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# Systematic literature review: a typology of Sustainability Literacy and Environmental Literacy

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Creating awareness about Sustainability Literacy (SL) and Environmental Literacy (EL) across educational institutions has increasingly captured the attention of researchers. Given the growing yet fragmented literature about SL and EL across academic disciplines, there is a need to expand and connect this knowledge. This research aims to examine the definitions of SL and EL, their association with Education for Sustainable Development (ESD) and Environmental Education (EE) as well as to present a coherent typology of definitions of SL and EL. The study employs a qualitative thematic analysis approach and the PRISMA guidelines for Systematic Literature Reviews (SLRs) using a sample set of 38 articles from the *Scopus* and *Web of Science* databases. The results provide a significant understanding of the notions, typology, and learning outcomes of SL and EL in the context of Education for Sustainable Development (ESD), as well as the most cited SL and EL definitions, the most associated concepts to SL and EL, and the most representative collaboration networks by countries. The findings reveal the interconnection of EL, Environmental Education (EE), ESD, and curriculum design, underscoring the need to integrate sustainability principles into the educational curriculum, as well as the integration of SL and Sustainable Development Goals (SDGs) in Higher Education. Finally, this study uncovers an urgent call to enlarge global and local collaboration networks to expand sustainability knowledge worldwide.

## KEYWORDS

sustainability literacy, environmental literacy, systematic literature review, education for sustainable development, sustainability curriculum, sustainability learning outcomes, global citizenship education, sustainability competencies

## Introduction

The historical context of Environmental Education (EE) and Education for Sustainable Development (ESD) implies a shift from an approach focused on environmental issues to a broader integration of environmental, social, and economic dimensions aimed at achieving sustainable development. In this transition, the concepts of Environmental Literacy (EL) and Sustainability Literacy (SL) become important to tackle sustainability global challenges as they are outcomes from EE and ESD, respectively. According to [UNESCO \(2022\)](https://unesco.org/en/articles/2025/04/29/energy-demand-projected-to-grow-by-50-percent-by-2050), by the year 2050, energy demand is projected to grow by 50%, food demand by 35%, and water demand by 30%. These substantial increases in essential resources highlight critical sustainability challenges that must be addressed to achieve a fair and thriving global society. Understandably, educational institutions play

a fundamental role in spreading sustainability awareness (Ahel and Schirmer, 2023; Chen C. et al., 2022; Ferrer-Estévez and Chalmeta, 2021; Ling et al., 2021; Murray and Cotgrave, 2007). However, one of the major challenges that higher education institutions face is enhancing SL (Dallaire et al., 2018; Nolan et al., 2021). Given the increasing number of publications on ESD since the launch of the SDGs in 2015 (Araujo et al., 2020), the literature on SL has become fragmented. Therefore, this research aims to examine the definitions of SL and EL and their associated concepts. The research questions addressed in this SLR are:

1. What are the most cited definitions of SL and EL found in this SLR?
2. How can a coherent typology of definitions of SL and EL be structured?
3. What are the most associated concepts to SL and EL?
4. What are the most representative collaboration networks by countries?

## Environmental education and education for sustainable development

In the world today, expanding knowledge of sustainability is essential for promoting ESD and SL. To illuminate the evolution of ESD, the Stockholm Conference in 1972 was the first international conference that acknowledged the need for EE (UNESCO, 1972), indicating EE plays an important role addressing environmental issues (Lo et al., 2002; Sterling, 2013; Thomas et al., 1999). Followed by the Tbilisi Declaration that specified “EE should be provided for all ages at all levels” (UNESCO, 1978, p. 244), UNESCO (1978) mentioned that EE refers to “...knowledge, values, attitudes, and practical skills to participate in a responsible and effective way in anticipating and solving environmental problems” (p. 2). With this international endorsement, the term EE became increasingly widespread in the following decades. Arguably, during the 1970s and 1980s EE had a clear boundary on environmental issues, environmental interpretations, and environmental science (Sterling, 2013). To understand the change in terminology, accompanied by key milestones of ESD, Figure 1 illustrates a timeline with an overview of the evolution of ESD.

It is important to highlight the emerging interconnectedness between EE and other themes such as peace, justice, inequality, human rights, and development. As a result, the Brundtland Commission Report defined Sustainable Development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987, p. 41), linking the concepts of “environment” and “development” in the contextualization of EE and ESD respectively. Consequently, as the Rio Summit stated, “the need to re-orient Education for Sustainable Development (ESD)” (United Nations, 1992), during the 1990s a broader perspective of EE arose. Subsequently, on December 20th, 2002, the United

Nations General Assembly declared 2005–2014 as the Decade of Education for Sustainable Development (DESD) (UNESCO, 2004; ESD Section, 2007).

In three decades, from 1972 to 2002, the concept of EE evolved into ESD. Currently, the UNESCO Office Venice, and Regional Bureau for Science and Culture in Europe (2024) states that ESD “gives learners of all ages the knowledge, skills, values and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources, and inequality” (p. 11). Since ESD encompasses environmental, social and economic dimensions, the use of the term ESD has gained increasing influence worldwide, particularly after the United Nations launched Agenda 2030 including 17 SDGs (United Nations, 2022).

Although EE, Education for Sustainability, and ESD are utilized in the literature as interchangeable terms (Adlong, 2013; Rukmana et al., 2023; Sterling, 2013), it is relevant to mention that consensus on the terminology of EE, Sustainability Education, Sustainable Education, and Education for Sustainability has not yet been reached. For instance, while Barkemeyer et al. (2014) noted that sustainable development discourse tends to emphasize environmental over social aspects, Kopnina (2014) argued focusing on social aspects often overlooks the environmental perspective.

In addition, Sterling (2013) highlighted various perspectives in the ongoing debate regarding the terms EE or ESD: some argue EE is synonymous with ESD, others contend ESD is a component of EE or vice versa, and some suggest ESD is a holistic term while EE should be discarded. For example, whereas De Andrade Guerra et al. (2018) found commonalities between the two terms EE and ESD and treated them as synonymous, Ilovan et al. (2019) utilized the terms of EE and ESD with defined characteristics, and Holm et al. (2015) employed only the term ESD, leaving out term EE. Despite these differing viewpoints, the transition from EE to ESD remains an evolving topic.

Acosta Castellanos and Queiruga-Dios (2022) confirmed two predominant currents in the literature: EE and ESD, noting that Europe is the most noticeable geographical region transitioning from EE to ESD. However, this result does not imply that EE is outdated, as the other regions in the world (Asia, North America, Oceania, Africa, and Latin America) still produce publications using this term (Acosta Castellanos and Queiruga-Dios, 2022). Consequently, it is expected that scholars continue to generate research on ESD, which is the most prominent stream (Acosta Castellanos and Queiruga-Dios, 2022), as part of the agenda 2030 that includes the global efforts to work on the sustainable development of goals.

As UNESCO (2017) stated, ESD should be integrated into all curricula in formal education across all levels. Even though the labels are important to achieve coherence and a shared understanding of the meaning of ESD, there is an urgent need to develop training and expand sustainability knowledge that translates to pro-sustainable behavioral change (Kuehl et al., 2021; Chen C. et al., 2022; Décamps et al., 2017; Sanchez et al., 2024) as well as embrace SL at all education levels (Potter-Nelson and Meyers, 2022; Leiva-Brondo et al., 2022; Sanchez et al., 2024).

**Abbreviations:** EE, environmental education; EL, environmental literacy; ESD, education for sustainable development, SDGs, sustainable development goals, SL, sustainability literacy.

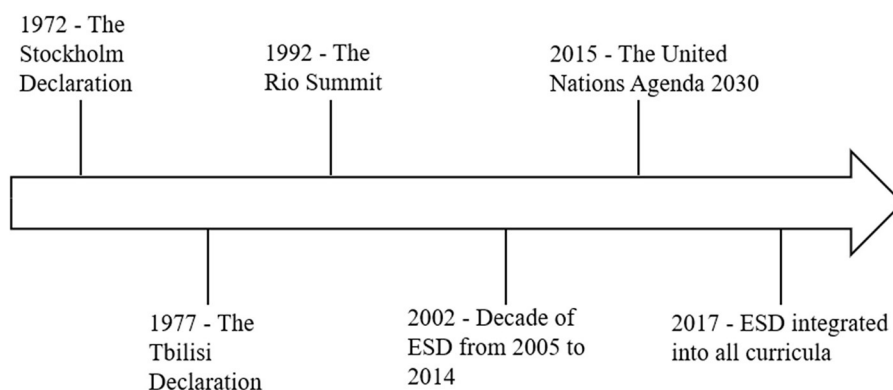


FIGURE 1  
Evolution of education for sustainable development timeline.

## Environmental literacy and sustainability literacy

The conceptual dialogue surrounding SL is intrinsically linked to the United Nations' SDGs and the framework of ESD, all of which are crucial in accomplishing sustainable development and achieving the SDGs (Ahel and Schirmer, 2023). Systematically, SL is an outcome of ESD (Décamp et al., 2021), and EL is an outcome of EE (Elder, 2003; Moody et al., 2005). Since the literature about the definition of SL is fragmented, this research contributes to a better understanding of the notion of SL and EL in the context of ESD. To clarify the concepts and learning outcomes of SL and EL, this study will develop a SLR that serves as a robust and comprehensive methodology for critically appraising research, positioning it on par with high-caliber primary studies (Petticrew, 2001).

Previous studies have focused on EL and the eco social crisis (Martínez-Aznar et al., 2022) as well as studies probing the modeling of EL among university students (Aighewi and Osaigbovo, 2010; Teksoz et al., 2012). Therefore, this literature review embarks on a pioneering effort to explore the notions of SL and EL, highlighting the most cited definitions, associated concepts, and the most representative networks and author collaborations.

## Methods

This qualitative SLR study employs a thematic analysis to examine the definitions of SL and EL and structure a typology of EL and SL based on their learning outcomes. To select a relevant sample of articles, this SLR follows the Preferred Reporting Items for Systematic reviews. The authors sourced and curated relevant articles on SL and EL from databases like *Scopus* and *Web of Science Core Collection*. *Scopus* is the most comprehensive academic database accepted worldwide (Nuryana et al., 2023) and *Web of Science* is one of the most prestigious databases in the scientific community (García-Buendía et al., 2021). As a result, *Scopus* and *Web of Science* were selected due to the high-quality

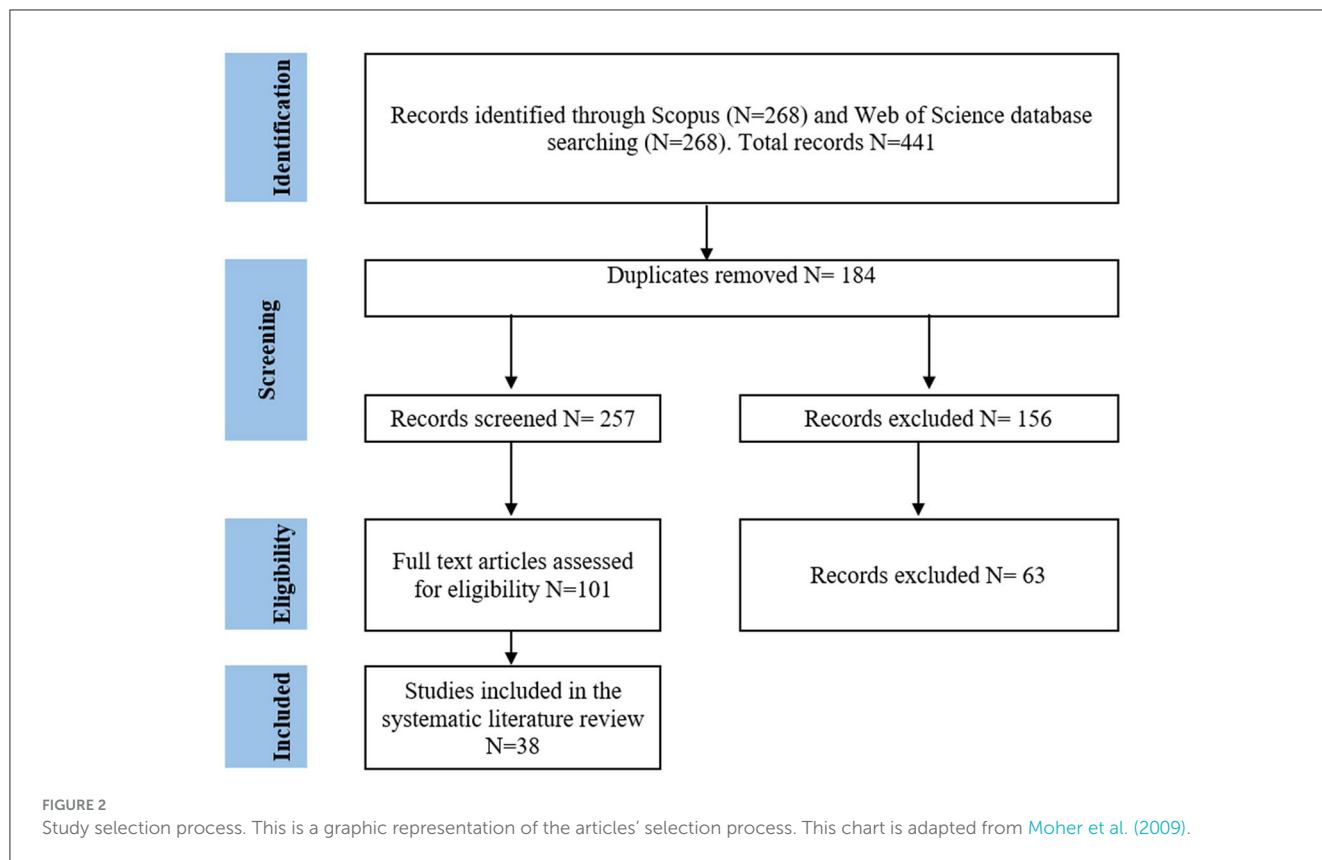
peer review, rigorous methodological standards, and reputation in the community of scholars.

## The search strategy

Adhering to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021; Liberati et al., 2009), the search strategy was conducted between August 2023 and September 2023. The search for articles was conducted in two specific databases, *Scopus* and *Web of Science*. Google Scholar database was not utilized to search for the articles. This SLR employs high-quality journals. Fleming et al. (2014) mentioned that these journals generally offer higher methodological quality. In addition, high-quality journals typically undergo rigorous peer-review process (Abushouk et al., 2021), which enhance validity, reliability, and relevance of the research they publish. Moreover, these journals often require informing adherence to reporting standards and checklists such as EQUATOR, PRISMA, or MOOSE to ensure transparency and rigor (Abushouk et al., 2021). Furthermore, high-quality journals are more likely to publish research that meets rigorous scientific and methodological standards, providing robust statistical analyses and meaningful contributions to the field.

The search strategies were highly targeted and precisely designed to examine SL and EL definitions in scholarship conducted or associated with higher education institutions. Therefore, the search equation comprised ("Universit\*" OR "higher education institution" OR "institution of higher learning") AND ("sustainability literacy" OR "sustainability-literate" OR "sustainability literate" OR "sustainability proficiency" OR "environmental literacy" OR "sustainability litera\*" OR "sustainability literacy assessment" OR "sustainability literacy measurement" OR "environmental litera\*"). These search terms resulted in 441 articles from the selected databases (*Scopus* and *Web of Science*).

Figure 2 summarizes the stages of the article's selection process. Initial results reported 441 articles from both databases,



encompassing quantitative, qualitative, and mixed methodologies studies published between 1982 and 2022.

## Inclusion and exclusion criteria

The authors reviewed all 441 articles of the initial search and removed 184 duplicates, leaving 257 articles. Subsequently, we screened the abstracts of these 257 articles to ensure their relevance to the objectives of the systematic review. After carefully reading the abstracts, we excluded 156 articles that were not relevant to the research focus, resulting in a final set of 101 articles that aligned with the purpose of the study. The abstract screening helped us initially filter articles for relevance before proceeding to a full-text review. Articles were excluded based on irrelevant topics or focus, poor reporting, or methodological flaws.

Initial inclusion criteria were set for articles published in journals and papers in their final stage that offered full text and were subjected to peer-review and available in either English or Spanish. Essential details like title, abstract, keywords, authors' credentials, journal designation, and publication year of the discerned records were cataloged in a Microsoft Excel spreadsheet. Next, the authors read 101 articles searching for definitions of SL and EL. As a result, 27 publications were excluded because they did not provide definitions of either SL or EL.

Subsequently, 74 articles underwent evaluations, categorizing them based on relevance to the topic. To ensure sources were of the highest quality and rigorously researched and reviewed, the

next set of selected papers were those that had been published in journals ranking in the Journal Citation Report (JCR) or Scimago Journal Ranking (SJR) quartile 1 (Q1) and quartile 2 (Q2). This classification helps to understand credibility, impact, and standardized evaluation of the articles selected. A meticulous investigation of the remaining articles was conducted to further validate their pertinence, culminating in a final list of 38 articles. This research aimed to examine peer-reviewed journal articles as opposed to other sources that may contain SL and EL information, such as university and departmental mission statements or instructor syllabi because these items are more difficult and elusive to obtain, are unstandardized, and can be changed and updated frequently. Relying on high-quality, well-researched published materials is a more reliable way to incorporate previous researchers' findings. The eligible sample is composed of 38 articles published in high quality journals ranked in Q1 and Q2 by the JCR and the SJR.

## Thematic analysis and intercoder agreement

This study adopted PRISMA guidelines set forth by [Page et al. \(2021\)](#) to develop a structured literature review which employed a qualitative thematic analysis approach ([Miles and Huberman, 1994](#)) to analyze the data. Data was coded using the software ATLAS.ti version 23. The process to analyze the definitions of SL and EL is as follows:

1. Identification of the final sample following PRISMA guidelines for the SLR.
2. Review of the final sample composed of 38 articles that included definitions of SL and EL.
3. Preliminary definitions of SL and EL were identified and coded in the software ATLAS.ti.
4. Analysis of the data required the review of background literature, descriptions found in the sample, and additional literature from the reference lists.
5. An iterative process of evaluating the definitions of SL and EL was carried out by the authors.
6. Data on the specific definitions of SL and EL was grouped.
7. The final number of citations for each definition was extracted from Google scholar database.

The authors used deductive coding, in which themes were identified and reviewed. The principal investigator read the full-texts articles, developed the coding system, communicated the coding strategy to the co-authors, trained the co-authors to perform the thematic analysis, and assigned a data set to each member. To ensure reliability, the data were coded independently by two co-authors. Each coder saved the coding in an independent bundle file, which afterwards was merged into the master file. To reduce any bias in the analysis, the Inter-coder Agreement (ICA) percentage was calculated using ATLAS.ti version 23. As a result, the Krippendorff's c-Alpha-binary was 0.94.

## Results

### The most cited definition of environmental literacy and sustainability literacy

The concept of EL proposed by Roth (1992) is the most cited definition which states, “the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems” (p. 10). Table 1 shows the most cited definitions of SL and EL in the literature subject to this study. Even though SL and EL are related concepts, the concept of EL precedes SL. In addition, the definition of SL is more consistent with the broader concept of sustainability. In this sense, the foundational concept and framework of SL encompasses vital insights into social, environmental, and economic sustainability, which increases the complexity of the concept. As a result, Nolet (2009) mentioned, “Sustainability literacy is construed generally here as the ability and disposition to engage in thinking, problem solving, decision making, and actions associated with achieving sustainability” (p. 421).

The typology of definitions of SL and EL based on specific learning outcomes provides a framework to understanding the similarities and features supported in the literature. Thus, this research illuminates the prevailing discourse of the notion of SL, highlighting its definitions and specific learning outcomes to the ESD. As it is exhibited in Table 2, the foundational concept of both SL and EL includes knowledge, awareness, attitudes, skills, and behaviors toward sustainability,

TABLE 1 Definitions of sustainability literacy and environmental literacy.

Definition	Source	Cite*
“Environmental literacy is essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems” (p. 10)	Roth, 1992	1252
Environmental Literacy “is distinct from simple awareness or personal conduct knowledge because of its depth of information and the actual skills (thinking and doing) that are imparted” (p. 55)... “Knowledge must be deep, skills must be developed, and experiences made real for EE to work at its best” (p. 116)	Coyle, 2005	624
“...environmental literacy is to empower people with a belief in their ability to contribute to environmental solutions through personal behavior, either as an individual or part of a group” (p. 47)	Pe’er et al., 2007	596
“Environmental literacy is built on awareness by the acquisition of greater knowledge and understanding of the components of the system, the links between them and the dynamics of the system” (p. 250).	Smyth, 1995	244
“Sustainability literacy is construed generally here as the ability and disposition to engage in thinking, problem solving, decision making, and actions associated with achieving sustainability” (p. 421).	Nolet, 2009	364
Sustainability literacy indicates “the skills, attitudes, competencies, dispositions and values that are necessary for surviving and thriving in the declining conditions of the world in ways which slowdown that decline as far as possible” (pp. 10-11)	Stibbe, 2009	387
“Sustainability Literacy which can be defined as the knowledge, skills, and mindsets that help compel an individual to become deeply committed to building a sustainable future and allow him or her to make informed and effective decisions to this end” (p. 141)	Décamps et al., 2017	199

\*The table shows the most cited publications that contained definitions of Sustainability Literacy and Environmental Literacy in Google Scholar as of April 8, 2023.

being the environmental dimension the intersection between EE and ESD.

In addition, Appendix A shows the description of the 38 studies analyzed, the classification of those articles according to the definition of either SL or EL, and the methodology used in each paper. The 38 articles contain 25 articles focused on EL and 13 articles focused on SL. The most predominant research design in the sample of articles is quantitative research design. Six articles used mixed methods (MM) research design, four employed qualitative design (QUAL), and 20 used quantitative design (QUAN). Most of the studies were published in journals that focused on sustainability and education; environmental, cultural, economic, social sustainability; and policy and practice research. The audiences are mainly researchers, scholars, academics, students, teachers, and policy makers.



**TABLE 2** Typology of sustainability literacy and environmental literacy specific outcomes.

ESD learning outcomes	SL and EL learning outcomes	Sources
SL	Sustainability knowledge	Akeel et al., 2019; Chen X. et al., 2022; Décamps et al., 2021; Ferrer-Estévez and Chalmeta, 2021; Ling et al., 2021; Micklethwaite, 2022; Dallaire et al., 2018; Tunji-Olayeni et al., 2023
EL	Environmental knowledge	Chen et al., 2020; Janoušková et al., 2020; Moody and Hartel, 2007; Pan and Hsu, 2022
SL	Awareness and knowledge in sustainability issues	Lau, 2010; Décamps et al., 2017, 2021; Winter and Cotton, 2012
EL	Awareness and knowledge in environmental issues	Elder, 2003; Kroufek et al., 2015; Liu et al., 2019; Moseley, 2000; Teksoz et al., 2012; Tuncer Teksoz et al., 2013
SL	Knowledge, skills, attitudes/dispositions/feelings, values, behaviors	Bloyd Null et al., 2021; Chen C. et al., 2022; Cotgrave and Kokkarinen, 2011; Décamps et al., 2021; Dent and Dalton, 2010; Murray and Murray, 2007; Nolet, 2009; Radwan and Khalil, 2021; Swaim et al., 2014
EL	Knowledge, skills, attitudes, behaviors	Chen et al., 2020; Coyle, 2005; Dada et al., 2017; Disinger and Roth, 1992; Fang et al., 2018; Owusu et al., 2017; Hines et al., 1987; Hsu and Roth, 1998; Husamah et al., 2022; Joseph et al., 2013; Liang et al., 2018; Morrone et al., 2001; Mullenbach and Green, 2018; Orbanic and Kovač, 2021; Pan and Hsu, 2022; Roth, 1992; Teksoz et al., 2012; Tuncer et al., 2009; Tuncer Teksoz et al., 2013

## Sustainability literacy and environmental literacy in non-English-speaking contexts

The discourse on SL and EL in non-English speaking countries is influenced by both global and specific contexts, as well as unique educational settings. This SLR included research applied in countries where English was not the primary language, such as China, Taiwan, Brazil, France, Nigeria, and the Czech Republic. A commonality among all those studies is the alignment to the global concern of expanding sustainability and environmental knowledge.

The research applied in non-English speaking contexts is associated with the ongoing international debate of using the terms SL or EL. In countries such as Brazil, Nigeria, France, and Czech Republic, the common term used was SL. In contrast, China and Taiwan used the term EL. On the one hand, Fang et al. (2018) highlighted the need to train environmentally conscious citizens with high-quality EL in Taiwan. On the other hand, Caldana et al. (2023) mentioned the importance of establishing more formal rules and educational policy to integrate SL throughout the business management, economics, and accounting curricula in Brazil. In addition, Akeel et al. (2019) pointed out the need to improve SL in Nigeria, and Tunji-Olayeni et al. (2023) noted the dearth of

studies focused on SL in Nigeria. Décamps et al. (2021) cited the need to measure sustainability knowledge worldwide. The research identifies how non-English speaking countries are working on SL and EL to address local and global problems as well as to contribute to the SDGs.

## Associated concepts to environmental literacy and sustainability literacy and the co-occurrence of authors' keywords

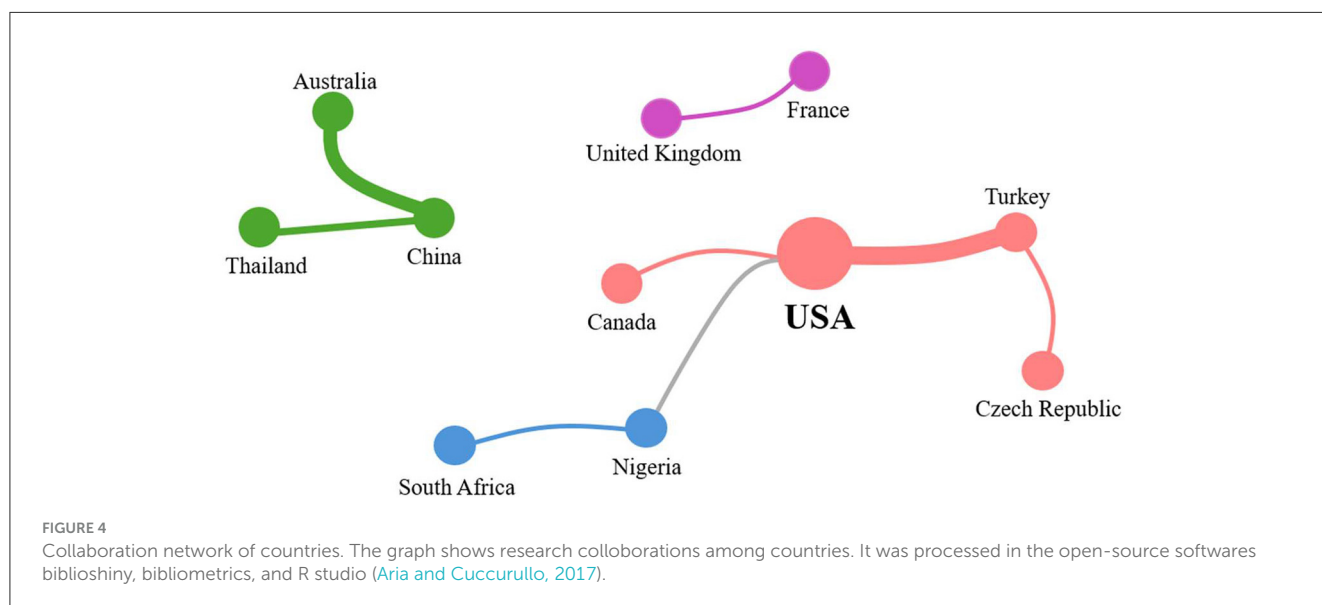
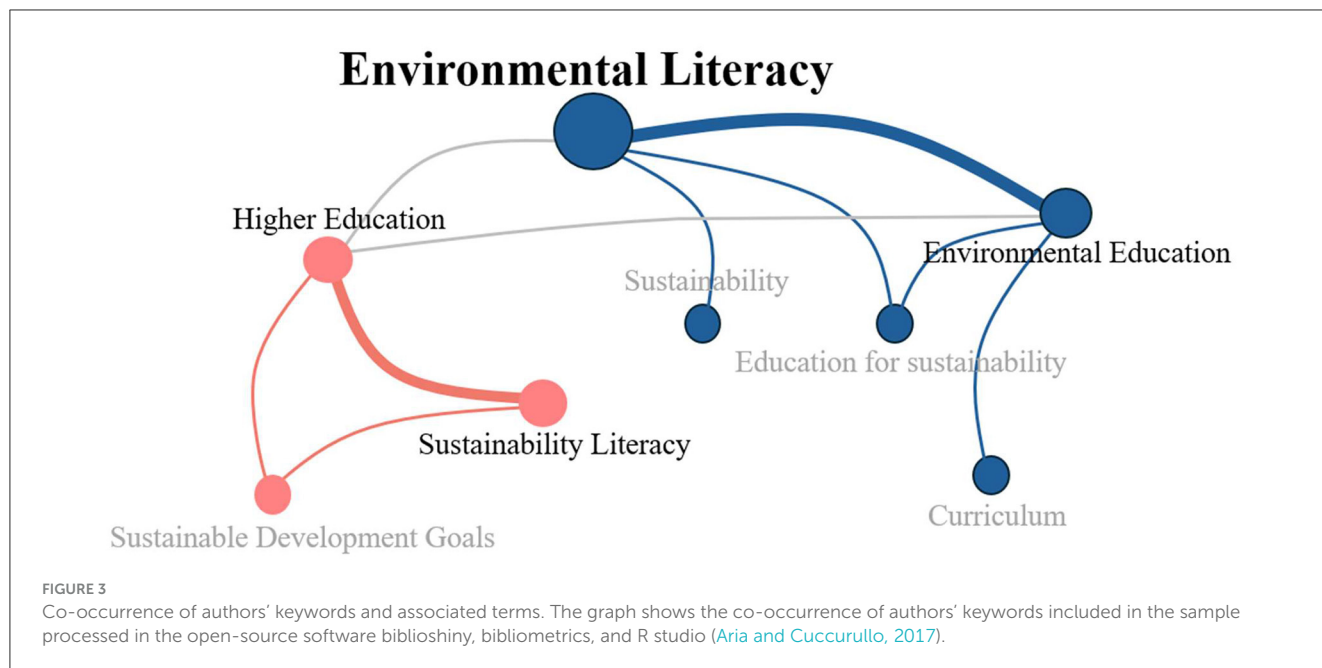
The co-occurrence of the authors' keywords was applied to the sample of the 38 articles. To gain a better understanding of the associated concepts to SL and EL, the authors conducted a co-occurrence network analysis. Data was analyzed using the R Studio software version 4.3.0, biblioshiny, and bibliometrix, which are open-source computer software (Aria and Cuccurullo, 2017). Figure 3 shows two clusters of the co-occurrence network. Cluster 1, shown in red, is composed of three major words: higher education, sustainability literacy, and sustainable development goals. Knowledge is one of the major outcomes of SL. Increasing SL in higher education institutions implies expanding students' sustainability knowledge which is directly related to enhancing students' knowledge of sustainability development goals. There is a strong relationship among SL, sustainable development goals, and higher education.

On the other hand, Cluster 2, shown in blue, exhibits the interconnection among the following terms: EL, EE, sustainability, education for sustainability, and curriculum. EL is a learning outcome of EE; likewise, SL is a learning outcome of Education for Sustainability or ESD. The central node, EL, is consistent with literature in the sample because 21 out of 38 articles were directly related to the concept of EL.

## Collaboration network by countries

In this study, the collaboration network by countries refers to how authors from different countries collaboratively work on a research topic based on co-authorship patterns. These collaborations allow the creation of connections through joint publications on an international scale and identify which countries have the greatest connections and which countries are leading research on a specific topic.

Exploring the social structures of the field, collaboration among scholars across countries is an important factor in strengthening research networks. Understanding how scholars interact among themselves helps to map potential clusters and institutional partnerships to enhance research (Donthu et al., 2021). Figure 4 illuminates these collaboration networks by countries. The United States shows a greater effort in strengthening collaborative research bonds with countries such as Turkey, Canada, and Nigeria. Nigeria extends connections with South Africa, while the United Kingdom and France are working together on sustainability research projects. Finally, researchers in China tend to collaborate with scholars from Australia and Thailand.



## Discussion

This research provides a review of current studies on SL and EL, providing an understanding of the current issues and implications for future research. Firstly, the most cited definitions of EL and SL give understanding of these concepts and their development. Roth (1992) and Coyle (2005) are the most cited definitions of EL. Roth (1992) emphasizes the ability to perceive and interpret environmental systems and take appropriate action. This definition highlights the importance of understanding environmental dynamics and the need for proactive actions to maintain or improve environmental health. Therefore, the definition, in addition to implying an understanding of the problems, suggests that actions must be taken toward solving problems effectively.

The typology of SL and EL reveals an overlap between SL and EL in terms of the learning outcomes they cover, indicating interconnection between ESD and EE. As stated in the literature, “education for sustainability,” “education for sustainable development,” and “sustainability education” are interchangeable terms (Wu and Shen, 2016). Moreover, Briggs et al. (2018) mentioned EE and ESD are overlapping concepts. EE was prior to ESD and focuses on preparing individuals to deal with environmental issues. ESD extends its scope to prepare people to cope not only with environmental but also social and economic issues (UNESCO, 2007). In this sense, SL encompasses a broad range of outcomes like knowledge, skills, attitudes, values, mindsets, and behaviors to achieve sustainability from an integrative approach that includes dealing with and finding solutions to environmental, social, and economic issues.

The conceptualization of SL and EL has significant implications for higher education policy and practice. For instance, integrating SL and EL into higher education contributes to the advancement of the SDGs as part of the 2030 Agenda launched by the United Nations and adopted by all United Nations Member States in 2015 (United Nations, 2022). The SDGs established by the international community are “action oriented, global in nature, and universally applicable” (UNESCO, 2014, p. 3). However, the ongoing debate surrounding the terms EE and ESD, the transition from EE to ESD, and the lack of a clear definition of these concepts have made their integration and implementation in educational institutions challenging. As a result, a common understanding of how to structure ESD across educational institutions, how to foster ESD among students, and how to assess the progress of ESD integration is needed.

Additionally, the co-occurrence analysis of authors’ keywords shown in Figure 3 illustrates the interconnections related to concepts and themes within the literature by grouping the keywords into two clusters. One group highlights the intersection of higher education, SL, and the SDGs, and the other group points out the interconnection of EL, EE, and curriculum design. These interconnections underscore the necessity of integrating sustainability principles into the educational curriculum. This finding aligns with previous studies that emphasize the need to incorporate SL into higher education curricula (Ceulemans et al., 2011; Pappas, 2012; Sanchez et al., 2023, 2024). In addition, these clusters correspond with international policies and global initiatives promoting ESD. For instance, in alignment with the SDGs launched by UNESCO in 2015, SDG Number 4 highlights the need “to achieve inclusive and equitable quality education and promote lifelong learning opportunities for all” (UNESCO, 2017, p. 6). In this regard, the aim of target 4.7 of this SDG states, “By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through Education for Sustainable Development...” (UNESCO, 2017, p. 8). Consequently, there is an urgent need to foster ESD, as SL raises awareness among current and future generations of students to engage with global sustainability challenges.

Moreover, the collaboration network among countries illustrates the need to strengthen connections between local and global scholars, allowing outreach beyond academia to business corporations as an additional approach to expanding SL worldwide. Décamps et al. (2017) and Hansen et al. (2021) show an example of a collaborative initiative to support and assess SL in higher education by the creation and development of Sulitest (the Sustainability Literacy Test). Sulitest is a collaboration with the Partnership Exchange for the United Nations’ SDGs (Décamps et al., 2017, p. 9) which facilitates higher education institutions and organizations to have access to a free online instrument to assess sustainability knowledge. Sulitest is a global initiative that has fostered SL across the globe.

Furthermore, the common and fundamental “feature of the 2030 Agenda for Sustainable Development is its universality and indivisibility” (UNESCO, 2017, p. 6). As all member states of the United Nations agreed to the 2030 Agenda launched in 2015, “Governments are expected to take ownership” and develop “national frameworks” and policies to achieve the SDGs (p. 6). In this sense, achieving quality education for all requires expanding national and international collaboration networks and

involves governments, educational institutions, civil society, private and public sectors. Strengthening these relief efforts can foster knowledge sharing, interdisciplinary research, and innovation in sustainability education.

## Conclusions

SL has increasingly been recognized globally as pivotal in shaping the trajectory of ecological, political, socio-cultural, and economic advancements. To truly achieve sustainable development, education is paramount to equip students with the knowledge and skills necessary to take actionable steps toward a more sustainable future. SLRs shed light on key conversations surrounding notions like SL and EL, pinpointing gaps and constraints that challenge educators, students, and staff in effecting meaningful shifts in individuals’ knowledge, perspectives, and actions.

It is important to note SL is an emerging research field, and as an outcome of ESD, there is increasing interest in studying SL in higher education. Even though SL is a complex concept due to the integration of environmental, social, and economic perspectives, in recent years, a growing number of publications about it has been detected. As a result, SL is a milestone for scholars and more research is needed to expand sustainability knowledge worldwide.

In addition, EL is a concept that has evolved over time and predates the concept of SL. Likewise, EE existed prior to the notion of ESD. Even though EL has spread through education and has now shifted to the concept of SL, the latter encompasses a broader scope. Research on EL and SL contributes to the advancement of ESD, as those concepts facilitate the dissemination of sustainability knowledge, SDGs, and their integration into higher education through curriculum design. In addition, to expand SL within educational institutions, a common understanding is needed of how to structure ESD across educational institutions, how to foster ESD among students, and how to assess the progress of ESD integration.

This SLR synthesized existing literature on ESD and identified key research gaps and outlines a foundation for advancing research and practice in sustainability education. This research underscored the existing discourse on the conceptions of SL and EL, highlighting varying definitions and learning outcomes; such insights pave the way for prospective research avenues and actionable interventions.

## Limitations and future research

There are limitations when conducting SLRs (Yuan and Hunt, 2009, p. 1). Owens (2021) says the risks include “selection bias, inadequate blinding, attrition bias, and selective outcome reporting” (par. 9). Additionally, even top-tier databases like *Scopus* and *Web of Science* “cannot fully account for the influence of scholarly work on teaching, practice, and public knowledge” (Wilder and Walters, 2021, p. 1). As a result, the authors acknowledge that taking high-quality journals from these two databases may not capture the entirety of high-quality publications on SL and EL, which may introduce a certain degree of bias. To mitigate this limitation and reduce bias in the review process, this SLR has employed a rigorous methodology, adhering to PRISMA



guidelines, as well as presenting and calculating the Inter-coder Agreement (ICA) to analyze data.

For future research, it is important to recognize EE and ESD are relevant for higher education institutions in equipping the next generation of students with the competencies needed to address sustainability-related issues. More research is needed regarding ESD in schools and higher education institutions as well as the integration of SL into existing curriculums in both developed and developing countries. Additional studies in contrasting and assessing educational interventions to promote ESD, SL, and pro-environmental behaviors in rural and urban areas as well as global and local regions are crucial. Further studies are essential to provide a common understanding of how to structure ESD across educational institutions, how to foster ESD among students at all educational levels, and how to assess the progress of ESD integration within schools and higher education institutions. Expanding scholarship and collaboration networks to advance these integrations of SL, sustainability competencies, and sustainability related learning outcomes into curriculum provides new avenues of research. This research's findings confirm that SL is an emerging field, and it is indeed necessary to increase collaboration research networks to strengthen emerging scholarship on ESD.

More studies are needed to address strategies for designing, developing, and assessing sustainability competencies and sustainability learning outcomes across different academic disciplines and curricula. Experimental and quasi experimental interventions that analyze the advancement of students' sustainability learning outcomes are also needed. Quantitative and qualitative studies that measure and expand sustainability knowledge for faculty and students are needed to enhance ESD worldwide. Moving forward, it is vital to continue exploring innovative pedagogical approaches and fostering interdisciplinary collaborations to enhance ESD and empower students, faculty, and staff in higher education institutions to become agents of positive change in creating a more sustainable world.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Author contributions

S-JS: Data curation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing, Conceptualization,

Investigation, Methodology, Project administration, Software, Supervision. YP: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. J-SM: Data curation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. DR: Conceptualization, Writing – review & editing. SA: Writing – original draft, Writing – review & editing. TG: Conceptualization, Formal analysis, Visualization, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2025.1490791/full#supplementary-material>

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