



Antecedents and consequences of environmental literacy among students: systematic literature review

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ABSTRACT

Introsuction. Although global initiatives promote environmental education, students' environmental literacy remains low, limiting their ability to act responsibly and adopt sustainable behaviors. This study aims to identify the antecedents and consequences of environmental literacy among students through a systematic literature review.

Methods. Following the PRISMA protocol, 41 Scopus-indexed studies published over the past two decades were systematically analyzed to reveal research trends, leading authors and countries, as well as the main antecedents, consequences and direction for future research in environmental literacy.

Results. The results showed that environmental literacy peaked in 2013, 2022, as well as 2024 and was expected to continue until 2025, with Indonesia contributing the most and showing the greatest interest in this topic. The results also signified several predictors of environmental literacy, including learning models, government programs, and demographic variables. The consequences of environmental literacy were related to environmental knowledge, problem solving, environmental protection competence, and pro-environmental behavior.

Conclusion. These findings highlight the need for integrating environmental literacy into educational systems through innovative, culturally relevant learning models and for further studies to explore underexamined factors using quantitative approaches to strengthen empirical understanding.

Implication. This study offered future academics and policy experts to consider several determinants and consequences that were shown to improve environmental literacy among students.

KEYWORDS

environmental literacy, students, environmental education, determinants, systematic literature review

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INTRODUCTION

Environmental literacy is crucial for improving sustainable behaviors and addressing global environmental challenges such as climate change. International initiatives such as those by UNESCO, the Council of Europe, and the UIA have emphasized the importance of environmental education. Historical documents like the Belgrade Charter and the Tbilisi Declaration have laid the foundation for environmental education, aiming to create a population aware of environmental crises and committed to solving them [1].

This relationship is particularly significant among students, who are future stewards of environment [2]. Students encounter various environmental issues throughout their educational experiences, which shape both learning processes and overall well-being. Prior studies highlight the role of environmental education and sustainability awareness in fostering critical consciousness and responsible behavior toward environmental challenges [3], including innovative pedagogical approaches that integrate environmental contexts into learning activities [4]. Other research emphasizes the psychological and physical health implications of environmental stressors, such as eco-anxiety, environmental crises, and stress-related health problems among students [5]. In addition, the educational environment itself, particularly the quality of environmental conditions in educational institutions, has been shown to influence students' health and learning outcomes [6]. Finally, scholars underline the importance of the broader socioeconomic and political context, arguing that environmental issues in education are inseparable from questions of social justice, environmental inequalities, and societal structures shaping science and environmental education [7]. Technological advancements have also led to environmental pollution and other negative consequences [8], while being beneficial in many ways. This contributes to lower levels of physical activity, which is crucial for the health and impact of students to increased absenteeism as well as decreased academic performance [9]. Several studies have shown that students who are not prepared to face environmental problems will become pessimistic, having undeveloped attitudes and motivation to behave sustainably [10], as this pessimism can be a barrier to taking meaningful action. The lack of environmental literacy among students hinders individual ability to make responsible decisions concerning environmental issue [11].

THEORITICAL BACKGROUND

Environmental literacy issues have been recognized among academics and policy experts around the world. In the Indonesian context, students generally have a low to moderate level of environmental literacy, which has a crucial impact on environmental sustainability [12]. Environmental literacy among students in Malaysia has a moderate to low level despite positive attitudes and behaviors towards surroundings [13]. In other nations, such as the United States, it is also at a low level, primarily among middle school students [14]. Significant differences are shown across the levels of the behavior among European countries influenced by a combination of historical, cultural, geographical, socio-economic, and demographic factors [15].

Improving environmental literacy among the remaining population is for personal gain and to inspire broader pro-environmental actions in society. Therefore, identifying the determinants of this behavior will help cultivate better attitudes and responsibility toward surroundings [16]. Previous studies attempted to investigate the factors influencing environmental literacy. For example, some studies mentioned that learning models were very important, including the use of learning models to solve environmental problems [17]. Meanwhile, other studies (e.g.[18]) believed that programs of education often influence environmental literacy among students. These programs could even influence intellectual development and be conducted with community participation [19].

The majority of studies identified demographic predictors, such as gender and school type, as strong determinants of environmental literacy among students [20]. Early studies mostly focused on assessing knowledge levels using standardized instruments such as the Middle School Environmental Literacy Survey (MSELS), Environmental Knowledge Test (TEK), and Environmental Knowledge Test [21].

The growing interest in environmental literacy has not been matched by a comprehensive synthesis of its predictors and outcomes among students. Existing studies often focus narrowly on

factors or consequences of behavior (e.g., [22]) without connecting the two in a holistic framework. Consequently, a pressing need exists for a systematic literature review (SLR) that incorporates findings in both determinants and consequences of environmental literacy among students. The existing literature review conducted by Merritt et al. [23] focused on determinant factors of environmental literacy while overlooking its consequences and providing limited coverage of online environmental education. Erdogan et al. [24] focused on determining factors and ignored the consequences that affected this behavior. The study was only conducted in one class and focused only on education policies and practices in grade 8.

Some other reviews have attempted to examine the factors that determine environmental literacy in specific contexts, such as university students [25], teachers [26], prospective teachers [27], tourists [28], kindergartners [29], textbooks [30], and seminary students [31]. This study aims to fill the gap in the literature by identifying and comprehensively analyzing the factors that can influence and the impact of environmental literacy among students who have previously received little attention from previous experts. The results are expected to contribute to policymakers, schools, and institutions of education in improving environmental literacy among students. In detail, this study will answer some study questions (RQ), which are as follows.

RQ1: What are the major study trends in environmental literacy over the past two decades?

RQ2: Which countries have been most frequently explored in environmental literacy studies?

RQ3: What are the antecedents of environmental literacy?

The structure used during the process of this study is presented as follows. The introduction section provides the matters and issues of environmental literacy. The next section proposes the methodology used to identify and analyze selected papers. Subsections explore the findings and discuss the antecedents and consequences. Finally, it ends with a conclusion and a suggestion for future study.

RESEARCH METHODS

1. Design

Using a SLR with PRISMA protocol, this study aimed to comprehensively review and identify existing knowledge on environmental literacy. The use of the PRISMA protocol provided substantial benefit in terms of improving reporting quality, facilitating critical appraisal, supporting evidence-based decision-making, and ensuring adaptability through specialized extensions. The detail of using the PRISMA protocol was shown in Figure 1, following the procedures systematic from Page et.al [32].

2. Data and Source

The data were collected in all time frames searching, from 2025 to the present, from the Scopus database. The use of the Scopus database is significant for its comprehensive coverage, rigorous quality assurance, and advanced search capabilities. To achieve the objective, the analysis formulated a search strategy in keyword, abstract, and title (TITLE-ABS-KEY ("environmental literacy") AND TITLE-ABS-KEY ("students") AND PUBYEAR >2005 AND PUBYEAR <2025).

3. Selection Process

The initial identification produced 469 documents spanning from 2005 to 2025. The participation in this identification focused on the study reviews, and was limited to 299 papers. During the process, the analysis excluded conference paper (n=105), book chapter (n=37), book (n=12), review paper (n=5), conference review (n=5), backtracking (n=2), note (n=2), short survey (n=1), and errata (n=1). Non-English papers (n=11) were also excluded, which were written in Spanish, Turkish, and Slovenian. Since this study focused on pure environmental literacy, 102 papers on environmental education, 18 papers on curriculum, and 6 papers on teaching were all excluded. Concerning the inclusion process of the analysis, three reviewers were used to ensure the selected studies were relevant for further analysis, leading to 41 eligible and highly relevant documents for in-depth examination. The details of the selection process were shown in Figure 1.

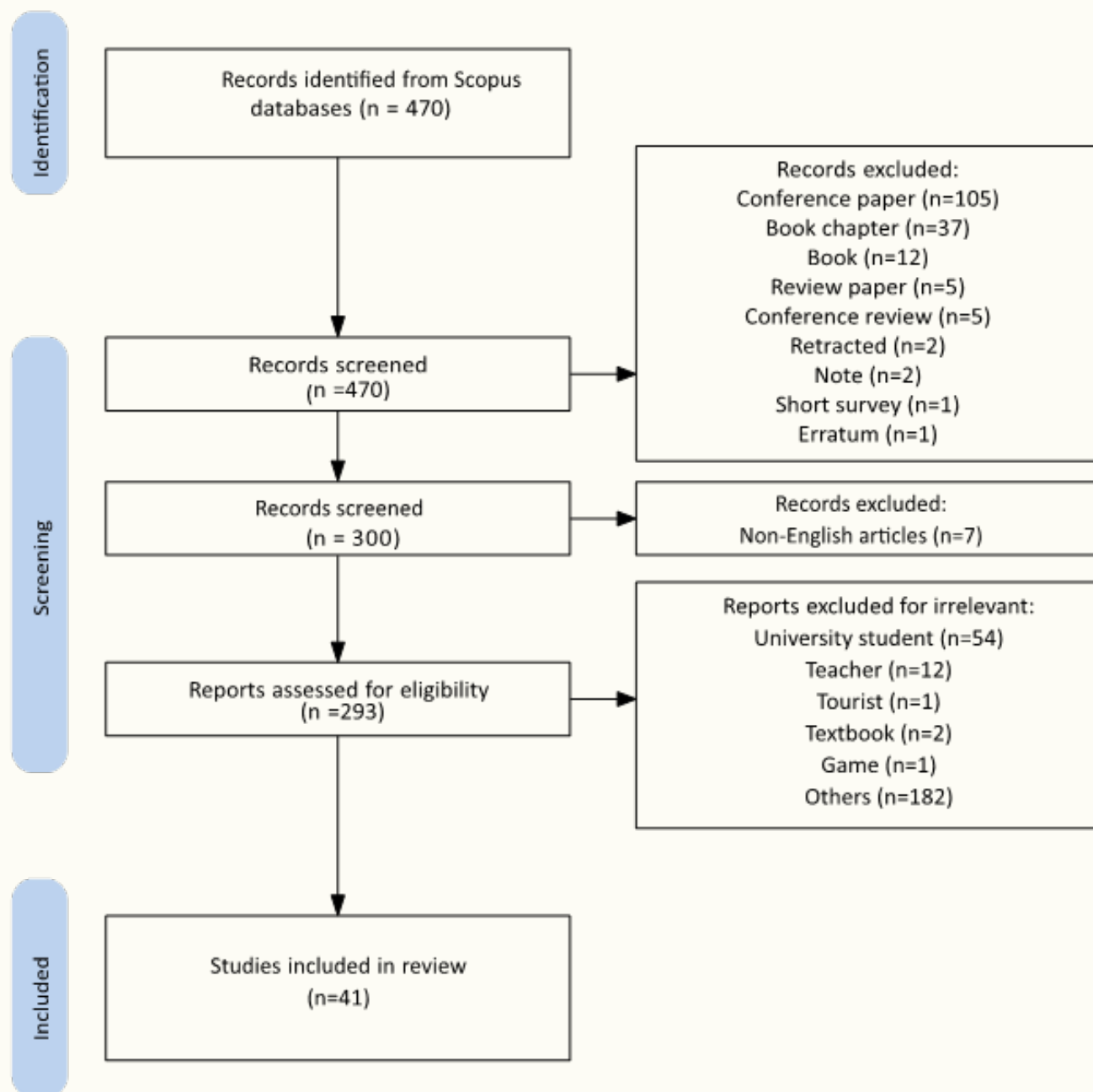


Figure 1 The selection process using PRISMA protocol

STUDY RESULTS

1. Study Trends

Figure 2 showed the annual publication of papers related to environmental literacy. The figure signified a fluctuating trend during the period of observation. The investigation started in 2005 and found no studies related to environmental literacy, signifying that the figure show data beginning from 2006. From this time frame, the process showed the peak of publication was in 2013, 2022 and 2024 with a total of 10 articles. Figure 3 showed the productive authors from various nations for identifying the antecedents and consequences of environmental literacy. As shown in the figure, Indonesia was the most concerned country in this theme, while Bulgaria was the lowest country to publish papers with one article. Australia, Greece, Hungary, and Taiwan contributed the same portion for the theme with a total of two papers per country. Relating to the discussion, recognizing and generalizing the theme on a global scale proved beneficial.

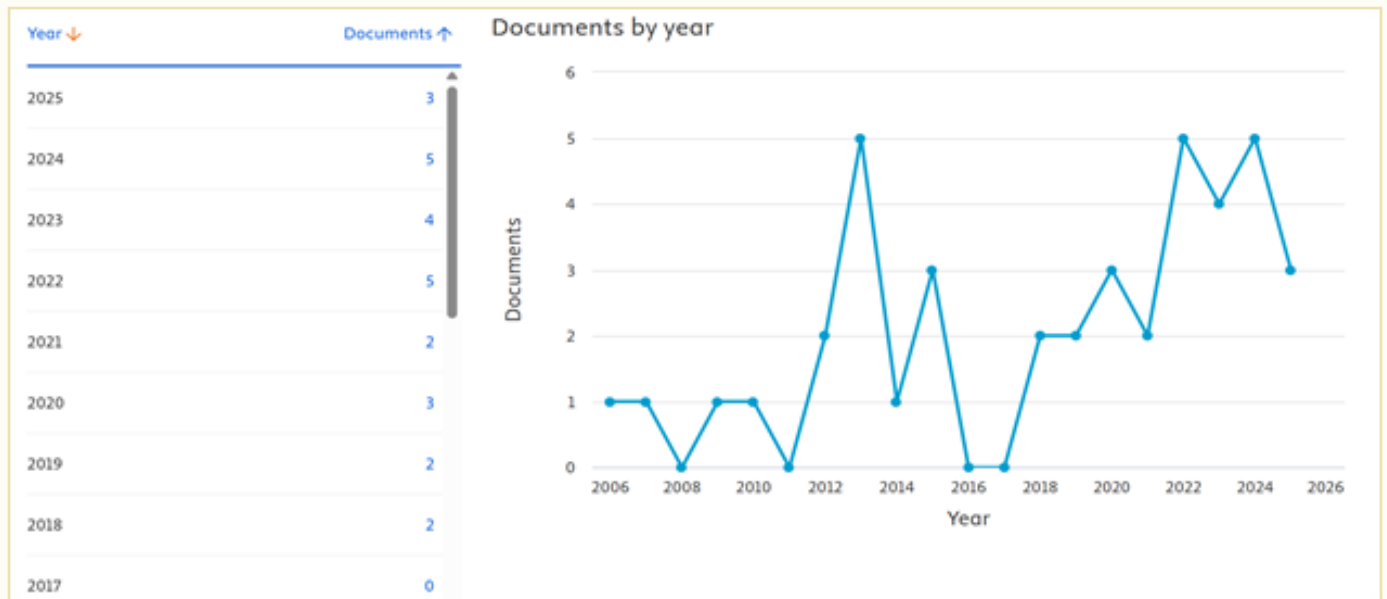


Figure 2 Study trends in environmental literacy

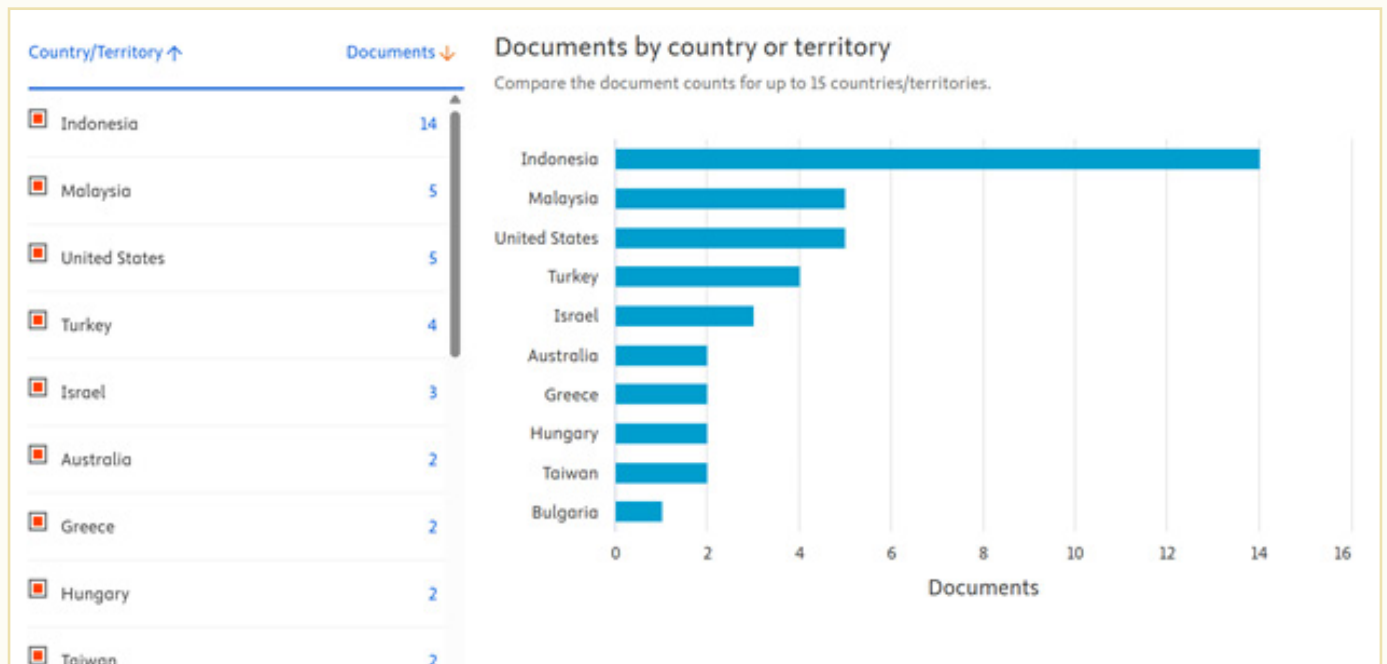


Figure 3 Demographics of countries

2. Antecedents and Consequences of Environmental Literacy

Table 1 showed the identified determinant papers from the Scopus database. Following the completion of the investigation, seventeen predictors were successfully identified. Learning models were the most recognized determinant for environmental literacy among students. Meanwhile, teacher participation, TV program, psychology of students, autonomy of students, worksheet, time outdoors, ethnicity, education of parents, and sources of information were all identified as the lowest contributors to this theme. The table also showed the second and third highest determinants, including education program, school, gender, as well as augmented reality (AR). The result discovered other predictors that were included, such as project and curriculum.

Table 1 Antecedents of environmental literacy

Authors (Year)	Teacher participation	Learning model	Augmented Reality	TV Program	Psychology of Students	Project	Education program	Autonomy of Students	School	Gender	Worksheet	Curriculum	Time outdoors	Linguistic analysis	Ethnic	Parents education	Sources of information
Herlanti et al. [33]	•																
Agustira et al. [34]		•															
Shakirova et al. [35]			•														
Lestari et al. [36]			•														
Chao [37]		•															
Tabaru et al. [38]		•															
Arici [39]			•														
Ardyansyah et al. [40]			•														
Takyi et al. [11]		•			•												
Cincera et al. [18]							•										
Hermawan et al. [41]		•															
Wajdi et al. [17]		•															
Lubis et al. [42]		•															
Frensley et al. [43]					•				•								
Klein et al [19]							•										
Suryawati et al. [21]		•															
Yusuf et al. [20]			•							•		•					
Mahat et al. [44]							•										
Wilujeng et al. [45]											•						
Kinslow et al. [46]							•										
Gilmanshina [47]							•										
Craig& Allen [48]												•					
Erdogan [24]							•										
Korolija et al. [49]		•															
Lin & Shi [50]		•															
Jannah et al. [13]										•							
Stevenson et al [51]										•			•		•		
Goldman et al.[52]							•										
Juntunen & Aksela [53]						•											
Hardy [54]														•			
Marcus [55]									•								
Ozsoy [56]									•								
Kostova & Vladimirova [57]						•											
Chu et al. [58]															•		
Macris & Georgakellos [59]									•								•
	1	10	3	1	1	2	8	1	4	3	1	2	1	1	1		

Understanding the impact of environmental literacy among students was crucial for developing an effective program of education. Based on the provided abstracts, several major antecedents and consequences had been identified. First, the identification showed that environmental literacy influenced the knowledge of students, as recognized by four experts in the sphere. Second, environmental literacy also had an impact on problem solving (n=2) among students. Third, the result showed that this behavior had an influence on environmental protection competence (n=2) and pro-environmental behavior (n=2). It also signified that environmental literacy drove creativity, approval of nature value, sensitivity to air, conduct of environmental behavior, responsibility, environmental sensitivity, positive behavior, mathematical thinking skills, agent of sustainability, recycling, and ethics among students. The details of the consequences of environmental literacy were shown in Table 2. Meanwhile, the combination of antecedents and consequences of the behavior was shown in Figure 4.

Table 2 Consequencess of environmental literacy

Authors (Year)	Knowledge	Creativity	Approval nature value	Sensitivity to air	Conducted environmental behaviour	Responsibility	Environmental sensitivity	Positive behaviour	Mathematical thinking skill	Agent of sustainability	Problem solving	Environmental protection competence	Pro-environmental behaviour	Recycling	Ethics	Parents education	Sources of information
Herlanti et al. [33]	•																
Suherman & Vidakovich [60]		•															
Chao [37]	•			•		•		•									
Tabaru & Yel [38]						•											
Arici [39]	•							•		•							
Farida et al. [61]									•								
Takyi et al. [11]										•							
Yeh et al. [22]											•						
Putra et al. [62]	•																
Suryawati et al. [21]											•						
Gilmanshina et al. [47]												•					
Wong et al. [63]													•				
Juntunen & Aksela [53]												•			•		
Marcus [55]													•				
Hatzidiakos et al [64]															•		
	4	1	1	1	1	1	1	1	1	1	2	2	2	1	1		

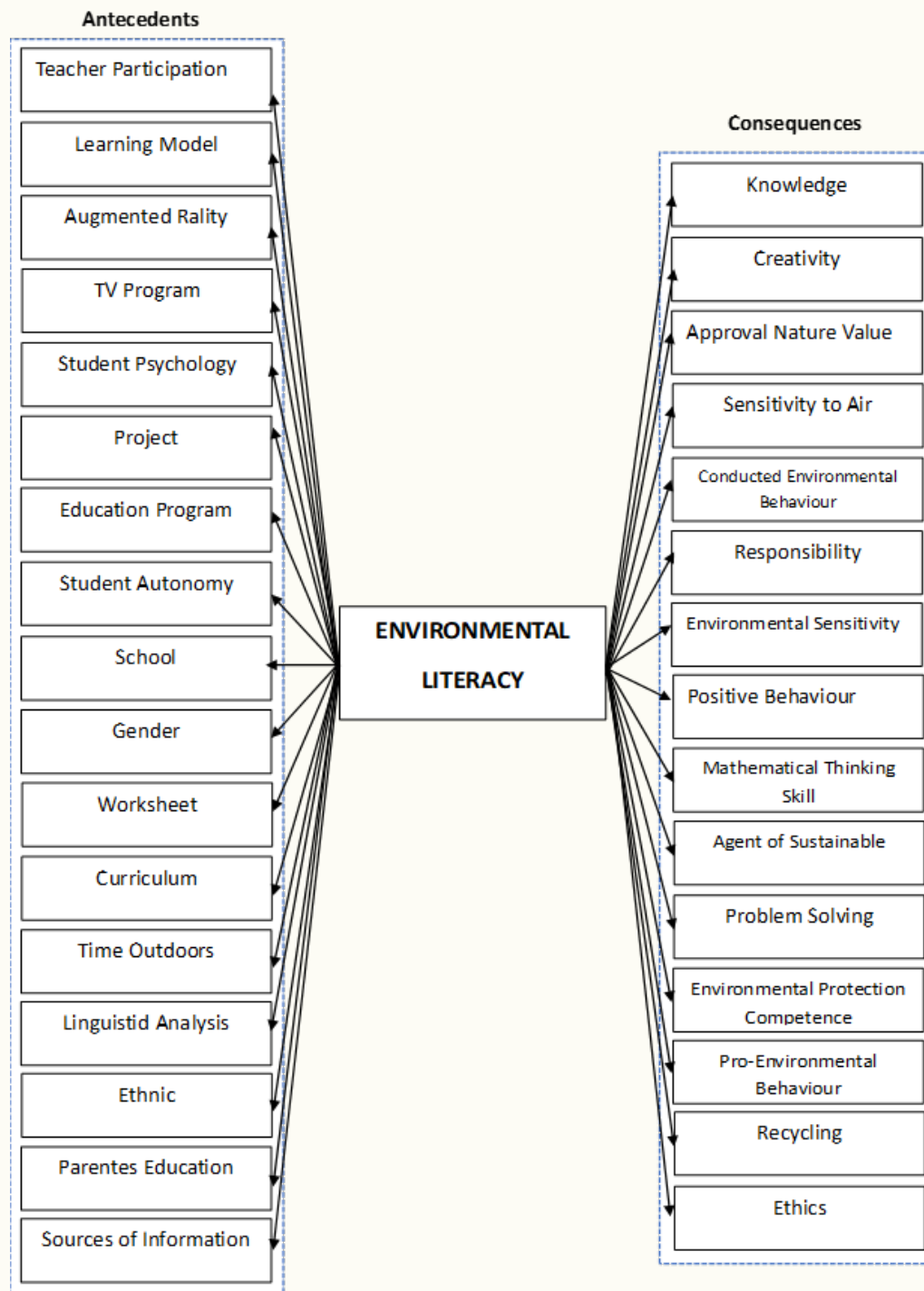


Figure 4 A model of antecedents and consequences on environmental literacy

DISCUSSION

These findings showed that learning models were a dominant factor in promoting environmental literacy among students. Several studies (e.g., [36]) identified that learning models were developed to improve this behavior in students. Learning models were also combined with local wisdom [41], multiliteracy [34], and place-based teaching. Ecological issues were considered for implementation [48] through case studies on current environmental issues and also through investigations of students in the classroom [50]. Since the behavior was important, applying various learning models was recommended. This also showed effects on other thinking skills, such as critical thinking and problem-solving, which improved environmental literacy among students.

Environmental education was the next dominant factor, where it contributed significantly to environmental literacy among students as explained by several studies (e.g., [52]). These findings discussed the role of environmental education programs in both formal and non-formal settings. In vocational education, the incorporation of environmental education by teachers and mandatory subjects also determined the behavior among students [37]. Further studies could incorporate environmental education into school programs, particularly in science education for sustainability as an essential part of school life [47]. Literature review results identified that environmental projects were factors that influenced environmental literacy among students [53]. These findings showed the influence of environment-based projects aimed at improving behavior through partnerships across disciplines and even between generations [57].

The next finding was that AR had an effect on environmental literacy among students [35]. AR supported environmental awareness, positive behavior, and development of environmental knowledge as well as skills [39]. Therefore, AR technology should be used in education to improve this behavior and to develop other variables that influence environmental literacy. From demographic factors, several literature reviews showed that gender contributed to environmental literacy [58]. Studies found that environmental literacy of female students was higher compared to males [20]. However, male students showed significantly higher environmental knowledge, affection, and cognitive skills than female [11]. Male and female students might have complementary skills when handling environmental issues [13]. Other demographic factors included the type of school, where private school students were found to have higher environmental literacy than public institutions [20]. In addition, academic school students had higher environmental literacy than technical or vocational institutions [37]. Several factors that contributed less to environmental literacy were studied, namely teacher participation [33], TV programs [11], psychology of students, and autonomy of students [43]. Other factors also included environment-based student worksheets [59], environmental curriculum, time spent in nature [49], linguistic analysis [54], ethnicity [58], education of parents, and sources of information [59]. This increased the demand for further studies to improve environmental literacy.

This study explored the consequences of environmental literacy for students. Environmental literacy strongly influenced the knowledge of students [57];. Better environmental knowledge was also associated with the ability of students to agree with natural values, be more sensitive to air quality, and engage in certain environmental behavior more frequently [37]. Moreover, good environmental literacy built in the school community had a significant impact on the knowledge of students [62].

The analysis identified the importance of environmental literacy since it influenced problem-solving abilities among students [21]. The ability helped generate alternative plans, propose better problem-solving strategies, and even analyze environmental problem-solving solutions. This process would help students develop creativity and mathematical thinking skills, identify environmental problems, evaluate issues, plan actions, as well as develop sensitivity to local and global environmental issues. The next finding showed that environmental literacy improved environmental protection competencies of students [48], for better behavior in environmentally friendly manner [55]. Environmental literacy also influenced several aspects, such as responsibility [38], environmental sensitivity, positive behavior of students [39], and ethics [64].

CONCLUSION

In conclusion, this study explored the antecedents and consequences of environmental literacy among students. The search in the Scopus database led to 485 papers and was further extracted into 41 most relevant articles. The reviews showed that the theme of environmental literacy was recognized among experts in 2026 and signified an upward trend during the period of observation in 2013, 2022, and 2024. It was also remarked that the theme has been a concern among experts in the world, with Indonesia as the most concerned country. The review showed 17 determinants of environmental literacy, including teacher participation, learning model, AR, TV program, psychology of students, project, and education program. Others included autonomy of students, school, gender, worksheet, curriculum, time outdoors, linguistic analysis, ethnicity, education of parents, and sources of information. Consequently, this study showed 15 consequences of having environmental literacy, comprising knowledge, creativity, approval of nature value, sensitivity to air, conducted

environmental behavior, responsibility, environmental sensitivity, positive behavior, mathematical thinking skill, agent of sustainability, problem solving, environmental protection competence, pro-environmental behavior, recycling, and ethics.

This study provided some implications during the course of the analysis. Institutions of education should incorporate environmental literacy into learning programs. As recognized by several experts, environmental programs or education should focus on environmental problem-solving skills at the local and global levels. Since there were many consequences of environmental literacy, initiatives to improve environmental education that focus on financial literacy at all levels of education could provide long-term benefits for the surroundings. This study also implied that various interesting learning models would be needed to inspire environmental literacy. The incorporation of local culture that prioritized environmental education to improve pro-environmental knowledge and attitudes could be enlarged with interesting learning models to stimulate environmental knowledge as well as literacy among students. Following the discussion, the analysis increased the demand for future studies to further investigate factors that have been overlooked by experts. This included teacher participation, TV programs, psychology of students, autonomy of students, environment-based worksheets, environmental curriculum, time spent in nature, linguistic analysis, ethnicity, education of parents' background, and information sources. The consequences of environmental literacy also included responsibility, environmental sensitivity, positive student behavior, and ethics. The absence of quantitative calculations should be a limitation that needs to be prioritized in these studies

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The authors declared no conflicts of interest