



## **Preparing pre-service teachers for integration of education for sustainable development in school: A systematic review (2013-2022)**

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### **Abstract**

Teacher education is accountable for ensuring that all students acquire the knowledge and skills required to promote sustainable development, primarily via education for sustainable development (ESD). However, most of the research on ESD in teacher education focuses on specific education courses and countries. Thus, this review systematically explores global trends in ESD research within teacher education. Based on two databases, Web of Science and Scopus, 27 publications were retrieved from 2013 to 2022 using the SLR methodology and further analysed using the PRISMA method to obtain the main themes. First, the significant findings portrayed that ESD integration does not have any boundaries between fields. Second, the evidence demonstrates that ESD is integrated using various expanding strategies and methods into teacher education across nations and programmes. Third, by understanding the existence of various variables, actions and measurements may be performed before or after the incorporation of ESD into teacher education curricula in connection to the availability of external factors that may impact ESD implementation. These three findings indicated that there are still research gaps concerning ESD in teacher education to be explored. In conclusion, this study is beneficial for practitioners in evaluating which ESD approach is currently being used and in identifying ESD-related research needs in teacher education. In order to achieve the Sustainable Development Goals (SDGs) by 2030, the enhancement of ESD in teacher training institutions might lead to a new vision of education.

**Keywords:** Education for sustainable development, pre-service teacher, sustainability, sustainable development goals, systematic literature review, teacher education

### **Introduction**

Globally, teacher education has increasingly recognised the need of responding to the world's environmental, economic, and social concerns. Teacher education is responsible for ensuring that all learners gain the information and skills necessary to support sustainable development by 2030, especially via education for sustainable development (ESD). As stated in the Education 2030 Framework for Action, teacher policies and regulations should be in place to ensure that teachers

and educators are empowered, adequately recruited and compensated, well trained, professionally qualified, motivated, and distributed equitably and efficiently across the entire educational system, as well as supported within well-resourced, efficient, and effectively governed systems (UNESCO, 2016).

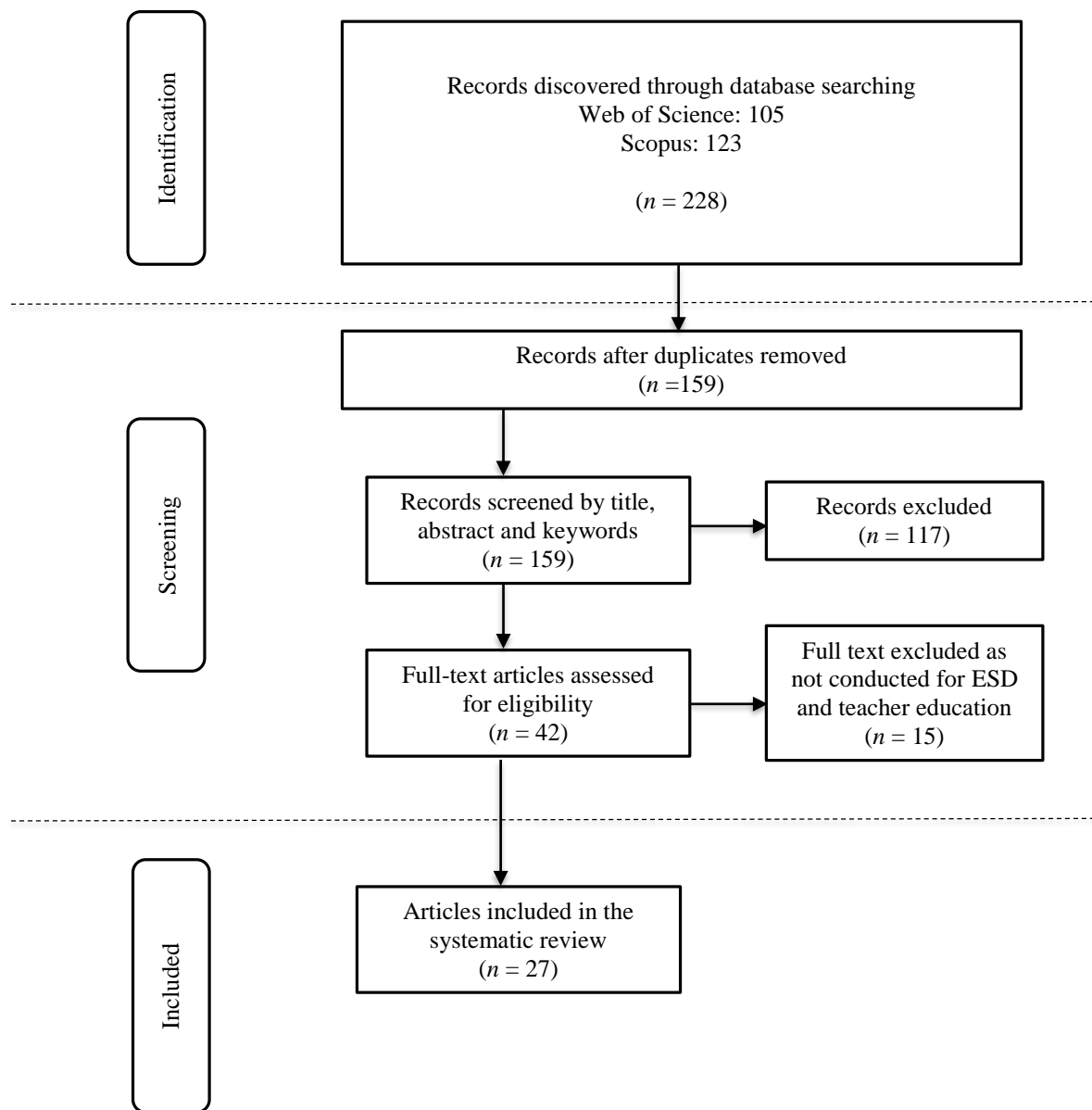
ESD is a comprehensive and transformative approach to education that takes into account learning objectives and outcomes, pedagogy, and the learning environment, therefore, accomplishes this goal by transforming society (Didham, 2018). Regardless of the specific aims, Leicht et al. (2018) mentioned that ESD has constantly been advocated as an educational approach that fosters the development of the knowledge, skills, values, and attitudes essential for the transition to a more sustainable and just society for everyone. Even though teachers' roles in inspiring change in schools and education are well recognised (Timm & Barth, 2021), survey data suggest that, while pre-service teachers perceive themselves to be competent in many elements of teacher professionalism, they are less equipped to educate for sustainability (Dahl, 2019). Along these, the survey indicates that sustainability education training for pre-service teachers is typically supplemented rather than integrated into their other preparation (Dahl, 2019).

Despite emerging trends in ESD research in teacher education, most of the findings focus on specific major education courses and specific countries, thereby leaving a gap. Nonetheless, it is unquestionably necessary to examine global trends in ESD research within teacher education. As a result, the expanding corpus of research must be addressed and brought to the community's attention as a whole. So, this systematic review will examine current research on ESD in teacher education with three main objectives.

The first objective of this study is to explore what are common fields of studies involved in preparing pre-service teachers for ESD integration. By determining the field of studies involved, future research can continue with further exploration or fill the void by extending ESD to new fields of study. Secondly, the objective is to explore the evidence available on the extent to which ESD is integrated into teacher education across countries and programmes. Some countries are already taking steps toward achieving the Sustainable Development Goals (SDGs) through teacher education, thus those efforts should be given appropriate recognition and serve as an example for other nations. The last objective is to identify what are the ESD-related variables that are most highlighted in teacher education throughout the world. This endeavour may assist future researchers in constructing a new research framework in teacher education since education has been encouraged by the SDGs to keep up with global demands (Said & Ahmad, 2021).

## **Methodology**

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) has been frequently utilized by researchers due to its comprehensiveness and applicability to diverse investigations (Rafiq et al., 2021). As indicated in Figure 1, this systematic review observes the PRISMA technique, which consists of four processes: known identification, screening, eligibility, and inclusion. As a result, the following is the systematic review process:



Source: Page et al., (2021)

**Figure 1.** PRISMA systematic review adapted.

### *Identification process*

The systematic review begins with the identification procedure as described in the PRISMA guidelines. Two databases were chosen, which are Web of Science (WoS) and Scopus to guarantee that high-impact publications are chosen. Scopus covers peer-reviewed publications in the scientific, technical, medical, and social sciences, as well as the arts and humanities, whereas the WoS covers a broad variety of academic disciplines (Hamid et al., 2017).

The keywords in the context of education for sustainable development and teacher education are included. The search string for each database is listed in Table 1.

**Table 1.** Search string listed in this study.

Database	Search string
Web of Science (WoS)	TS = (“Education for Sustainable Development *” OR “ESD” AND (“teacher education *” OR “teacher training *”) AND (“pre-service teacher* OR student teacher”))
Scopus	TITLE-ABS-KEY = (“Education for Sustainable Development *” OR “ESD” AND (“teacher education *” OR “teacher training *”) AND (“pre-service teacher* OR student teacher ”))

\*: Search String

### *Screening process*

The screening process begins when articles are identified, with the initial stage being to delete duplicates that appeared in databases. Approximately 69 duplicate articles were removed during the initial screening phase, leaving 159 appropriate for further screening. The titles, abstracts, and keywords of these 159 articles were checked to ensure they were relevant to Education for Sustainable Development (ESD) and teacher education. Further 117 publications were excluded from consideration throughout this screening process due to their lack of relevance to the study's purpose. Following exclusions, the remaining 42 publications were evaluated using the criteria for inclusion and exclusion provided in Table 2.

**Table 2.** Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Studies from 2013 until 2022 (10-year period) Journal articles	Studies executed before 2013  Book chapters, proceedings of conferences, review articles, reports
English written articles and discussing about education for sustainable development (ESD) and teacher education.	Articles are written in other languages (not English) and not discussing about education for sustainable development (ESD) and teacher education.

Finally 27 publications were selected as potentially appropriate for inclusion in this systematic review following a comprehensive selection procedure using inclusion and exclusion criteria.

### *Included articles*

This systematic review covered publications on education for sustainable development (ESD) in teacher education, with twenty papers from WoS and seven from Scopus being included. These databases were chosen for the high quality of their content, notably in the sector of education. The studies' objectives were all connected to ESD in the context of teacher education. The countries where the studies were conducted are Austria (1), Germany (2), Greece (1), India (1), Ireland (1), Italy (1), Korea (2), Malaysia (1), Norway (1), Pakistan (4), Romania (1), Slovenia (1), Slovakia (1), South Africa (1), Spain (4), Sweden (1), Thailand (1), and Turkey (2).

### *Data analysis*

All selected papers were exported to the reference management system Mendeley. Then, thematic analyses were conducted to determine the main themes in order to address the main research objectives as stated below.

RO1: What are common fields of studies involved in preparing pre-service teachers for ESD integration.

RO2: What evidence is available on the extent to which ESD is integrated into teacher education across countries and programmes.

RO3: What are the ESD-related variables that are most highlighted in teacher education throughout the world.

This review analysed the articles interpretively, categorizing the themes for the research questions. The descriptive statistic was used to analyse fields of studies involved in preparing pre-service teachers for the first research question. For the second research question, evidence that ESD is integrated into teacher education is classified into five main themes; (a) ESD module and course integration, (b) online learning, self-directed learning and reflective practice, (c) outdoor education and project-based learning, (d) course and model development and (e) case study & critical thinking. The third research question is classified into three main themes; pre-ESD experience, post-ESD experience, and external factors. Findings from the articles are discussed in the following section.

## **Results and discussion**

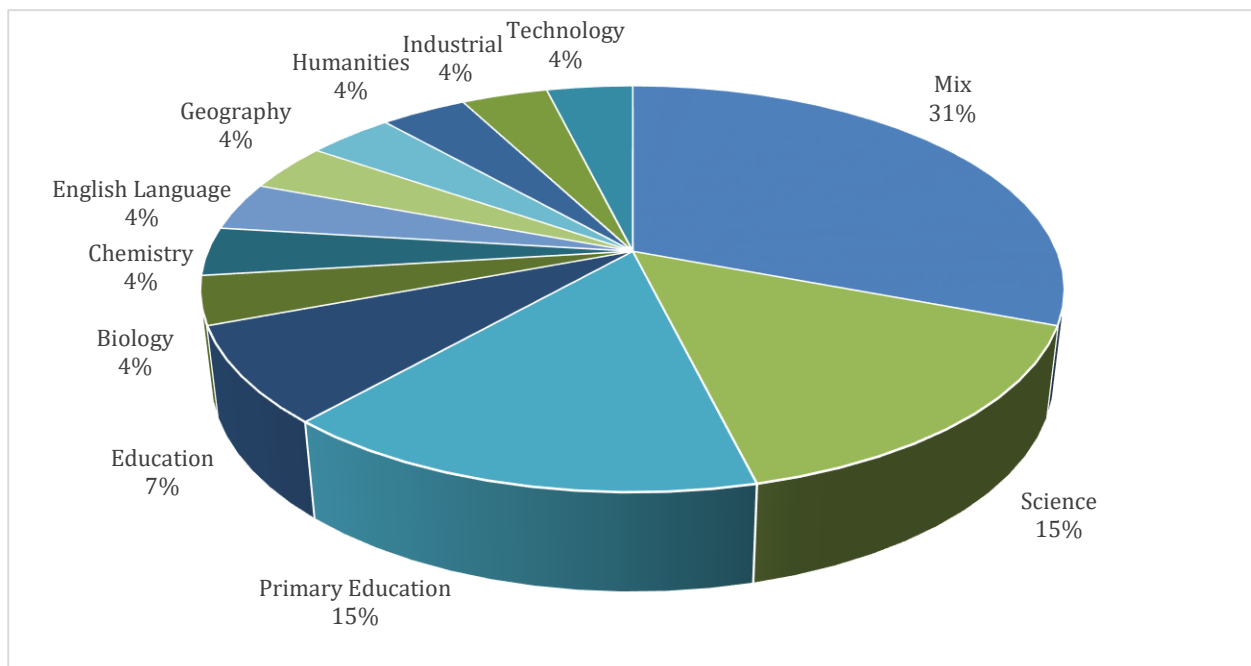
*RO1: Common fields of studies involved in preparing pre-service teachers for ESD integration*

Understanding the field of study will aid in identifying the ESD teacher education gap and main focus. A large percentage of ESD research in teacher education has been accomplished with the participation of pre-service teachers in a mixture of field studies which is 31% of the whole articles included; (Gopalakrishnan et al., 2019; Kang, 2019; Manasia et al., 2020; Avsec & Ferik Savec, 2021; Echegoyen-Sanz & Martín-Ezpeleta, 2021; Kalsoom & Qureshi, 2021; Kang, 2021, Nousheen & Kalsoom, 2022). This demonstrates that the ESD integration does not have any boundaries between fields.

In this systematic review of the literature, the science field (Ateş & Gul, 2018; Jegstad et al., 2018; Karaarslan Semiz & Teksoz, 2020; Hogan & O'Flaherty, 2021) and primary education field (Alvarez-Garcia et al., 2019; Malandrakis et al., 2019; Fuertes-Camacho et al., 2021; Rico et al., 2021) were found to be the most prevalent fields of study with 15% of percentage. Two studies recruited pre-service teachers who were education majors with a 7% of percentage (Colas-Bravo et al., 2018; Nousheen et al., 2020).

Additionally, several disciplines of the study were identified as being engaged as a single piece of ESD research within this systematic literature analysis, including Biology (Bezeljak et al., 2020), Chemistry (Burmeister & Eilks, 2013), English Language (Strakova & Cimermanova, 2018), Geography (Ammonet et al., 2022), Humanities (Kalsoom et al., 2017), Industrial Education (Sunthonkanokpong & Murphy, 2019), Technical and Vocational (Chinedu et al., 2019) and Technology (Singh-Pillay, 2020). One further study makes no explicit reference to the pre-service teachers' field of study (Andersson, 2017)

As can be seen from Figure 2, voluminous disciplines of studies have focused on the integration of ESD into teacher education on a global scale. However, agricultural, art, economics, law, sociology, and medical disciplines, to mention a few, are the gaps that ESD integration may cover. This effort is to ensure that the integration of ESD is properly supported in all school courses. Additionally, Hogan and O'Flaherty (2022) argued that ESD practitioners must be conscious of the nature and culture of the discipline area, as each discipline perpetuates a distinct culture that can have implications for the integration of ESD.



**Figure 2.** Field of studies involved in preparing pre-service teachers for ESD integration.

*RO2: Synthesis of research on evidence which ESD is integrated into teacher education across countries and programmes*

Integration of ESD into teacher education have a significant influence on the pre-service teacher's ability to function as a change agent and affect the attitudes and behaviours of future generations. This evidence-based synthesis (Table 3) discovered that several ways are being tested and implemented to develop a new generation of pre-service teachers equipped to teach ESD.

**Table 3.** Evidence which ESD is integrated into teacher education.

Author	Sample	Findings
Burmeister & Eilks (2013)	Chemistry student teachers (n = 46) in Germany.	The module was engaging, pertinent, and beneficial for their future careers as high school chemistry instructors. Additionally, they expressed a sense of increased competence in the areas of sustainability and ESD.
Andersson (2017)	Pre-service teachers (n = 323) in two different teacher education programmes in Sweden.	The ESD course has a short-term influence on pre-service teachers' ability to effectively engage students in environmental discussions without affecting their attitudes.
Jegstad et al., (2018)	Science student teachers (n = 43) and lecturers (n = 8) in Norway.	Student teachers got expertise in outdoor education and going into the unknown in a secure learning environment through outstanding teaching experiences in an outdoor setting and pupil-active teaching strategies such as inquiry learning and phenomenon-based teaching. This was linked to ESD pedagogy as well.
Strakova & Cimermanova (2018)	English Language student teachers in Slovakia (n = 48)	There is evidence that using case studies in pre-service teacher education has a beneficial effect on the development of pre-service teachers' critical thinking abilities.
Colas-Bravo et al., (2018)	Pre-service teachers of the Education Degree of the School of Education (n = 25) at the University of Macerata, Italy.	Attaining sustainable consciousness in teachers requires activating and developing higher order cognitive abilities, as well as a projective and macrostructural representation of reality.
Chinedu et al., (2019)	TVE educators (n = 11) and TVE final year students (n = 65) in Malaysia	The case study's TVE programmes do not adequately represent sustainability, limiting the program's capacity to efficiently equip teachers to carry out instructional duties that promote sustainability.
Nousheen et al., (2020)	Student teachers (n = 287) in Pakistan.	Student teachers' attitudes toward sustainable development have shifted in a good direction. This article argues for the inclusion of ESD in a variety of academic programmes, particularly teacher education programmes in Pakistan, in order to improve students' attitudes toward sustainable development.
Karaarslan Semiz & Teksoz (2020)	Pre-service elementary science teachers in Turkey (n = 8)	The participants demonstrated slow development in four systems thinking abilities: understanding the link between the past, present, and future, creating empathy for non-human beings, building a sense of place, and adopting a systems thinking viewpoint to daily life.
Manasia et al., (2020)	Undergraduate and postgraduate students from 15 faculties of the University POLITEHNICA of Bucharest, Romania. (n = 312)	The findings imply that professional knowledge, professional engagement, and self-management are critical characteristics of teachers' job preparedness. Additionally, professional knowledge has a significant

Singh-Pillay (2020)	Pre-service technology teachers (n = 54) in South Africa.	and beneficial impact on teaching practice and professional involvement. Project-based learning boosted the application of knowledge to sustainability challenges and provided experience with prejudice-busting, teamwork, understanding of their social duties to the community, and the development of skills for sustainability change agents.
Avsec & Ferik Savec (2021)	Pedagogical and non-pedagogical student teachers from the University of Ljubljana, Slovenia (n =225)	The transformational part of ESD in pre-service teachers involves consideration of critical reflection, self-awareness, risk tolerance, a holistic perspective and an openness to variety, as well as social support. Additionally, it was shown that self-directed learning acts as a moderator of transformational learning in pre-service science teachers.
Rico et al., (2021)	Pre-service primary teachers (n = 24) in Spain.	Students gained knowledge about a STEM subject in an environment and setting conducive to ESD, and some misunderstandings were uncovered. Additionally, following implementation, students' attitudes about the subject of study, as well as their self-efficacy and perceived importance of ESD, increased.
Fuertes-Camacho et al., (2021)	Primary education student teachers (n = 924) and in-service primary teachers (n = 88) in Spain	ESD demands the use of participatory approaches that inspire and empower students to alter their behaviours. Reflective practice must be supplemented with communication and monitoring systems that foster confidence and a desire for improvement.
Kalsoom & Qureshi (2021)	Final year pre-service teachers. (n = 44) in Pakistan.	There is a need for independent ESD courses to be included in teacher training programmes to equip pre-service teachers to be ESD educators.
Hogan & O'Flaherty (2021)	Lecturers (n = 9), teaching assistants (n = 2), science education pre-service teachers (n = 21) in Ireland.	In science education, there is a strong connection between science and society, as well as a requirement for learners to acquire critical scientific literacy that enables them to navigate effectively through the numerous views provided in the media and public discussions on sustainability concerns.
Echegoyen-Sanz & Martín-Ezpeleta (2021) Nousheen & Kalsoom (2022)	Pre-service primary education and early childhood education teachers (n = 188) in Spain. Pre-service teachers studying a course namely ESD in a public sector university in Pakistan. (n = 49)	Ecofeminism is a thematic node that connects fundamental concepts and attitudes in order to promote the ESD aim. In online educational environments, sustainable pedagogies increased pre-service teachers' awareness of sustainability.



The evidence supporting ESD integration in teacher education will be classified into multiple categories to facilitate discussion.

#### a. ESD module and course integration

In certain countries, such as Sweden (Andersson, 2017) and Pakistan (Nousheen et al., 2020), ESD courses are already available. According to Andersson (2017), a five-week ESD course was grounded on the pluralistic tradition of framing environmental challenges as complex moral and political problems. Meanwhile, Pakistani student teachers are enrolled in a sixteen-week course that covers a range of subjects, concerns, trends, and issues relating to ESD which is explored through course materials, assignments, presentations, and projects (Nousheen et al., 2020). Spain's ESD research (Rico et al., 2021) demonstrates a distinction by adjusting and merging the syllabus of two independent courses, the teaching-learning sequence (TLS) to take a step toward cross-curricular integration of ESD and STEM education. Hogan and O'Flaherty's study in Ireland (2021) took a similar approach, by attempting to examine the nature of science as an academic area and its capacity for incorporating ESD. Apart from science, Kalsoom and Qureshi (2021) explore the impact of adding ESD into an existing 11–13-week Research Methods in Education programme. Simultaneously, a study conducted in Sweden (Echegoyen-Sanz & Martn-Ezpeleta, 2021) used the ecofeminism concept and it succeeded to influence pre-service teachers' environmental views and increasing their ability to design their own teaching materials. However, Chinedu et al. (2019) discovered that TVE programmes in Malaysia do not adequately represent sustainability since educators and students of TVE programmes believe the programmes do not adequately train pre-service teachers for sustainability. This issue must be addressed in future research so that TVE programmes can contribute to the achievement of the SDGs.

#### b. Online learning, self-directed learning and reflective practice

The most recent strategy, as described in Nousheen and Kalsoom (2022), sustainability pedagogies such as case studies, critical events, conversations, debates, and problem-based learning may all be taught effectively online. Other than online learning, Avsec and Ferik Savec (2021) noted that technology-enhanced self-directed learning was identified as a mediator of transformational learning among pre-service science teachers in order to improve the idea and practice of teacher ESD. Fuertes-Camacho et al. (2021) use the Reflective Practice Questionnaire to involve future teachers in reflective and critical thinking in order to prepare them for sustainability competencies. As Buckler and Creech (2014) state, competencies cannot be taught but must be learned by action, based on experience and reflection.

#### c. Outdoor education and project-based learning

In the instance of the Norwegian institution for teacher education, ESD is promoted via a residential field course situated in a mountainous region (Jegstad et al., 2018). Through the outdoor ESD training, the pre-service teachers of Karaarslan Semiz and Teksek (2020) enhanced their systems thinking skills. Singh-Pillay (2020) investigated pre-service technology teacher experiences of project-based learning as pedagogy while learning about ESD and found that the method has facilitated a change in the perception and behaviour of pre-service teachers regarding

sustainability issues, critical citizenship, and their role as future teachers. Intriguingly, it is yet unknown how ESD may be implemented into agricultural education.

#### d. Course and model development

Burmeister and Eilks (2013) develop a six-week course module with one ninety-minute session each week. The module's material proved beneficial in providing prospective teachers with ideas and pedagogies and familiarising them with sustainability challenges. While Manasia et al. (2020) suggest that the model used to assess pre-service teachers' job preparation may also be used to assess their preparedness to integrate ESD concepts into STEM teaching and learning activities. The findings' immediate relevance and application should motivate more policymakers, school leaders, and practitioners working in the field of teacher education to embrace and adapt the technique globally.

#### e. Case study and critical thinking

Strakova and Cimermanova's (2018) investigate the possibility of boosting pre-service teacher preparation in critical thinking by employing case study analysis. They believe that higher-order thinking skills are essential for teachers who must evaluate the consequences of their everyday decisions and actions while addressing ad hoc circumstances. In addition, an e-portfolio tends to be a tool that encourages reflection and critical thinking, which are essential skills for ESD awareness growth (Colas-Bravo et al., 2018).

The current evidence demonstrates how ESD is integrated into teacher education across nations and programmes and may assist researchers and educators to develop strategies for enhancing ESD instruction for pre-service teachers during their training. Moreover, ESD initiatives are not only implemented via theoretical input but also through practical application, which increases their effectiveness (Mahat et al., 2016). Didham (2018) further remarked that assuring curricular flexibility enables additional possibilities to connect teaching and learning to real-world concerns, enhances the practical relevance of learning, and boosts the success of ESD implementation with stakeholder participation. ESD in teacher education initiatives also contributes to a reorientation toward high-quality teacher education (Bourn et al., 2017).

#### *RO3: Synthesis of research on ESD-related variables that are most highlighted in teacher education*

The synthesis of ESD-related variables (Table 4) that are most prominent in teacher education may assist future researchers to generate ideas and advancing the existing body of knowledge.

**Table 4.** ESD-Related variables that are most highlighted in teacher education.

Variables	Author & Year
Sustainability Consciousness	(Kalsoom et al., 2017), (Colas-Bravo et al., 2018), (Nousheen & Kalsoom, 2022)
Views/understanding/beliefs of ESD	(Andersson, 2017), (Bezjeljak et al., 2020), (Ateş & Gul, 2018)
Sustainability awareness/attitudes/actions	(Sunthonkanokpong & Murphy, 2019), (Nousheen et al., 2020), (Echegoyen-Sanz & Martín-Ezpeleta, 2021)

Personal pedagogical knowledge/teachers' agency/professional competencies thinking skill	(Gopalakrishnan et al., 2019), (Kalsoom & Qureshi, 2021), (Ammoneit et al., 2022) (Strakova & Cimermanova, 2018), (Semiz & Teksoz, 2020)
Experiences with technology-enhanced transformative learning/experiences of project based learning	(Avsec & Ferik Savec, 2021), (Singh-Pillay, 2020)
Self-efficacy	(Malandrakis et al., 2019)
Teaching readiness	(Manasia et al., 2020)
Intention to implement ESD	(Kang, 2021)
Other: Gender, the students' habitual place of residence, the type of leisure activities, educational factors, barrier, social media usage, subject discipline	(Alvarez-Garcia et al., 2019), (Kang, 2019), (Gopalakrishnan et al., 2019)

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To aid discussion, variables may be split into three categories: pre-ESD experience, post-ESD experience, and external factors.

#### a. Pre-ESD experience

The sustainability consciousness research by Kalsoom et al. (2017) evaluates the sustainability awareness of preservice teachers in their final year when ESD is absent from teacher education. Preservice teachers in Pakistan may have the opportunity to learn about sustainability challenges and build pro-sustainable attitudes and behaviours, according to the findings of this baseline research. Therefore, the study's findings might potentially be utilised by the nation's education policymakers in the development of ESD-based education policies. Colas-Bravo et al. (2018) offer a classification approach to extract categories of consciousness and determine the degrees of consciousness of preservice teachers. Given that the purpose of ESD is to reorient education and learning so that all people may contribute to sustainable development, it is crucial to understand how to attain a level of consciousness that enables involvement in the achievement of sustainable development.

Additionally, Bezeljak et al. (2020) sought to determine pre-service teachers' knowledge and comprehension of SD and ESD. The results are consistent with prior findings that teachers lack knowledge of the interrelationships between various sustainability dimensions. The curriculum design would benefit from an interdisciplinary approach because SD and ESD are cross-curricular themes that should be covered in the natural sciences, social sciences, and humanities. The researchers conclude that all disciplines should bring diverse viewpoints to learning about and for the SDGs. Accordingly, Ates and Gul (2018) focused their research on the beliefs of pre-service science teachers regarding ESD and sustainable behaviours. Since it was found that the relationship between teachers' beliefs and behaviours is moderate, future scholars should investigate the cultural, social, cognitive, and psychological elements influencing sustainable behaviour.

Another fascinating area of study is the variable of self-efficacy in ESD teacher training programmes (Malandrakis et al., 2019). Therefore, the researchers proposed that for ESD teachers and pre-service teachers to be effective, they must develop the ability to integrate knowledge and approaches from various disciplines. Furthermore, they must critically analyse the essence of various social-environmental concepts and processes in order to comprehend the root causes of sustainability issues and recognise alternative practices. Moreover, the teaching readiness variable

is chosen as a focus on ESD (Manasia et al., 2020). Consequently, professional knowledge and practice, professional engagement, and self-management might be seen as major aspects of teachers' job readiness, with each comprising several subcomponents.

Kang (2021) explored the intention to implement ESD among pre-service teachers. In order for pre-service teachers to build favourable attitudes about ESD and increase their self-efficacy in student engagement and instruction within the framework of ESD, he advised that teacher education institutes should integrate ESD-related topics into their curricula. Aside from this, pre-service geography teachers rated themselves as acquiring a high level of ESD competence (Ammonet et al., 2022). Even so, it has been argued that pre-service teachers overestimate their abilities at the start of their school practicum and their progress during the practicum. According to this theory, the study's competency evaluation may reflect the pre-service teachers' idealised self-concept.

The study by Sunthonkanokpong and Murphy (2019) identifies pre-service teachers' overall sustainability awareness, attitudes and actions while seeking the influence of their program year and type. However, the survey could not identify factors that influence students' levels of awareness, attitudes, and behaviours thus leaving a gap for future research.

#### b. Post-ESD experience

Based on the findings of Nousheen and Kalsoom (2022), sustainability consciousness variables may also be included in the post ESD category. The research outcome was measured in terms of a change in the sustainability consciousness of pre-service teachers after the experimental group experienced ESD-pedagogies in online teaching-learning settings and the control group was taught using a lecture-based method. According to the findings of this study, sustainability pedagogies are also effective in online educational contexts. However, the current study makes no claims regarding the superiority of one pedagogical method over others; rather, it recommends the use of many sustainability pedagogies in online educational situations.

The paper by Andersson (2017) analyses the impact of ESD on pre-service teachers' perspectives on how to teach students about sustainable development. This study found that pre-service teachers' ideas of how to teach SD topics might be influenced by their educational accomplishments. Other than that, Nousheen et al. (2020) investigated the influence of an ESD course on the attitudes of student teachers toward sustainable development and discovered that as a result of the participants' increased awareness, they reported more sustainable attitudes. Similarly, a comprehensive educational intervention centred on the ecofeminist movement is outlined, and its effect on the sustainability attitudes of pre-service teachers is evaluated (Echegoyen-Sanz & Martín-Ezpeleta, 2021). Overall, there is a need to train teachers from a broad perspective, with assignments tailored to enhance their creativity and ability to combine diverse competencies around ESD topics.

Furthermore, Kalsoom and Qureshi (2020) explore the effect of incorporating ESD into an existing course on pre-service teachers' agency to serve as ESD educators in schools. In order to empower pre-service teachers as ESD educators, contrary, the findings suggest that ESD-specific courses must be included in teacher training programmes. Intriguingly, the researchers investigate the development of pre-service science teachers' systems-thinking skills via outdoor ESD training (Semiz & Teksoz, 2020). Admittedly, future research must test the hierarchical level among the twelve systems thinking skills and examine each ability in a variety of scenarios.

### c. External factors

The Gopalakrishnan et al. (2019) study intends to investigate pre-service teachers' personal pedagogical knowledge in the context of ESD based on their social media usage and subject discipline. As matter of fact, pre-service teachers should have been exposed to the knowledge creation process facilitated by social media, and they should have been taught arts/humanities either directly or in an integrative manner. In a different scenario, Strakova and Cimermanova (2018) studied the possibilities of enhancing the problem-solving abilities of a group of student teachers in their training through the use of critical thinking. It may be inferred that teachers should not be presumed to possess the requisite competencies for sustainable development. Otherwise, teacher education institutions must integrate ESD-focused training into the entirety of the teacher programme to ensure that teachers leave their initial training well-equipped to support the SDGs.

Avsec and Ferk Savec (2021) observe technology-enhanced self-directed learning experiences to develop the idea and practice of ESD among pre-service teachers. Findings show that enhancing the transformational part of ESD in pre-service teachers necessitates a focus on critical reflection, self-awareness, risk propensity, a holistic perspective and openness to variety, and social support. Likewise, Singh-Pillay (2020) evaluated the experiences of pre-service technology teachers using project-based learning as pedagogy while studying ESD. The findings demonstrated that project-based learning boosted the application of knowledge to sustainability issues. Therefore, technology-enhanced self-directed learning and project-based learning have significance for the methodology used to include ESD into the curriculum and challenge social-cultural prejudices.

Additionally, variables such as gender, habitual area of residence, leisure activities, and a number of educational criteria had a substantial effect on the development of ESD competences (Alvarez-Garcia et al., 2019). Meanwhile, Kang (2019) identified four categories of variables that impede ESD implementation; the few barrier, the individual barrier, the combination of individual and class-driven structural barrier, and the combination of individual and structural barrier. In summary, institutes of teacher education should develop study programmes that are more grounded in reality and the demands of an environmentally conscious society.

By understanding the existence of various variables, actions and measurements may be performed before or after the incorporation of ESD into teacher education curricula in connection to the availability of external factors that may impact ESD implementation.

## Conclusion

In conclusion, this systematic review has reviewed the latest papers related to ESD in teacher education. The main findings highlight the answers to three research question as follow; common fields of studies involved in preparing pre-service teachers for ESD integration, the evidence available on the extent to which ESD is integrated into teacher education across countries and programmes and the ESD-related variables that are most highlighted in teacher education throughout the world.

Notably, multiple disciplines of research have focused on the worldwide integration of ESD into teacher education. This endeavour is intended to guarantee that the integration of ESD is supported adequately in all educational curricula. The majority of research is undertaken in interdisciplinary fields, followed by science and primary education. The domains of the study

reveal a research gap in the field of ESD in teacher education and are beneficial to other disciplines of research.

The evidence supporting ESD integration in teacher education is classified into multiple themes; (a) ESD module and course integration, (b) online learning, self-directed learning and reflective practice, (c) outdoor education and project-based learning, (d) course and model development and (e) case study & critical thinking. There are no precise strategies to properly incorporate ESD, and the approach remains explorable depending on the scenario and learning environment.

The synthesis of ESD-related variables that are most prominent in teacher education is split into three themes; pre-ESD experience, post-ESD experience, and external factors. Before or after the introduction of ESD into the teacher education curriculum, action and measurement may be performed with regard to the availability of external elements that may impact how ESD is embraced.

Lastly, teachers have the ability to assist students in acquiring the information, skills, attitudes, and behaviours necessary to confront global issues and contribute to the development of a more equitable, peaceful, and sustainable world (UNESCO & Education International, 2021). There is no doubt that investment in ESD within teacher education would facilitate the achievement of the Sustainable Development Goals by 2030.

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