education, the stand-alone course was the most popular approach among other approaches. Nevertheless, most attempts have taken the nature of re-search initiatives or endeavours by several universities worldwide to incorporate ESD competencies into teacher education programmes, which highlights the absence of a common framework, neither globally nor nationally, for the integration, as well as a unified framework to evaluate the effectiveness of that integration.

In conclusion, this systematic review of the literature sheds light on the progress and gaps in the research related to mainstreaming ESD competencies in teacher education, which may prompt further developments in the field and open up prospects for realising the global aspirations to reorient teacher education towards sustainability.

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