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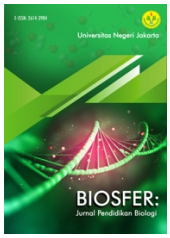

What are the valuable lessons from global research on environmental literacy in the last two decades? A systematic literature review

H. Husamah[1*], Abdulkadir Rahardjanto[1], Samsun Hadi[1], Nurdiyah Lestari[2]

[1] Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Malang, Indonesia
[2] Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Kupang, Indonesia

*Corresponding author: usya_bio@umm.ac.id

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ABSTRACT

Publications on environmental literacy (EL) in reputable international journals have continued to increase and develop in the last two decades, making it interesting to study. This systematic literature review (SLR) aims to investigatively review various studies published in journals indexed in the Scopus database related to EL. The review focuses on publication trends and valuable lessons to be learned from global research over the past two decades. We used the phrase "environmental literature" in the Scopus disbursement menu and found 296 articles. The inclusion and exclusion model used is PRISMA, so only 37 articles met the criteria to be analyzed. Data shows that EL publications have fluctuated, starting to increase in number from 2017 to 2023 although it had decreased in 2021. EL publications are mostly researched using quantitative methods, and some with qualitative, mix-method, and R&D. The dominant name in EL studies is F. X. Bogner. The two main keywords related to the EL keyword are environmental education and knowledge. Most of the articles published are collaborative, both internationally and between universities within one country. We discussed the valuable lessons in question, namely the sample size, gender, institution level, and main goal of each article. These findings can serve as a consideration or baseline for researchers to study EL according to their respective interests, needs and missions.

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INTRODUCTION

Environmental Literacy (EL) is primarily interpreted as awareness, sensitivity, and concern for the environment and its various problems, as well as cognitive, psychomotor, and affective in finding various solutions to existing problems and preventing new problems from arising (McBride et al., 2013). EL is an individual's ability to understand and interpret environmental conditions, from the results of this understanding and interpretation, the individual can decide on appropriate actions to maintain, restore and improve environmental conditions (Karimzadegan & Meiboudia, 2012; Kusumaningrum, 2018; Kuswendi & Arga, 2020; Tomás et al., 2022). EL is one of the fields in the study of Education for Sustainable Development (ESD).

ESD is one way to develop EL through class-based activities (Syahmani et al., 2021). ESD is focused on the socialization goals of EL (Locke et al., 2013). ESD is seen as the starting point for the formation of a society that has EL (Mahat et al., 2020). If EL can be developed in individuals then human awareness, knowledge and sensitivity to the balance of nature will be instilled (Ozgurler & Cansaran, 2014). EL is considered as one of the perspectives needed to achieve the Sustainable Development Goals (SDGs). The concept of EL usually includes aspects such as: environmental awareness and sensitivity; deep understanding of possible solutions; values, motivation, skills and competencies relevant to protecting the environment (Cincera et al., 2022). EL in all generations, to understand and respond to changes in the natural environment through environmentally friendly habits also needs to be improved (Mashfufah et al., 2018; Pe'er et al., 2007; Swanepoel & Loubser, 2002).

EL includes six main components, namely ecological knowledge, socio-political knowledge, knowledge of environmental issues, affect, cognitive skills and environmentally responsible behaviors (Srbinovski et al., 2010). In its development, according to Szczytko et al (2019), EL consists of four components, namely ecological knowledge, hope, cognitive skills, and behavior. EL is in line with efforts to empower communities to make wise decisions and act in an environmentally responsible manner (Goulgouti et al., 2019). EL is a person's understanding, skill, and motivation to make decisions with full sense of responsibility by paying attention to their relationship with nature, community, and future generations (Izhar et al., 2022; OELP, 2020). Practically speaking, someone who has EL is someone who individually or collectively is willing to make the right decisions about the environment and implement those decisions (Kudryaytsey et al., 2015). EL must continue to be campaigned, so that it becomes a research orientation and environmental education (EE) (Hermawan, Suwono, et al., 2022; Pan & Hsu, 2020).

In this regard, based on the search results in the database of the world's largest reputable journal, namely Scopus, which was conducted in July 2023 it was found that EL theme publications in the period 1971-2023 were 296 for the all-years category: search within article title (out of the total 714 for the EL theme for the all-years category: search within article title, abstract, and keywords). These publications need to be analyzed in depth to find information on publication trends and valuable lessons, so that they become a guide for readers and researchers in related fields (SDGs, ESD, EE, and EL). The logical technique and the most recommended by experts are to carry out an analysis or study of Systematic Literature Review (SLR).

There are main problems related to SDGs, ESD, EE, and EL research. These problems include a lack of data and diversity of research themes (Damoah & Omodan, 2023; Şeker, 2023; Suárez et al., 2023; Uddin, 2023), the need for broad stakeholder involvement (Kioupi & Voulvoulis, 2019; Kohl et al., 2022; Laurie et al., 2016), the need for extensive research capacity (which is currently still limited) (Kaya & Elster, 2019; Olsson et al., 2022; Wals & Kieft, 2010), limited funding (Coyle, 2005; Hamilton & Marckini-Polk, 2023b), lack of cross-sector integration (Garcesa & Limjuco, 2016; Izhar et al., 2022; Lewinsohn et al., 2015; Solheri et al., 2022), and limited access to the results and benefits of research (Afandi et al., 2023; Kaya & Elster, 2019; McClaren, 2019). related to the themes of SDGs, ESD, EE, EL and their integration. Solving problems regarding this research requires broad commitment so that the SDGs, ESD, EE, EL targets and missions can be achieved.

We have found four English-language review-based articles (and all of them are not SLRs) in the Scopus database related to EL, namely EL for young children (Basile & White, 2000), teachers' EL and teaching (Cheng & So, 2015), using urban harbors for experiential (O'Neil et al., 2020), and EL of aluminium alloys (Ohnishi, 2003). The other two publications are in the form of meta-analyses on assessing EL in the United States (Aydeniz & Ruggiero, 2015) and online EE (Merritt et al., 2022). There are two simple SLRs published in proceedings that are not/not yet Scopus indexed which discuss trends

and EL bibliometrics either in the form of articles in journals or in proceedings (Afandi et al., 2023; Hudha et al., 2023). Meanwhile, there are SLRs associated with EE, which are focused on early childhood (Ardoin & Bowers, 2020), positive youth development outcomes (Ardoin et al., 2022), civic engagement outcomes (Ardoin et al., 2023), disabled people in environmental-education-focused academic (Salvatore & Wolbring, 2022), EE benefit environmental outcomes in children and adolescents (van de Wetering et al., 2022), the use of GIS in geographical and EE evaluated (Konstantakatos & Galani, 2023), dan trends in EE studies (Masalimova et al., 2023). Thus, it can be said that there has not been found an SLR that is focused on EL aspects that are focused on the last two decades and published in scientific journals (indexed or accredited).

This SLR aims to investigatively review various studies published in indexed journals in the Scopus database related to the EL theme. The review is focused on publication trends related to EL themes in Scopus indexed journals and valuable lessons that can be gained from research on EL themes over the last two decades in the world. This SLR will contribute to the development of EL research, in the form of becoming a baseline, consideration, and even becoming a reference for researchers on this topic. We focus on the publication of original articles, something that has not been done by other researchers. A review of the scope of the information that we use only includes research/original articles, so that in real terms it provides an overview of the focus, interests, tendencies, and alignments of researchers on the EL theme. We describe an overview of EL research over the last two decades, so that it is possible to become a reference for policy makers, practitioners, and educational actors in efforts to develop EL, SDGs, ESD, and literacy on a local, regional and global scale.

METHODS

Research framework

This study is an SLR, which seeks to carefully and seriously identify, evaluate, and analyze the various articles found to answer research questions and analyze them in depth (Snyder, 2019; Xiao & Watson, 2019). SLR helps provide a brief description of the scientific topics discussed through a systematic and transparent method of answering research questions (Kurniati et al., 2022).

Research question

Research questions (RQ) are used to define the scope to develop a clear focus for the study. The RQ is determined based on the needs of the selected topic, namely: RQ1: How are the publication trends related to the EL theme in Scopus indexed journals? The trends in question include year distribution, research types/methods, authors, keywords, and international collaboration (Husamah et al., 2022a). RQ2: What valuable lessons can be drawn from research on EL themes over the past two decades? The valuable lessons in question are sample size, gender, institution level, and main goals (Teixeira et al., 2022).

Search article and inclusion criteria

After logging in to the Scopus database using an official account or subscription, we use the phrase "environmental literacy" in the disbursement menu in the Scopus database. The data obtained is downloaded in *CSV and *RIS formats which are then synchronized into the Reference Manager (Mendeley). Visualization of the relationship between keywords and authors using the VOSviewer software. VOSviewer supports the presentation of data that is communicative, real, interesting, and clearer. The following is the search history for articles in the Scopus database—as we have done: “(TITLE(“environmental literacy”) AND (LIMIT-TO (DOCTYPE,”ar”)) AND (LIMIT-TO (LANGUAGE,”English”)) AND (LIMIT-TO (SUBJAREA,”SOCI”)) AND (LIMIT-TO (OA,”all”))).

We apply the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) model to perform inclusion and exclusion to find articles that really fit. This model refers to Gallagher et al (2016) and has been used also by several authors in the SLR that has been published before (Husamah et al., 2022a; Nurwidodo et al., 2023). The order of inclusion and exclusion that we do is as presented in Figure 1.

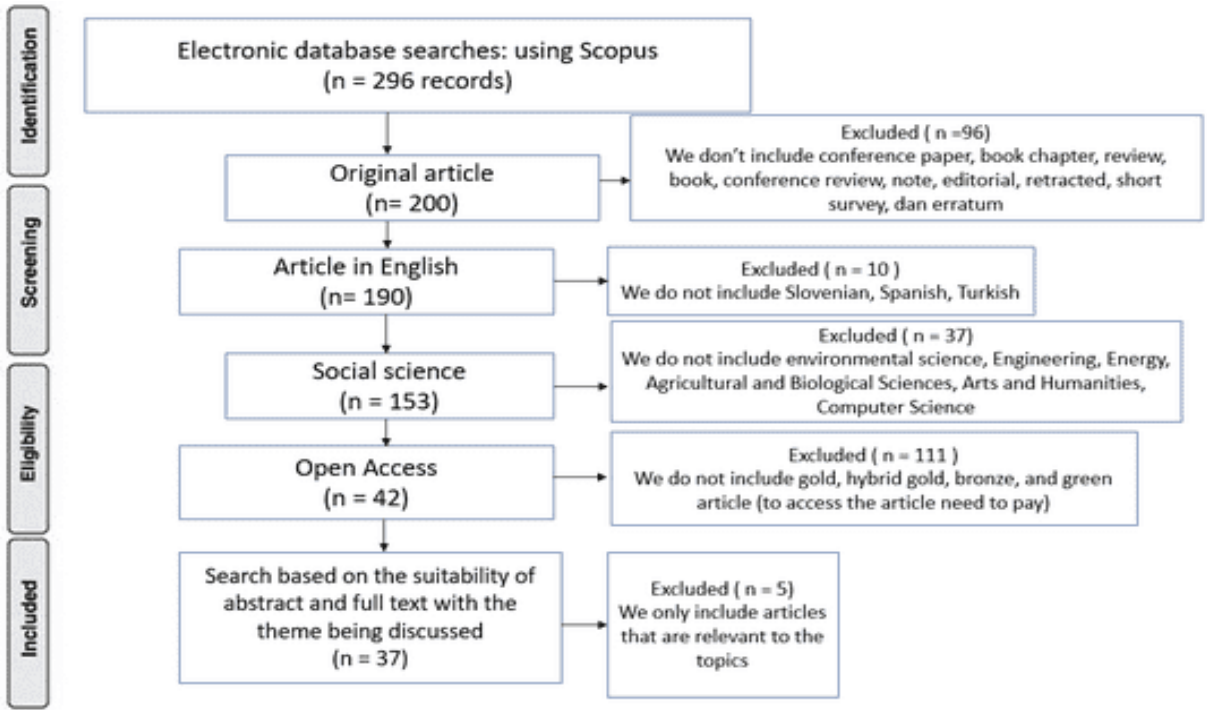

Figure 1. The flow of article selection using the PRISMA model

Figure 1 shows that in our initial search we found a total of 296 articles. As an initial screening, we only took articles which were original articles, totalling 200, which means that there were 96 articles excluded. We excluded conference papers, book chapters, reviews, books, conference reviews, notes, editorials, retracted, short surveys, and erratum. Then we use the criteria for articles published in English, the result is that there are 190 articles that meet the criteria. This shows that there are 10 articles that are excluded, because they were published in Slovenian, Spanish, and Turkish. Next, we use the inclusion criteria in the field of science or the subject area "social science". There were 153 articles that met the criteria, which means that there were 37 articles that we omitted or excluded. Excluded articles fall within the subject areas of environmental science, engineering, energy, agricultural and biological sciences, arts and humanities, and computer science. We then selected articles with "open access" or free download status, in which 42 articles were selected, and removed 111 articles. In the last phase, we re-examine the existing articles, make sure the articles are in accordance with the themes discussed, and ensure that the full text is accessible. Based on this we get 37 articles that meet the criteria. This means that there are 5 articles that do not meet the criteria and are finally excluded.

RESULT AND DISCUSSION

Trends in publications on the theme of environmental literacy

Distribution year

Figure 2 shows the number of articles published per year for the last twenty years (since the 2003-2008 articles were not found, the figure starts in 2009).

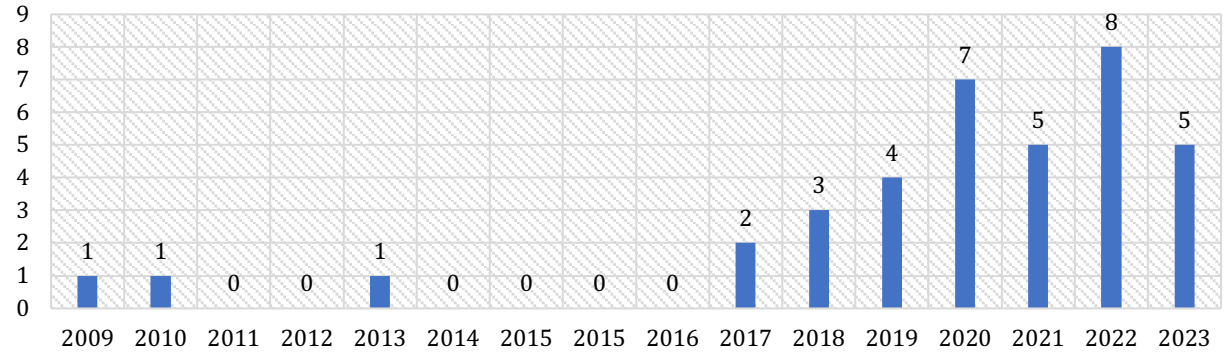

Figure 2. Distribution year of article

Based on Figure 2, the number of EL-themed publications has fluctuated. Articles have started to increase in number since 2017. The number of articles had decreased in 2021 (only 5 articles) but increased in 2022 (to 8 articles). Even though the number of articles in 2023 is only 5 articles, it is very possible that this theme will increase considering that this data search was carried out until July 2023. There are still six more months in 2023, thus allowing the number of published articles based on research results on the topic EL will continue to grow if the data is traced until the end of 2023. It can be said that the EL theme is interesting to study, especially during the COVID-19 pandemic. There is a relationship between EL and COVID-19 precautions (Ayuningtyas, 2022). The COVID-19 pandemic has also awakened many parties to care more about their environment and reminded people that nature gives time to recover from human activities that have caused a lot of damage and loss to nature (Mardiani et al., 2020).

The EE which was carried out during the COVID-19 pandemic emphasized the importance of everyone having a good EL level (W.-T. Fang et al., 2022; Raghunathan et al., 2022). EL encourages students' environmental perceptions to shift to ecocentric and leave anthropocentric (Weilhoefer & Schmits, 2022). We can say that EE, which has so far been implemented flexibly even during a pandemic, has been able to strengthen aspects of EE (Assaf & Gan, 2021; Brandão & de Souza, 2021; Grežo et al., 2021; Khalifé et al., 2022; Torres Parra et al., 2022). The pandemic period has made many parties aware that EE and EL are so important and should be the concern and commitment of the global community (Benítez et al., 2019; Edsand & Broich, 2020; Marpa, 2020; Reddy, 2021). This is also in line with Chen and Liu (2020) who emphasized that EE and EL will definitely become topics of interest to researchers due to the incessant campaign of "sustainability" and the urgency of multidisciplinary topics on sustainable development.

Research types/methods

The trend of types of research related to EL themes is presented in Table 1. EL research was predominantly conducted using a quantitative approach (22 articles or 59.46%). The type of research used is qualitative, a combination of quantitative and qualitative (mix-method), and Research and Development (R&D).

Table 1.
Types of research on environmental literacy themes

No	Type of Research	Amount	References
1	Quantitative	22	(C. W. K. Chen et al., 2020; W. T. Fang et al., 2018; Gheith, 2019; Huang & Hsin, 2023; Iwaniec & Curdt-Christiansen, 2020; Kuruppuarachchi et al., 2021; Nurwidodo et al., 2020; Örs, 2022; Pan & Hsu, 2020; Rose, 2010; Sarabi et al., 2020; Saribas et al., 2017; Sasa et al., 2022; Svobodová, 2023; Svobodová & Kroufek, 2022; Tian & Chen, 2023; Tomás et al., 2022; Tran et al., 2022; Wajdi et al., 2022; Wilujeng et al., 2019; Wu et al., 2020; Yilmaz, 2021)
2	Qualitative	6	(Erdoğan et al., 2009; Hamilton & Marckini-Polk, 2023a; Hsu et al., 2018; Liang et al., 2018; López-Alcarria et al., 2021; N. S. Putra et al., 2021)
3	Mix-method	5	(Bayer et al., 2021; Bloom & Fuentes, 2019; Jannah et al., 2013; Kaya & Elster, 2019; Suryawati et al., 2020)
4	Research and Development (R&D)	4	(Farida et al., 2017; Hermawan, Arjaya, et al., 2022; Husamah et al., 2022b; Rasis et al., 2023)

It can be emphasized that EL, as well as EE, can be studied with both quantitative and qualitative methods. If necessary, even a combination of quantitative and qualitative (known as the mix-method) can be applied. This really depends on the goals of each researcher (Baytak, 2011). Ballantyne et al (2001) also emphasized his opinion on this matter. Molina-Azorín and López-Gamero (2016) even firmly promoting and suggesting the need for mixed-method research, in research on environmental themes considering that this method is commonly used in several fields. It should be remembered that both quantitative and qualitative have their advantages and disadvantages (Rahman, 2016; Savela, 2018).

EL research can be approached with R&D methods. This is in line with the views of researchers who have implemented it (Farida et al., 2017; Hermawan, Arjaya, et al., 2022; Husamah et al., 2022b; Rasis et al., 2023), also in EE research (Rahmayanti et al., 2020). According to O'Flaherty and Liddy (2018) diverse methodological and pedagogical approaches are needed to have a broad impact on the implementation of EL and EE.

Author

Based on Figure 3 and Figure 4 the most dominant author in EL studies based on bibliographic coupling and co-citation → cited authors is F. X. Bogner (Franz Xaver Bogner).

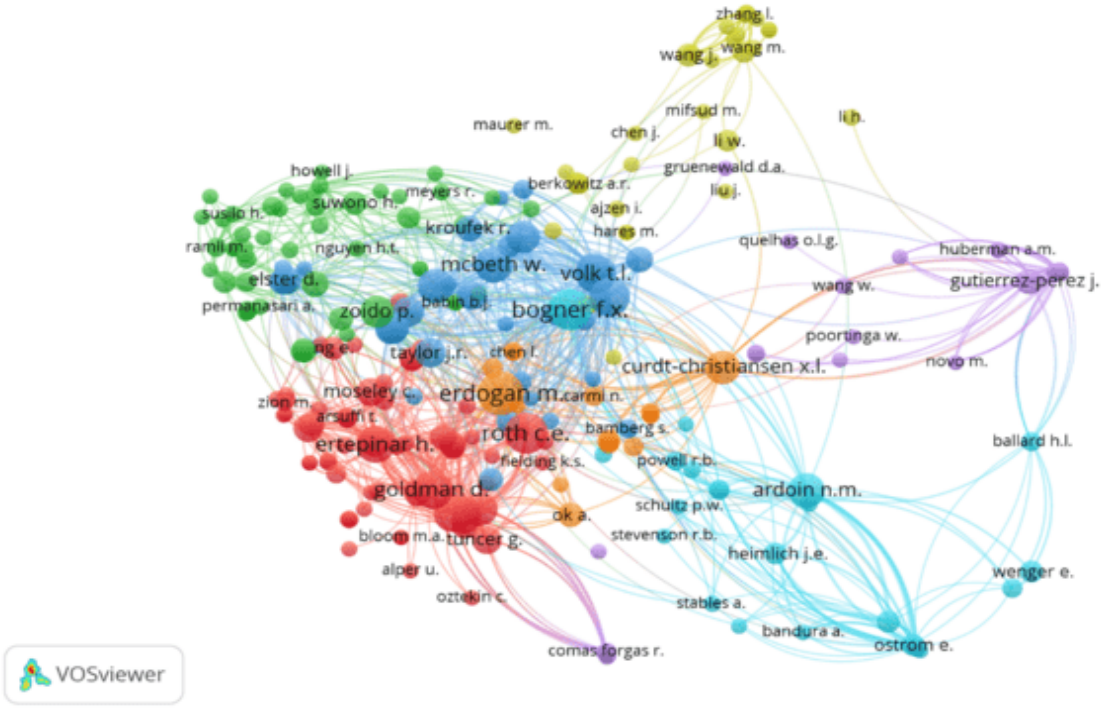

Figure 3. The dominant author in EL studies is based on bibliographic coupling

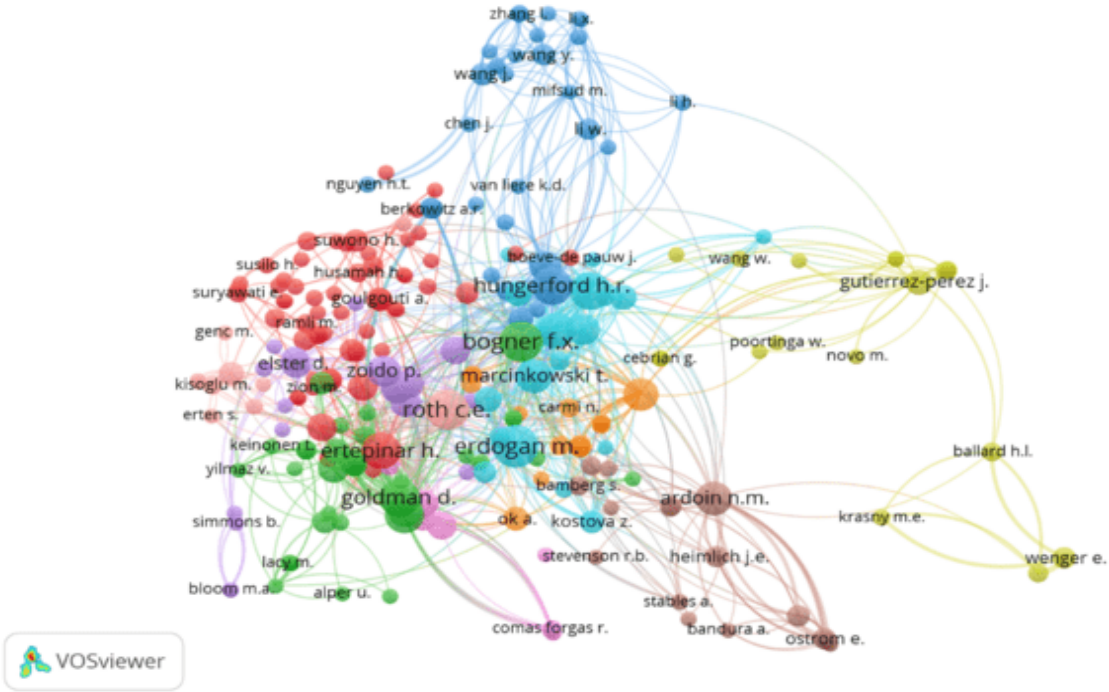

Figure 4. The dominant author in EL studies is based on co-citation → cited authors

Franz Xaver Bogner is a professor in the Department of Biology Education, University of Bayreuth, Germany and affiliate research scientist, Earth Education Research & Evaluation, College of Education, University of Arizona, United States. He has 195 documents and an h-index of 35 on Scopus (Author ID: 7004389288). Together with his research team, he has published dozens of articles related to EE and EL during the COVID-19 pandemic or in the 2020-2023 period (Baierl, Bonine, et al., 2021; Baierl, Johnson, et al., 2021; Baierl, Kaiser, et al., 2022; Baierl, Johnson, et al., 2022; Baierl & Bogner, 2021, 2023; Beyerl et al., 2022; Bogner & Suarez, 2022; Cincera et al., 2022; Conradty & Bogner, 2022; Fiedler et al., 2020, 2021; Maurer et al., 2020; Maurer & Bogner, 2020a, 2020b, 2022; Raab & Bogner, 2020, 2021; Schneiderhan-Opel & Bogner, 2020b, 2020a, 2021; Schönfelder & Bogner, 2020; Stöckert & Bogner, 2020a, 2020b, 2021; Torkar et al., 2020).

Keywords

Figure 5 shows the trend of keywords that are mostly used by authors in writing on the theme "environmental literacy". Based on Figure 5 there are two keywords related to the main keyword "environmental literacy", namely "environmental education" and "knowledge".

EL is the main goal of EE (Szczytko et al., 2019). The need for developing awareness and ability to prevent environmental problems is important for future sustainability and quality of life, in this case education in general and environmental education can be a solution (Erhabor & Don, 2016; Kousar et al., 2022; Pauw et al., 2015; Piscitelli & D'Uggento, 2022). The current education system must produce students who are environmentally literate in order to have sufficient knowledge about environmental issues and a caring attitude to behave responsibly (Liang et al., 2018; Maulaa et al., 2020; Solheri et al., 2022). The purpose of integrating EE into the curriculum structure is to build awareness, increase knowledge, shape attitudes, increase participation, and evaluate the surrounding environment (Abdullah et al., 2018; Mashaba et al., 2022; Permanasari et al., 2021; Zsóka et al., 2013).

EL is related to knowledge. EL is "knowledge" of environmental concepts and issues. Researchers related to the EL field must pay attention to the aspects of "the constitution of knowledge", "the sources of knowledge", and "the evidence for knowledge" (Wheaton et al., 2018). A person's EL status can be measured based on four criteria, one of which is "knowledge", as well as cognitive skills, attitudes, and behavior (Agfar et al., 2018). EL includes components of "environmental knowledge), attitude, and environmental concern (Meilinda et al., 2017). "Environmental model provides relationships between knowledge, attitudes, and behavior. The relationship of attitudes with behaviour is closer than with knowledge" (Maurer & Bogner, 2020b).

Figure 5. VOS-viewer display for type of analysis "Co-occurrence → keywords"

International collaboration

Figure 6 shows the collaboration of authors in publishing their articles. Author collaboration is carried out in the form of international collaboration, collaboration within one country, or without collaboration (publishing independently or within one institution). Figure 6 provides information that more articles were published with non-collaborating status (15 articles or 40.5%). However, international collaboration (13 articles or 35.1%) and collaboration in a country (9 articles or 24.3%), it can be said that most of the articles were published by author(s) with a collaboration pattern (total 22 articles or 59.5%).

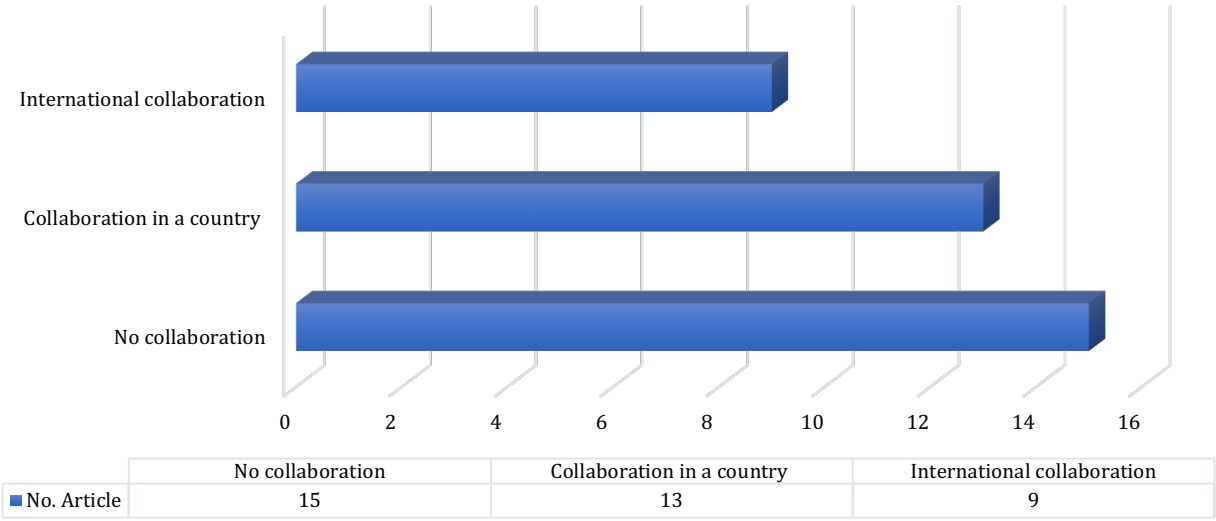

Figure 6. Author collaboration in writing articles

Research related to EL and EE requires widespread or global collaboration of scientists. This pattern supports efforts to develop programs and ideas, documentation and opportunities to solve current problems, such as environmental problems such as biodiversity loss, pollution and climate change (Chernysh & Roubík, 2020; Goodale et al., 2022; Gui et al., 2019; Jappe, 2007a, 2007b; Tirgar et al., 2019; Widmer et al., 2015). Vaughan-Lee (2016) make us all aware that there is no problem that shows the importance of unity and cooperation in global competence more than environmental problems. The survival on this earth really depends on how all the potential in the world collaborates to solve environmental problems.

Valuable lessons from environmental literacy research

We reviewed 37 selected articles and tried to dig and find valuable information that illustrates the valuable lessons that can be learned. The valuable lessons referred to are the sample size, gender, institution level, and main goal of each article. The results of this review can be presented in Table 2.

Table 2.
Valuable lessons from each of the analyzed articles

No	Reference	Main goal	Sample size	Gender	Institution level
1	(Erdoğan et al., 2009)	The link between the goals of science education in elementary schools and the six basic components of EL	Not explained (student 3rd to 8th grade)	Not explained	Elementary school
2	(Pan & Hsu, 2020)	Effects of one-day EE program on El	100 students	Not explained	
3	(Bayer et al., 2021)	School-based agricultural education program	3,076 students	Not explained	
4	(Svobodová & Kroufek, 2022)	EL of ISCED 2 PUPILS	436 students	Male: 226 Female: 210	Junior High School

No	Reference	Main goal	Sample size	Gender	Institution level
5	(Svobodová, 2023)	EL of ISCED 2 Pupils	371 students	Male: 187 Female: 184	
6	(Suryawati et al., 2020)	The relationship between EL with thinking skills, actions, and sensitivity to environmental issues	372 students	Male: 169 Female: 203	
7	(N. S. Putra et al., 2021)	the level of students' and stakeholders' EL	70 students and 40 school community	Not explained	
8	(Jannah et al., 2013)	Determine the level of EL amongst students	345 students	Male: 165 Female: 180	
9	(Farida et al., 2017)	Learning design to develop EL	Not explained (students)	Not explained	
10	(Wilujeng et al., 2019)	The effectiveness of learning using worksheets to improve EL	30 students	Not explained	Senior high school
11	(Nurwidodo et al., 2020)	The role of eco-school program towards EL	275 students	Not explained	
12	(Hermawan, Arjaya, et al., 2022)	develop learning model to improve students' EL	36 students	Not explained	
13	(Hamilton & Marckini-Polk, 2023a)	Implementation of place-based education has a positive impact on communities and the environment	226 students	Not explained	
14	(Tomás et al., 2022)	The incidence of EL in the sustainable pedagogical behaviors	650 teachers	Not explained	Early, primary and secondary school
15	(Huang & Hsin, 2023)	the relationship between EL and sustainable development in schools	Not explained	Not explained	
16	(Rose, 2010)	Professional development for improving EL teachers	Not explained (teachers)	Not explained	
17	(Saribas et al., 2017)	Effects environmental education course on EL and self-efficacy beliefs	58 pre-service elementary teachers	Male: 8 Female: 50	
18	(W. T. Fang et al., 2018)	EL students in relation to ecotourism activities	835 students	Not explained	
19	(Liang et al., 2018)	EL of undergraduate students	29,498 students	Male: 14,483 Female: 14,626	
20	(Gheith, 2019)	Level of EL among prospective teachers	112 prospective teachers	Male: 0 Female: 112	
21	(Bloom & Fuentes, 2019)	Professional development program for inservice science teachers	17 inservice science teachers	Male: 7 Female: 9	University
22	(Kaya & Elster, 2019)	Clarification of the EL framework, based on expert consensus	95 experts	Not explained	
23	(Sarabi et al., 2020)	Knowledge, attitude, and accountability towards the environment	210 students	Not explained	
24	(C. W. K. Chen et al., 2020)	Impact of EE on EL	221 students	Not explained	
25	(Yilmaz, 2021)	EL levels of social studies teacher candidates	164 teacher candidates	Male: 50 Female: 114	
26	(López-Alcarria et al., 2021)	EL model based on teachers action-competencies	30 early childhood education teachers	Male: 26 Female: 4	
27	(Kuruppuarachchi	Existing knowledge, awareness,	800	Not	

No	Reference	Main goal	Sample size	Gender	Institution level
	et al., 2021)	attitude and behavior, perceived issues, and solutions of undergraduates on major environmental issues	undergraduates	explained	
28	(Sasa et al., 2022)	The influence of demographic factors on the EL level	323 students	Male: 173 Female: 150	
29	(Wajdi et al., 2022)	Effect of PBL with environmental-based comic model in empowering students' environmental literacy	97 students	Not explained	
30	(Örs, 2022)	EL levels of nursing students in terms of a sustainable environment	278 nursing student	Not explained	
2	(Tran et al., 2022)	Modelling the level of EL and environmental teaching activities	324 in-service preschool teachers	Not explained	
32	(Husamah et al., 2022b)	Develop and validate an EL instrument for prospective science teacher	634 students	Not explained	
	(Rasis et al., 2023)	Open inquiry learning kits and EL	33 students/ pre-service biology teachers	Not explained	
34	(Hsu et al., 2018)	Community practices that contribute to EL	Not explained (Community)	Not explained	
35	(Iwaniec & Curdt-Christiansen, 2020)	The role of parents to increase their children's awareness, attitude and behavior about environmental issues (EL)	368 parents	Male: 275 Female: 93	General public
36	(Wu et al., 2020)	Community EL level and preferences for using mass media related to EE issues	435 citizens	Not explained	
37	(Tian & Chen, 2023)	The EL measured by questionnaire survey	547 people	Not explained	

Based on Table 2, valuable information is obtained, as a basis for further research. The main research goals can be grouped into: (1) intra-curricular and extra-curricular programs in developing EL in elementary school, junior high school, and senior high school; (2) EL level at junior high school, senior high, university, and the general public; (3) learning designs/models, learning media, and development of instruments related to EL at senior highs and universities; (4) the link between EL and sustainable development at the early, primary, and secondary school levels; (5) the role of the community or society in supporting EL development.

EL implementation studies are very broad, showing that this theme can be approached from various sides, various approaches, and various disciplines (holistic, interdisciplinary, multidisciplinary, and multidimensional). Various studies show that sustainability and education are closely interdependent (Al-Kuwari et al., 2022). This provides a mandate that educational institutions, from elementary to tertiary institutions need to be committed to sustainable development and ESD. A holistic, transdisciplinary, multidisciplinary and multidimensional approach that integrates the pillars of social, political, environmental, economic and institutional sustainability and allows all parties to contribute widely to sustainability (Bunyatova et al., 2021; Butt & Dimitrijević, 2022; Jabareen, 2011; Parry & Metzger, 2023; J. D. Putra, 2022; Shao et al., 2011; Shoolestani & Shoolestani, 2015). Social community also means participatory aspects and human capacity development in various communities, including the vulnerable (Gähler, 2012) and culture (Gospodinova & Boutier, 2022; UCLG, 2018). ESD can also relate to and describe complex application experiences in psychological, physiological, medical, and sociological aspects (Avgusmanova et al., 2017). An interdisciplinary and holistic approach to ESD considers human aspects: physical, cognitive, social, emotional which are in line with multiple intelligences and basic competencies (Aada, 2019).

Based on Table 2, in the context of sample size, information is obtained that most of the articles have explained the sample size of their research (32 articles or 86.49%). Sample sizes range from tens to tens of thousands (30-29,498). Even so, there are several studies that do not explain the sample size (5 articles or 13.51%).

Calculation of sample size is very important for researchers because it shows the quality of research. A sample size that is too small may be able to provide an overview or show differences as expected (not precise). On the other hand, a very large sample size certainly adds to the burden because research will become more complex, increase costs, and extend time, making it unfeasible. Both of these situations must be taken into consideration and need to be avoided by researchers (Martínez-Mesa et al., 2014). The sample size needs to be estimated; because too large a sample is unnecessary and unethical, but too small a sample is unscientific and also unethical (Andrade, 2020). Often research articles do not adequately report on the adequacy of their sample size, or are uninformative and so are often poor, often non-existent. This occurs in various fields of scientific disciplines (Vasileiou et al., 2018).

Based on Table 2, in the context of gender, most of the studies did not explain the gender aspect of their research sample (25 articles or 67.57%). Meanwhile, research that explains gender aspects, gender status is quite balanced. Research showing that their research sample was predominantly female was 7 articles (18.92%), while research showing that their research sample was predominantly male was 5 articles (13.51%).

There are many reasons why researchers need to routinely consider gender and gender in their research practice. Gender and gender are related to decision-making, communication, stakeholder engagement, and preferences for implementing interventions. Gender aspects consisting of gender roles, gender identities, gender relations, and institutionalized gender can influence how the implementation strategy works, for whom, under what circumstances and why, all of which are related to research processes and results. Research for both quantitative and qualitative is recommended to measure and analyze sex and gender in practice (Tannenbaum et al., 2016).

Gender influences the way people live, work and relate to each other at all levels, including in relation to awareness (literacy). Gender disaggregation marks differences or similarities between women and men that require further analysis; and further analysis is guided by gender frameworks and questions to understand how gender power relations are shaped and negotiated. “Crucial aspects of understanding gender power relations include examining who has what (access to resources); who does what (the division of labor and daily practices); how values are defined (social norms) and who decides (rules and decision-making)” (Morgan et al., 2016).

Based on Table 2, in the context of the institution level, EL research is more dominant at the university level (18 articles or 48.65%) and the lowest is at the elementary school level (3 articles or 8.11%). Thus, it can be said that EL research in tertiary institutions tends to be the "favorite" of researchers. ESD, which is multidisciplinary, is an important and complex system for higher education institutions that tends to be comprehensive (Bi et al., 2022). Various factors are also recommended to be considered in the implementation of ESD, namely curriculum, teaching, extracurricular activities, educational leadership, professional development, and community partnerships (Parent & Speer, 2014; Shayya et al., 2020) all of which can be escorted by scientists in universities.

We also get interesting results, that there are opportunities for EL research and publication at the elementary school level because the number is still limited. Research and implementation of environmental literacy at the elementary school level. The EL status of elementary school students can be assessed by exploring the relationship between the environmental knowledge subscales (Saltan & Divarci, 2017). The Organization for Economic Cooperation Development (OECD) even states that EL in elementary school students tends to be low when referring to the results of the Program for International Student Assessment (PISA) tests. This is due to several aspects tested in the science field related to environmental themes (Nugraha et al., 2022). Experts state that in the last three decades, primary schools need to be involved in preparing students who are ready to become "environmentally conscious, committed, and active citizens'". Various existing studies show that the implementation of EE at the elementary school level still has various problems and a limited success rate (Cutter & Smith, 2001).

Studies related to EL with EE, SDGs, and ESD are related. ESD is a vehicle for creating and realizing EL within the framework of EE implementation which is needed for a proper understanding of the

challenges of sustainability of environmental functions, where this issue is included in the SDGs spotlight (Acosta-Castellanos & Queiruga-Dios, 2022; Pönkä, 2019; Valencia, 2018). SDGs have a clear framework and can be integrated into EE as an embodiment of ESD (Fekih Zguir et al., 2021; Kioupi & Voulvoulis, 2019; Kopnina, 2020). Therefore, EE is an integration of SDGs and ESD as an effort to create a society that has EL and contributes to ensuring the realization of sustainable development and protecting the function of the planet.

Research opportunities related to SDGs, ESD, EE, EL, and their integration in the future are very diverse. In this case, for example, it is related to evaluating the impact of ESD in supporting the achievement of the SDGs (Ssossé et al., 2021), developing and innovating the ESD curriculum (Andersson et al., 2013; Julien et al., 2018), EE implementation models (Ardoin et al., 2013; Kabassi et al., 2023; Wulandari et al., 2019), as well as developing instruments and measuring the impact of EL on community social behavior (N. A. Rahman, 2019; Szczytko et al., 2019; Wu et al., 2020; Yu et al., 2022). Apart from that, future research can focus on integrating SDGs in education, developing indicators for achieving SDGs, analyzing sustainable development policies on a local and global scale, and sustainable technological innovation. What needs to be remembered is that cross-disciplinary collaboration and the involvement of many parties will be the key to understanding this complex environmental sustainability problem. Of course, data and evaluation results produced by intense and quality research will play an important role in guiding collective action in achieving various SDG targets in the future.

CONCLUSION

This SLR provides some interesting results, both in terms of trends and learning lessons. First, interesting information based on trends are: (1) The number of EL-themed publications has fluctuated; articles started to increase in number since 2017; the number of articles decreased in 2021, increased in 2022, and it is very possible that publications in EL will increase considering that this data search was carried out in the first semester; (2) EL research is more dominantly carried out with a quantitative approach; however, there are those who use a qualitative, mix-method, and R&D approach; (3) The most dominant author in EL studies based on bibliographic coupling and co-citation is F. X. Bogner; (4) The keywords that are mostly used by the author in writing EL themes are "environmental education" and "knowledge"; and (5) more published articles with non-collaborative status. However, if we combine international collaboration and collaboration in a country, it can be confirmed that most of the articles published by author(s) are collaborative. Second, 37 articles have been reviewed and explored valuable lessons, as follows: (1) Main research goals: (a) intra-curricular and extra-curricular programs in developing EL in primary and secondary schools; (b) study of the EL level at all levels of education up to the general public; (c) learning designs/models, learning media, and development of instruments related to EL at senior high schools and universities; (d) the link between EL and sustainable development at the primary and secondary school levels; (e) the role of the community or society in supporting EL development. (2) In the context of sample size, information is obtained that most of the articles have explained the sample size of their research, although there are several studies which have not explained the sample size. (3) In the context of gender, most studies do not explain the gender aspects of their research samples. (4) In the context of the institution level, EL research is more dominant at the university level and the lowest (still needs to be improved) at the elementary school level. This SLR does not analyze some other interesting information, such as funding, number of authors, research location, author's country of origin, and the main results of each article. Therefore, researchers and authors who are interested in conducting SLRs on this theme should consider including these aspects. The findings that we get in this SLR can be a consideration or baseline for researchers to study EL according to their respective interests, needs and missions.

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