Innovative Higher Education for Sustainable Development: A Literature Review

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Abstract. The objective of this study is to identify challenges in implementing education for sustainable development (ESD) into higher education institutions (HEIs). We introduced innovative pedagogies utilizing educational technology as a solution to promote ESD. We conducted an extensive literature review and keyword analysis on the topic. According to PRISMA protocol, the search yielded a total 367 articles and with a set of inclusion/exclusion criteria, 30 articles were selected for the further analysis. The keyword analysis was conducted to explore the main clusters in the selected articles using VOSviewer software. As a result, we identified three main clusters: 1) current challenges on ESD implementation, 2) implications of ESD in higher education curriculum, and 3) innovative pedagogical strategies for ESD. The result shows that in implementing ESD, the challenges are mainly related to the lack of framework for measuring competencies and systematically designing teacher training on the necessary ESD competencies. The findings also imply that the effective use of Information and Communications Technology (ICT) has a great potential to enhance teachers' technological and pedagogical expertise for ESD teaching and learning.

Keywords: Innovative pedagogy · ICT · Higher education · Education for Sustainable Development

1 Introduction

Humanity faces multiple crises, including the COVID-19 pandemic, social inequality, and climate changes with more frequent extreme weathers such as heatwaves, floods, droughts, and wildfires [1–3]. A comprehensive societal transformation towards a sustainable society through education is one of the keys to empower individuals to become a change agent towards sustainable development [4]. Such systematic transformation requires people from all walks of life to build their knowledge and skills to be part of the changes and solutions.

In this regard, integrating and implementing education for sustainable development (ESD) into all education levels has been recognized as a key enabler of sustainable development [5]. Indeed, the 17 Sustainable Development Goals (SDGs) has a dedicated goal for quality education, namely SDG4 or Education 2030 Agenda. Under the SDG4,

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one target (Target 4.7) specifically addresses ESD and related approaches, aiming to "ensure that all learners acquire knowledge and skills needed to promote sustainable development" [5].

It should be noted that across numerous ESD global frameworks, teachers have been identified as an important agent for empowering the next generation for sustainable development. As such, building capacities of educators and trainers are one of the five priority action areas for ESD by UNESCO [4, 6]. It is therefore evident that teachers should be supported to be able to apply different innovative pedagogies for ESD to ensure that students are learning to act for our planet and becoming change agents for social transformation towards SD [7].

Despite the important roles that teachers play in ESD, there is a lack of studies on what has worked and what has not worked in successful ESD implementation and integration. A systematic review is needed to fill this knowledge gap.

The previous studies that can shed light on that higher education educators often felt that they were not well prepared and lack of knowledge and competencies hindered them from integrating sustainability-related topics into their teaching [8–10]. This is consistent with recent research findings that the development of competencies related to sustainability is a challenge in higher education institutions (HEIs) where future teachers are trained and qualified [11].

The current study aims to conduct a systematic review on the ESD implementation and challenges at HEIs in the academic literature. To achieve this aim 1) to explore the current state of studies related to ESD implementation in HEIs, 2) to identify main clusters of studies and their interrelationships among key concepts. As our aim is to identify implications and challenges on ESD implementation in HEIs, academic papers were selected as the relevant sources for the review. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol is applied to conduct a comprehensive search over literature databases [12].

2 Methodology

To identify issues in the existing literature the PRISMA protocol was employed, where the specific methods for scoping literature review consist of following four steps: 1) identification, 2) screening; 3) eligibility and 3) inclusion (Fig. 1). The current reviews were only limited to academic and peer-reviewed papers.

Step 1: Identification - The academic papers were searched broadly in the following four major databases: Education Resources Information Centre (ERIC), Science Direct, Scopus, and Google scholar in a year range from 2015 to 2021. The query consists of relevant keywords ((implications OR challenges) AND (education for sustainable development OR ESD) AND "innovative pedagogy" OR "ICT") included in the title or abstract. This initial query search yielded a total of 367 articles (ERIC n = 27, Scopus n = 245, SD n = 15, Google scholar n = 80).

Step 2: Screening - In this phase, a numerous duplicated papers were removed. After removing 57 duplicated papers the results went down to 310. Then the titles and abstracts were reviewed considering the relevance to the research scope. And after the title and abstract screening 249 articles were excluded from further analysis.

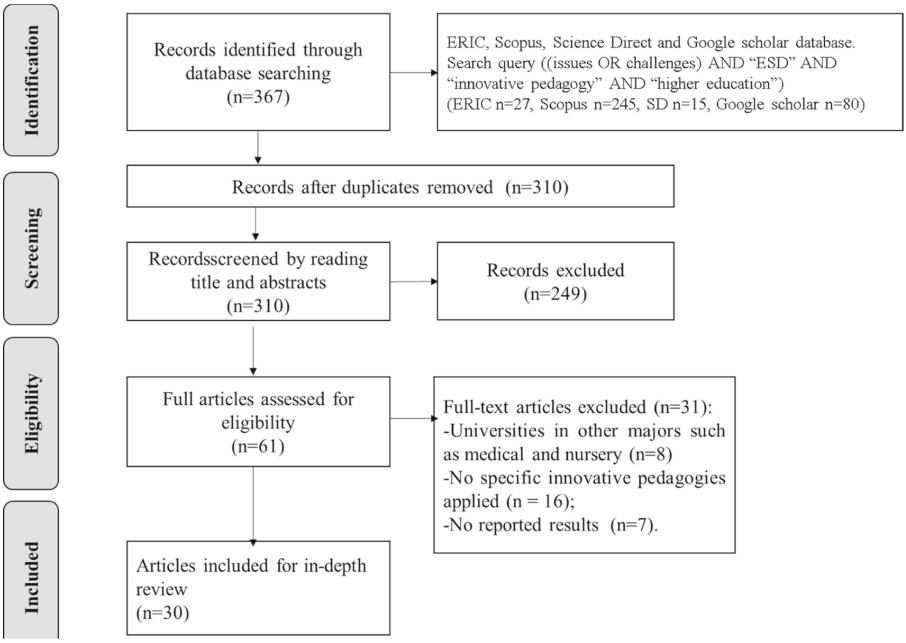

Fig. 1. The flow of the Study

Table 1. Inclusion and Exclusion criteria of the review

Inclusion	Exclusion
Must report ESD implementation at higher education institutions	Non-formal education or K12 education
Must report the intervention of innovative pedagogy on ESD implementation	Not mention about ESD implementation or intervention
Must target university teachers, students, as well as pre-service teachers at HEIs	Other than university teachers, students, and pre-service teachers at HEIs
Must be open access for full text	Book chapter or conference paper
Must be conducted in English and	Articles in other languages

Step 3: Eligibility – The papers were efficiently excluded which did not meet the inclusion and exclusion criteria by reading title and abstracts. Table 1 shows the inclusion and exclusion criteria of the review.ESD implementation at higher education institutions.

After this eligibility phase, 30 publications were deemed eligible for in-depth analysis, and the whole screening finished in end of December 2021. Figure 1 shows the flow of searching and screening articles, the number of articles we have identified, and reasons for inclusions and exclusions.

Step 4: Inclusion – Among the selected main articles on ESD implementation, and the integration of ICT in teaching and learning with sustainable development at HEIs, eight articles are qualitative studies such as case studies or evaluation studies; five articles are empirical or quantitative studies; ten articles are a review of literature of the research topic; and seven articles are mixed-method studies. And the majority of the studies were found in the sustainability related journal (16/30).

3 Data Analysis

Table 2 shows the main 30 articles that were selected for further review. These selected articles were from 16 countries, mainly from Western Europe, led by Spain (9/30) and

Table 2. Main 30 articles found and reviewed on the three clusters (2015–2021)

#	Ref.	Country	Cluster
1	Marouli (2021)	Greece	2
2	Stössel et al., (2021)	Germany	1
3	Glavič (2020)	Slovenia	2
4	Schina et al., (2020)	Spain	2
5	Portuguez Castro and Gómez Zermeño, (2020)	Mexico	2
6	Valderrama-Hernández et al., (2020)	Spain	3
7	González-Zamar et al., (2020)	Spain	3
8	Hajdukiewicz and Pera, (2020)	Poland	2
9	Waltner et al., (2020)	Germany	1
10	Holst et al., (2020)	Germany	1
11	Fuertes-Camacho et al., (2019)	Spain	3
12	Kioupi and Voulvoulis, (2019)	UK	1
13	Alonso-García et al., (2019)	Spain	2
14	Leal Filho et al., (2019)	UK	1
15	Zamora-Polo et al., (2019)	Spain	1
16	Kang (2019)	South Korea	1
17	Competente (2019)	Philippines	1
18	Abad-Segura et al., (2020)	Spain	2
19	Waltner et al., (2018)	Germany	1
20	Leal Filho et al., (2018)	8 countries	1
21	Daniela et al., 2018)	38 countries (Latvia)	2
22	Aleixo et al., (2018)	Portugal	1
23	Joyce (2018)	UK	2
24	Bürgener and Barth, (2018)	Germany	3
25	Evans et al., (2017)	Australia	1
26	Lozano et al., (2017)	Sweden	3
27	Mochizuki (2016)	India	3
28	Wiek et al., (2015)	UK	3
29	Azeiteiro et al., (2015)	Portugal	2
30	Álvarez-García et al., (2015)	Spain	1

followed by Germany (5/30). Other articles come from European (11/30) and Asian (3/30) countries, as well as Oceania (2/30).

To identify the major themes in this body of literature, a comma-separated values (CSV) file containing the abstracts of all 30 articles was created. The CSV file was then uploaded to VOSviewer software to perform an analysis of the abstracts to map the major research clusters and visualize their relations among the keywords. Through this process, 937 different keywords were found and analyzed and the keyword clusters were generated.

4 Results and Discussion

Figure 2 illustrates main three clusters of studies on implementing ESD in higher education. The first cluster, shown in blue, has "implementation" as its central node. The second cluster, marked in red, has "information and communication technology" as the keyword with the highest centrality. The third cluster, shown in green, is led by "higher education institutions" as the central node. In general, the clusters are organized according to three main themes, namely: 1) implications on the implementation of ESD in higher education institutions in general, 2) innovative pedagogy of ESD, and 3) problems and challenges in integrating ESD into the higher education context, each clusters consisting of different keywords. The following sections provide more detailed explanations for each cluster.

4.1 Cluster 1: Issues and Challenges on ESD Integration at HEIs

Despite the unanimous voices at the Rio Conference that education is a crucial driver of sustainable development, recent studies show limited progress made over the past

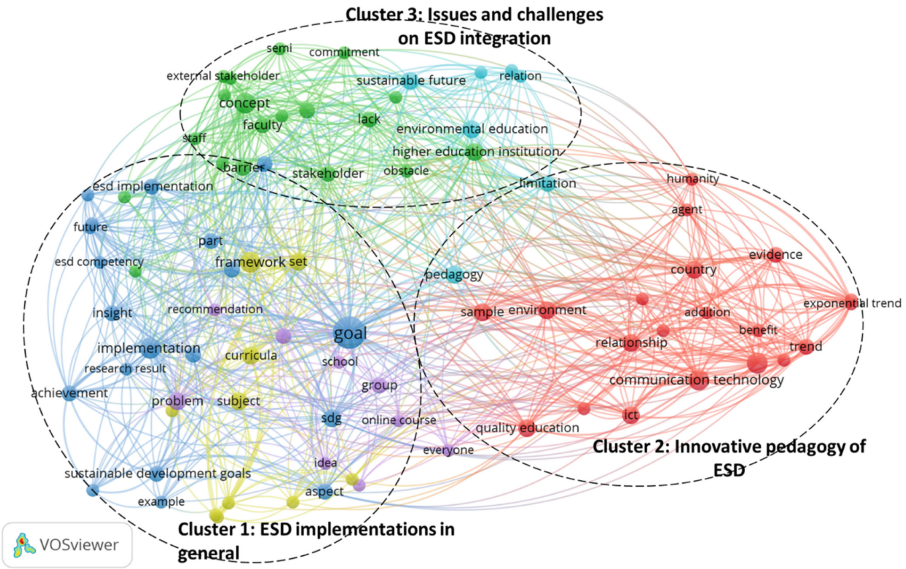

Fig. 2. Keywords co-occurrence network (30 articles).

30 years [13]. Therefore, in this last cluster, studies mainly discuss the issues and challenges of implementing ESD at HEIs, covering 12 articles.

First, since there is no universal formula for sustainability, a lack of theoretical framework was identified one of the main issues. Therefore, ESD has been interpreted differently worldwide and often depending on different contexts [14]. Thus, studies identified a mismatch between existing conceptual or theoretical frameworks related to students' ESD competencies and their actual awareness or ESD implementation [15]. Waltner et al. (2020) also found that teachers do not need more abstract policies but solid support to teach ESD in schools [16].

Second, higher education institutional barriers identified as remaining issues. For instance, due to the limited capacity integration of sustainability concepts into the HE curricula have been identified as a problem [17]. Similarly, another study identified lack of financial resources as a reason for decline in funding for HEIs perceived as a main barrier to promote ESD at HEIs [18]. In addition, lack of teacher training and school leaders support was identified as challenges at HEIs [19].

Third, numerous studies have been conducted on the integration of ESD into teacher education for the successful implementation of ESD. For example, studies have identified several barriers and challenges in implementing ESD in teacher education, such as the lack of integration of ESD into teacher education curricula [8], lack of competency development [11], and lack of hands-on activities [20], and lack of time [21]. Also, some studies provide the examples of effective implementation of ESD in classrooms include the experience of teachers who had ESD courses in their teacher education as a significant predictor of successful implementation of ESD [22].

Lastly, although sustainability in higher education has been studied for decades, little is known about the outcomes of its implementation in higher education [18]. However, evidence of ESD and related educational concepts has been scarce [23]. For instance, monitoring and evaluating ESD and measuring ESD-relevant teacher education programs requires ESD competencies [24]. This allows for data-informed ESD policy development and implementation. Another problem with the implementation of ESD is that although policymakers encouraged integration of ESD for teachers through out cross-curricular subjects, teachers do not implement ESD in classrooms and schools [22]. Because policy efforts do not guarantee the successful implementation of ESD in schools; instead, ESD depends heavily on the teachers themselves. Furthermore, teachers do not implement ESD in schools because of perceived barriers such as lack of knowledge, teaching materials, overcrowded curricula, and lack of time and interest regarding SD [22]. Therefore, continuous professional development of teachers on ESD methods and transformative teaching and learning is identified as the remaining key issues of ESD [25].

4.2 Cluster 2: Education for Sustainable Development Implementation

The concepts of sustainability and SD appear to be integrated into higher education programs to very different degrees. However, there is little research on the relationship between how courses are offered and implemented in higher education. Therefore, nine articles in this cluster discuss the current status of ESD implementation at HEIs in general.

Wiek et al. identified the five key sustainability competencies, such as systemic thinking competency, interpersonal competency, anticipatory competency, strategic competency, and normative competency, and suggest that higher education institutions should teach these competencies to graduates who are essential to solving real-world sustainability problems [26]. Bürgener and Barth found that a competency-based ESD teaching and learning program can improve future teachers' competencies [27]. In addition, Fuertes-Camacho et al. found that ESD training program at HEI improved the students' levels of sustainability competencies on sustainable food consumption [28].

Mochizuki argued that although ESD aims to foster sustainability competencies, it is still not clear how to promote these competencies and what pedagogy is needed is critical for designing transformative ESD learning interventions [29]. Therefore, Lozano et al. proposed that the framework connects ESD pedagogical approaches and competencies, suggesting that further studies are needed to validate the framework in the HEIs context [30].

However, at HEIs ESD subjects couldn't reach their learning objectives and students did not acquire enough sustainability competencies [31]. At HEIs, ESD has been initiated mainly by individual teachers or departments, highlighting the importance of transformative approaches to sustainability at the country level [17]. Similarly, Leal Filho et al. found that most universities are fully aware of the SDGs; however, the numbers drop when asked about the application of the SDGs in teaching [19].

In addition, the recent studies considering to integrate innovative teaching methodologies such as inclusion of Information and communications technology (ICT) into the ESD courses to solve real-world challenges at HEIs [32]. This underscores the importance of integrating innovative pedagogy along with ICT into higher education curricula to improve students' sustainability competencies.

4.3 Cluster 3: Applying Innovative Pedagogies for Education for Sustainable Development

Through ESD, it is possible to combine issues from the social, economic, and environmental domains to solve sustainability problems [33]. However, there is an urgent need for a shift away from traditional didactic teaching toward more innovative pedagogies that foster real-world problem-solving skills. Pedagogical approaches that enable the development of the ESD key competencies are needed to promote sustainable development [34]. Therefore, studies fall into this cluster provides examples of innovative pedagogies to achieve ESD learning goals at HEIs including total of 9 articles.

In discussion of innovative pedagogies for ESD, Joyce suggested that innovative pedagogy must include the use of interdisciplinary, learner-centered, experiential, research-based and participatory decision making methods in teacher education [35]. For instance, Portuguez Castro and Gómez Zermeño conducted a study determined how challenge based learning through an e-learning courses at HEIs can strengthen the students' problem solving skills towards SD [36]. Also, the article by Schina et al. provides a pedagogy to practice ICT skills for pre-service teachers, including robotic pedagogical resources and programming interfaces to create interdisciplinary projects for various SDGs [37]. The study found that project-based learning using ICT was supported the development of future teachers' sustainability skills.

In addition, a study emphasized that the introduction of ICT in ESD will enable students to acquire knowledge, skills, and motivation to understand the SDGs [38]. For instance, technology enhanced teaching and learning process promotes active participations among students [39]. Also, Marouli emphasized that learning activities should promote collective learning through a community-based approach and digital technologies should only be used to enhance learners' critical thinking skills [40].

Other studies focused on to identify how specific ICT technologies are effective for teaching ESD topics. Various ICT tools are identified for effective ESD implementation in teacher education, such as e-learning, virtual learning and Massive Open Online Courses. For example, Azeiteiro et al. found that Environmental science e-learning course at HEI can provide necessary ESD knowledge, competencies, values, attitudes and behaviors for students [41]. Alonso-García et al. conducted a literature review on Spanish HEIs and found a positive relationship between good teaching practices with ICT and

Table 3. Summary of the findings

Clusters	Key findings	Recommendations
1. Issues and challenges on ESD integration at HEIs	Lack of ESD integration at teacher training curriculum; Lack of financial resources and funding; Lack of knowledge, skills, and competencies of the teachers; Lack of support from the top management.	Integrate ESD into the curriculum; Provide teacher trainings on ESD at HEIs level; Strengthen institutional resources for capacity building and financing.
2. Education for sustainable development implementation	Majority of the HEIs do not implement ESD; Sustainability competency-based learning at HEIs.	Enhance continues teacher trainings on ESD for teachers; Encourage teachers to implement ESD.
3. Applying innovative pedagogies for ESD	Learner-centered, experiential, research-based and participatory decision-making methods; Project-based learning; Educational technology or ICT-enhanced learning; – Virtual learning environment; – Educational robots; – E-learning and MOOCS; – ICTeESD can promote active participation and improve students' knowledge, skills and attitudes.	Provide teacher training on different pedagogical approaches; Improve teachers ICT skills to use different ICT tools into their teaching; Apply ICTs for different pedagogical approaches (action-oriented, problem-based; and project-oriented) to teach about ESD;

the SDGs [42]. More specifically, the study found that the virtual learning environment (VLE) was used in good teaching practices with in social science topics. Hajdukiewicz and Pera found that Massive Open Online Courses (MOOCs) can improve learners' knowledge, skills, values, and attitudes toward sustainability and meet the expectations of ESD by providing inclusive, accessible, and equitable educational opportunities with appropriate educational content design [43].

In current study, we aimed at better understanding on why universities only partially or not at all integrate ESD into their curriculum, and to suggest implications for the effective ESD implementations in HEIs. In addition, we investigated different levels of challenges and barriers of ESD implementation at HEIs and identified how innovative ESD pedagogy can enhance the ESD implementation at HEIs. Table 3 shows the main findings and recommendations for each cluster.

The results of the literature review provide several important insights into the implementation of ESD in higher education institutions to promote SD. First, there is no theoretical framework that demonstrates the relationship between teachers' ESD competencies and their actual ESD implementation at the HEI level. Second, innovative pedagogy ESD or ICT-enhanced ESD is considered an effective approach to promote sustainability awareness and to increase the integration of teachers' ICT and ESD pedagogical competencies into teaching and learning. Third, there is a lack of training for teachers in sustainability knowledge, skills, and competencies, as well as pedagogical approaches for successful ESD implementation in higher education institutions.

5 Conclusion

The results of this review provided recommendations for the future direction of both practical and academic work. In terms of practice, while it was found that educational technology as a solution for ESD, there is a gap in knowledge about the relationship between teaching ICT-based ESD pedagogical approaches in HEIs and how this may affect learners' sustainability competencies. There should be clear and defined approaches to the implementation of ESD in national curricula and the curricula of educational organizations. For academia, the implications identified in this review can serve as a basis for developing further research and strategies that contribute to successful implementation of ESD at HEIs.

In addition, the current study has several limitations. First, the academic papers were mainly selected from sustainability-related journals because the study focused on how sustainability issues are addressed or taught in higher education institutions, as well as how future teachers are trained. Therefore, further studies should explore this area of research in other education and teacher education journals. Second, the articles studied mostly refer to cases from developed countries. Future research should therefore focus more on the integration and implementation of ESD in relation to sustainable development in developing countries. Thus, there is a need for more research in these countries on the implementation of ESD and the number of publications that consider cases from developing countries in this context is small.

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