

A Review of Environmental Literacy Learning for Prospective Teachers

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Abstract: The urgent need to deal with specific environmental changes globally has made us aware of the importance of environmental literacy skills to achieve new relationships with the environment. This study examines and discusses the development of prospective teachers' environmental literacy. It also seeks to link the findings of the educational environment and the environmental impact of pre-service teacher environmental literacy education to the SLR approach. The literature search was conducted online in the Scopus-indexed database with "environmental literacy" and "pre-service teacher" assisted with Publish or Perish software. Then, the search results found 48 articles, followed by a procedure that included Identification, Screening, Eligibility, and Inclusion for each article. Fourteen articles fit the category, so an in-depth analysis was carried out regarding the application of environmental literacy to the prospective teacher education curriculum. The findings show prospective teachers are primarily concerned with environmental issues; however, this emotional reasoning or treatment perspective does not always translate into engaging behaviors or actions. The complexity of environmental problems makes it difficult for prospective teachers to identify how to be involved in this environmental action. Environmental learning to develop environmental literacy can be applied to the curriculum of prospective teachers. Prospective teachers have enormous potential to influence, providing examples and being role models for students in protecting the surrounding environment.

Keywords: Educational environment; Environmental literacy; Literature review; Prospective teachers

Introduction

In this 4.0 industrial evolution era, students should master thinking skills, technology mastery skills, and other soft skills in the context of the surrounding environmental problem-solving. Lecturers also have crucial strategic roles in constructing the students' behaviors dealing with their cognition, attitude, and psychomotor skills. The cognitive, affective, and psychomotor changes could be done by providing examples of activities the students try, experience, and struggle for. Thus, they will be helpful for their lives and

their environment (Ali et al., 2018). The efforts to improve the quality process and the student's learning outcomes can be made by selecting an appropriate constructivist approach. The integration of the learning approach should be relevant to the learning material context. It should be based on the current environmental issues to facilitate students in solving the environmental problems and construct their environmental care characters (Mumpuni et al., 2013). Kadir (2016) found that the environment functioned as exploration, experimentation, and self-expression to obtain new concepts and information to realize learning outcomes.

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Pratama et al. (2020) found that in a living environment, interactions occur. These interactions influenced each other in which the living creatures influenced the environment and vice versa.

Issues for the recent years show specific relevances because the ecological situations humans live in are not sustainable (Hoekstra & Wiedmann, 2014). The urgent needs to deal with the problems emphasize the importance of education as the strategy to reach the new relationship with the environment since 1990 (United Nations Educational, Scientific and Cultural Organization, 1992). Therefore, environmental education aims to redirect human relationships with the environment to improve awareness, knowledge, and responsibility toward the living environment (Garcia & Cobar-Garcia, 2018). The environmental learning implementation could be realized in the curriculum of the pre-service teachers of primary education. Science education is the appropriate study because this study is based on nature and observation. Thus, it could accurately ensure the students' cognitive development (Nurchayani et al., 2021). Environmental literacy education is important to understand the principles of ecosystem interaction. In Europe, Council on Higher Education (1998) added the environmental science topics for the University Level of Primary Education Department. Therefore, they have Environmental Education courses that must be followed for two hours per week. It has two credits. The course aims to support the pre-service teachers of primary school to understand the ecological concepts and environmental issues, awareness of environmental problems, and positive attitudes toward the environment (Saribas et al., 2017). Environmental education from an early age should be the main foundation given to the younger generation to understand the environment. The main aspect in advancing environmental insight is to develop an environmental curriculum that already exists today. In Indonesia, environmental education is used in the 2013 curriculum. The curriculum demands learners to find information, explain a daily life phenomenon, solve problems, and provide a solution (Dewi et al., 2019). However, in reality environmental learning has not been able to become the leading solution in instilling environmental literacy. Students' low attitude and concern towards the environment are very concerning because through education in schools, attitudes and behaviors that care for the environment should be instilled. Amini (2015) stated that the reality is that even though Natural Science lessons have been given since elementary school, they have not been able to equip students with knowledge and attitudes towards the environment. In order to teach environmental education and instill an attitude of environmental care to students, teachers or prospective elementary school teachers need

to master the concepts of environmental education and environmental education learning. Furthermore, Amini (2015) stated that prospective teachers are provided with knowledge about the basic concepts of environmental education and environmental education learning through Environmental Education lectures.

Many studies found the connection of environmental literacy as the soft skills developed by pre-service teachers of primary education (Hoekstra & Wiedmann, 2014). Green et al. (2016) found that environmental education in some places had not been used and been integrated with the curriculum. The environmental education integration depends on the teachers' policies and their experience. Teachers have greater potentials to influence, provide examples, and be the figures in the context of keeping the environment. This notion is strengthened by Desjean-Perrotta et al. (2008), Hungerford (2009), Yavetz et al. (2009), Tuncer et al. (2009). They argue that teachers can influence any students especially dealing with cognitive, positive behavior, values, beliefs, and actions toward their environment. Thus, they can realize environmental care awareness. An individual with excellent environmental literacy will understand and care about how the earthworks and its effects on humans (Teksöz & Ertepinar, 2010). Environmental education should be prioritized at various levels. It is important because most studies claimed that the cognition of learners and pre-service teachers and their behaviors about the environment was quite different. They also showed a low correlation between learners and the environment and many shortcomings of environmental education (Atasoy et al., 2008; Bay et al., 2010; Ernst & Theimer, 2011; Liefländer et al., 2013; Sümen & Çalisici, 2016; Teksöz & Ertepinar, 2010).

Literacy is an individual's skill description to identify, understand, create, communicate, and use his knowledge in various contexts (Farwati et al., 2018; Karimzadegan & Meiboudia, 2012). The developed environmental literacy concept is originally from science literacy (Farwati et al., 2018). Environmental literacy is defined as environmental education-related insight. It functions as the skill to recognize that an individual's selection influences the environment. The other functions are identifying any sustainable solution to a problem and acting in the most friendly way on the solution (Gayford, 2002). Then, Tuncer et al., (2009) and McBride et al., (2013) found four environmental literacy components: environmental cognition, attitude, utility perception, and awareness.

This systematic literature review is limited to studies related to environmental literacy development for prospective primary education teachers in 2015-2020. This literature review aims to analyze the development

of environmental literacy learning for prospective elementary school education teachers.

Method

The applied method for this research was a systematic literature review (SLR). Used the technique to identify, evaluate, and interpret the findings of specific topics to answer the research questions of the previous studies (Kitchenham & Charters, 2007). Kitchenham et al. (2007) argue that the meta-analysis method requires a mixed literature review and interpreted conclusions from specific fields of researches.

The method used in this study is a meta-analysis by conducting an in-depth literature review on ten journals related to the development of environmental literacy skills for primary school pre-service teachers. The literature search was done online in Scopus indexed database with keywords “environmental literacy” and “pre-service teacher” assisted with Publish or Perish software. The selection of the search scope with the Scopus indexer is based on the fact that Scopus is an indexer of journals with an international reputation, thus convincing the authors that the articles analyzed have gone through a rigorous selection process before being published.

The applied method was a modification of DeCoster (2009) it consisted of ensuring and chasing the research topics to be summarized, finding and collecting studies about the already determined issues, calculating the effect size, detecting the heterogeneity of the effect sizes, drawing a conclusion, interpreting the results, and modifying the procedures adopted from Preferred Items for Systematic Review and Meta-Analysis Statement (PRISMA). The systematic review was done with identification, screen, eligibility, and inclusion (Fakhriyah et al., 2021; Saptono & Hidayah, 2020). Here is the flowchart of the research procedure (Figure 1).

The first stage was identifying the relevant articles based on the keywords, previewing the titles and the abstract, and identifying the appropriateness with the applied criteria. The results, with the used keywords “environmental literacy”, and “pre-service teacher” in 2015 until 2024, assisted with Publish or Perish software were 48 articles. The researchers identified the articles based on the appropriateness and relevance of the keywords, titles, abstracts, and topics determined by the researchers. The selected articles were published in Scopus indexed journals. Articles reviewed studies, book recessions, non-science education reviews, and non-English written articles were excluded from the searches. The researchers screened the articles based on the determined topic or category. The results were reviewed and analyzed deeply based on the authors, published years, objectives, instruments, results, discussion, research implications, shortcomings, and recommendations. After that, the articles that met the topic were brought into the third stage. On the stage, there were eleven articles. The third stage dealt with eligibility and inclusion. The researchers tabulated the articles in the table and were adjusted based on the article criteria. They were 1) results about learning development-based environmental literacy for pre-service teachers, 2) the impacts of environmental education on pre-service teachers’ environmental literacy, and 3) the obtained articles were not the studies of the literature objectives or meta-analysis. Based on the results from fourteen articles, the researchers continued the analysis based on 1) the research type, 2) the research subject, 3) the environmental literacy component, 4) the environmental literacy measurement stage, and 5) the environmental education impacts on pre-service teachers’ environmental literacy development.

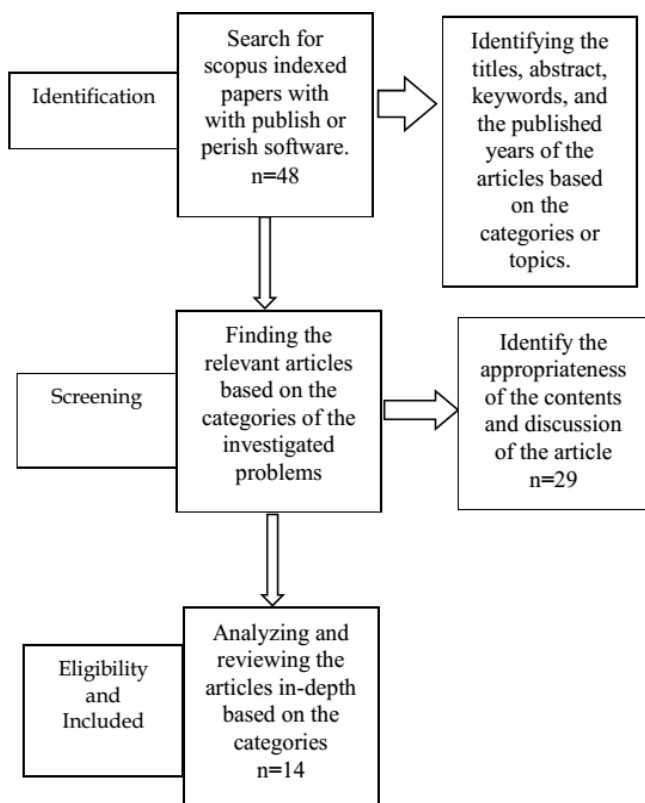


Figure 1. The research procedures

Result and Discussion

Studies concerning environmental literacy obtained data from 48 articles. The articles, fourteen articles that met with the determined topic were analyzed deeply. Here is the table of the Fourteen articles that underwent the full-text analysis.

Table 1. Included Articles for Analysis Purposes

Journal Names	Years and Publishers	Numbers	Quartile	SJR Index
International Research in Geographical and Environmental Education	2016, Informa UK Limited, trading as Taylor & Francis Group	1	Q2	0.52
Educational Sciences: Theory & Practice	2016, EDAM-Education Consultancy Limited	1	Q3	0.22
Teaching Education	2015, Routledge Taylor and Francis Group.	1	Q1	0.83
Ensenanza de las Ciencias	2018, Institut de Cirncies de l'Educcio de la Universitat Autonoma de Barcelona	1	Q2	0.50
Australian Journal of Environmental Education	2015, 2017 Cambridge University Press	2	Q2	0.47
Profesorado	2020, Universidad de Granada	1	Q3	0.34
Turkish Online Journal of Educational Technology	2015, Sakarya University	1	Q2	0.37
International Journal of Environmental & Science Education	2016, iSER, International Society of Educational Research	1	Q3	0.21
AIP Conference Proceedings	2018, American Institute of Physics	1	Not yet assigned a quartile	0.19
Data in Brief	2023, Elsevier Inc.	1	Q3	0.21
Journal of Teacher Education for Sustainability	2023, Sciendo	1	Q2	0.57
Jurnal Pendidikan IPA Indonesia	2021, Mason Publishing	1	Q3	0.38
Journal of Education and Learning	2023, Intelektual Pustaka Media Utama (IPMU) in collaboration with the Institute of Advanced Engineering and Science (IAES).	1	Not yet assigned a quartile	0.10

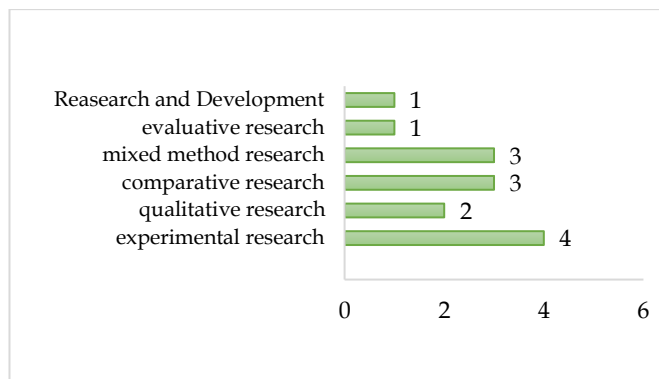


Figure 2. Distribution of research types

The obtained articles were analyzed based on (1) the research type, 2) the research subject, 3) the environmental literacy component, 4) the environmental literacy measurement stage, and 5) the environmental education impact on pre-service teachers' environmental literacy development. Most pre-service teachers were concerned with this environmental problem. However, the emotional reasoning or the nurturing perspective was not always translated into behaviors or actions (Lee et al., 2012). The complexity of the environmental problem made it difficult for teachers to identify and participate in this environmental action (Green et al., 2016). It was in line with Cheong (2005) and Esa (2010) They found that teachers could revitalize the environmental content knowledge and practices based on places and pre-service project participation in thinking critically on environmental issues that had

limited controversy with environmental education. The articles analyzed have a distribution of types of research which can be seen in Figure 2.

Furthermore, the distribution of measurement indicators and the impact of environmental literacy measurement results in the analysis can be seen in Table 2. It is written related to Author Based on Nationality affiliation, environmental literacy components, and environmental education's impact on pre-service teacher environmental literacy development.

Based on the distribution of the authors' affiliations, most correspondents about environmental literacy were from Turkey and the USA. Then, the information about the environmental literacy components was varied. However, they revealed the four main details: environmental knowledge, behavior, usage perception, and care (García-Carmona, 2018; Kroufek et al., 2015; Mashfufah et al., 2018; Saribas et al., 2017). The articles under study have similarities to the research subject, namely education students. García-Carmona (2018) found that the literate community about the environment mostly depended on the roles of the teachers. Thus, as prospective teachers, they would reach their development during the University level. The primary environmental competence could ensure their optimal training about environmental problems. The activity could introduce and promote environmental education at school and educate the students about the environment. It was in line with Barber et al. (2007), García-Carmona (2018), Garcia et al.

(2018) and Hattie et al. (2003) found that teachers' roles in promoting environmental preservation determined the school quality. The use of appropriate learning models will also strengthen environmental literacy skills. Environmental knowledge and environmental understanding can be taught to prospective teachers by developing a higher education curriculum by adding courses related to the environment, one of which is environmental education. (In addition, the inculcation of environmental knowledge needs to be instilled in the

younger generation from an early age. Kusumaningrum (2018) person's environmental literacy ability is needed to provide real action to the environment to maintain its condition and sustainability. This ability should be instilled from an early age, because the values taught to children will be embedded for a long time and are easily accepted by them. Taufiqi (2016) reveals that the best period in planting character education is in early childhood. If this period is missed, it will be increasingly difficult to form good character in children.

Table 2. Author Affiliation Recapitulation Based on Nationality, Environmental Literacy Components, and Environmental Education's Impact on the Development of Pre-service Teacher Environmental Literacy

Author affiliation based on nationality	The environmental literacy component	The learning development impacts environmental literacy
D. Saribas, et al. Turkey (2017)	<ol style="list-style-type: none"> 1) The environmental knowledge (EK), 2) environmental attitude (EA), 3) environmental usage perception (EUP), and 4) the environmental care (EC) 	The participants started with having excellent environmental attitudes, care, and perception toward environmental use. However, their skills and perceptions toward environmental uses could improve while the awareness did not change significantly.
Ö.Ö. Sümen, and H. Çalisic. Turkey, (2016)	Environmental education, learners' environmental perceptions, and related cognition and attitudes with nature	The description of STEM-learning to develop the environmental literacy of pre-service teachers of primary education with mind mapping Some teachers admitted the STEM-based activity could improve their environmental awareness and support the creativity and session effectiveness.
C. Green et al., USA, (2016)	Ecological literacy: understanding the ecological system criticisms, value awareness, and skills to act	Environmental education uses a project-citizen approach to integrate how the environmental citizens in teacher education
O.Á. García, J. S. Negre, and R. C. Forgas, Spain (2018)	Environmental literacy consists of environmental knowledge, attitude toward the environment, and behavior toward the environment	Two third (66.3%) of learners presented moderate and low cognitive levels. The learners' percentage with high-cognitive knowledge (33.7%) was higher than the learners' percentage with low cognitive level (30.2%). However, there were no significant differences observed in the cognitive level as the results of the statistics test. The primary school teacher candidates were trained in UIB. They had high environmental awareness so that they could reveal excellent intention to act. However, they did not have the demanded environmental knowledge to do their practices. The calculation of the effect size was 0.59, categorized as moderate.
Y. Gwekwerere, Canada (2014)	<ol style="list-style-type: none"> 1) The ecological knowledge and cognition about knowledge; 2) The source of environmental knowledge 3) Awareness toward environmental problems; 4) The willingness to help the environment, and 5) Belief and perception about living environmental education at schools. 	Some pre-service teachers judged their knowledge about the environment above the average. They learned from what they knew about the environment autonomously. The environmental knowledge was limited on the learners and teachers that had lower contribution toward the pro-environmental action. The pre-service teachers felt that participation in the environmental initiation was important to empower and motivate the learners to adopt the sustainable pro-environmental adoption.
García O.I, et al. Spain (2016)	Four components: cognition, influence- understandable as behaviors and environmental value-skill and environmental behavior	The designed questionnaire mostly had closed questions to mediate the answers about the obtained information. The instrument validity was valid to diagnose the EE teachers' preparations during the initial training in Spain. The internal consistency test found the reliability coefficient with a minimum score of 0.555 until 0.834.
Mashfufah, et al. Indonesia, (2018)	Environmental literacy: cognition, psychomotor, attitude, and behavior	The findings showed a positive correlation between environmental care, attitude, and cognition. It meant higher

Author affiliation based on nationality	The environmental literacy component	The learning development impacts environmental literacy
Kroufek, et al. Turkey (2015)	The four environmental literacy domains were cognition, disposition, competence, and environmental responsibility.	<p>knowledgeable persons about the environment. They would have higher positive behaviors toward environmental balance and awareness toward ecological plan and damage. There was also a positive correlation between environmental knowledge and behavior.</p> <p>The results showed no significant differences statistically between the two countries. However, there were interesting results if the ELSA sub-scale was analyzed. Learners of the Czech republic obtained higher results statistically in terms of consciousness sub-scale. It consisted of 9 items that mostly aimed at the environmental behavior that could be taken into responsibility. The environmental literacy level increased along with the increased aged. There was a strong correlation between the age and consciousness sub-scale.</p>
Dada D.O, et al., New Zealand (2017)	The environmental literacy components were (a) knowledge about ecology concept, impacts of the human toward the nature system, the environmental issues and environmental action strategies, (b) effective disposition correlated to individual sensitivity, attitude, responsibility, locus-of-control, values, and world perspective, and (c) the behaviors to express via activities or intention to act.	<p>The findings of the correlation exploration between the environmental literacy components of the research had correlations between the environmental literacy. It showed environmental education taken by the pre-service teachers influenced some correlations the environmental literacy components significantly. The strong correlation between the pre and post environmental literacy components to solve the environmental education problems was the intention to act and promote environmental care ($p = 610$ pretests) and intention to act and perform environmental behavior ($p=540$ posttest).</p>
Amirshokoohi A., USA, (2016)	The environmental literacy dimension: cognition, psychomotor, and behavior	<p>The findings showed the focused program on STS positively improved the pre-service teachers' environmental literacy and perceptions and attitudes toward the STS problems and teaching problems toward the primary school education learners. The findings showed that pre-service teachers obtained many advantages from the STS framework to teach and to learn. The findings showed that pre-service teachers obtained many advantages from the STS framework to teach and to learn.</p>
Nkaizirwa, et al. Africa, (2023)	The three dimensions measured are knowledge of the environmental system, knowledge related to actions and knowledge of the effectiveness of various actions for nature conservation.	<p>Post-intervention measurement data shows the moderating effect of social desire to respond to the relationship that exists between environmental attitudes and environmental knowledge in the comparison and treatment groups. In this journal, only data is presented without interpretation discussed in detail.</p>
Rasis, et al. Indonesia, (2023)	The main components of environmental literacy are a person's knowledge, attitudes and behavior	<p>The results of the research show that in general there is a tendency for students to obtain higher environmental literacy at the end of environmental education learning that applies open inquiry learning tools when compared with previous environmental literacy. These differences can be observed in all aspects of environmental literacy. The aspect of student disposition (affective) is the aspect that received the highest score in this research and was followed by the aspect of responsible behavior towards the environment. The knowledge (cognitive) and competency aspects in this research appear to be the aspect that obtained the lowest score. In fact, environmental education is needed to improve the knowledge aspects of prospective biology teachers.</p>
Suryani, Amin & Rohman, Indonesia, (2021)	The main aspects of environmental literacy include knowledge about ecology and the environment, attitudes towards the environment and behavior towards the environment	<p>The results of the ANCOVA test show that there is a significant influence of the use of monographs on environmental literacy. The knowledge domain obtained 0.047, the attitude domain 0.186, and the behavior domain 0.986. This research concludes that the use of monographs in learning influences aspects of ecological and environmental</p>

Author affiliation based on nationality	The environmental literacy component	The learning development impacts environmental literacy
Santiani, Fine Reffiane & Winarto, Indonesia, (2023)	The main components of environmental literacy include knowledge, attitudes and competencies.	<p>knowledge. However, it has not had a significant influence on the attitudes and behavior of prospective biology teachers towards the environment.</p> <p>Based on the research results, prospective science teacher students organize interdisciplinary science learning at school with the aim of forming environmental literacy in students who are able to implement the SDGs. Integrated teacher knowledge influences interdisciplinary learning so that the formation of interdisciplinary thinking skills is an initial stage carried out in higher education in the form of lectures.</p>

Environmental literacy is the skill to understand and interpret the health of the environmental system and take appropriate action to cure, restore, and improve the health system (Roth, 1992). It is a continuum of cognitive, psychomotor, and affective competencies to influence each other. They are grouped into three levels where the individual may be amid high and low competencies. Öztürk et al. (2016) revealed four environmental literacy components. They were (a) knowledge about the current environmental problems, (b) environmental attitude, such as feelings and values related to the environment, (c) usability, such as the individual responsibility toward the environment and intention to act, and (d) awareness, such as the sensitivity toward the environmental problems. Erdogan et al. (2011) defined six environmental literacy components in Turkey, they were 1) the knowledge about the history of nature and ecology, 2) the knowledge about environmental issues, 3) the knowledge of socio-politics and economy, 4) the cognitive skill, 5) the influence, and 6) the responsible environmental behavior. The environmental literacy components were (a) knowledge about ecology concept, impacts of the human toward the nature system, the environmental issues and environmental action strategies, (b) effective disposition correlated to individual sensitivity, attitude, responsibility, locus-of-control, values, and world perspective, and (c) the behaviors to express via activities or intention to act (Buethe & Smallwood, 1987; Goldman et al., 2014; Liu et al., 2015). Knowledge is an essential predictor of responsible behavior because it is assumed as the requirement of intentional action (Frick et al., 2004; Vicente-Molina et al., 2013). Therefore, environmental knowledge becomes the target of common intervention on environmental literacy (Onel & Mukherjee, 2016). However, knowledge cannot reflect the pro-environmental behaviors of an individual (Bamberg & Möser, 2007; Hungerford, 2009; Zsóka et al., 2013). Bamberg et al. (2007) and Kollmuss et al. (2002) did not find any linear correlation among knowledge, affective disposition, and behavior. However, environmental literacy cannot be separated from reliable behavioral

performance toward the environment because the individual's environmental literacy is reflected in his behavior toward the environment (Hollweg et al., 2011; Yavetz et al., 2009). Environmental learning requires the commitment of teachers or lecturers. Environmental learning activities can instill environmental literacy skills. Lecturers can carry out environmental learning to improve environmental literacy with various appropriate learning models. Mentioned by Amini et al. (2010) that the outdoor learning model can improve the mastery of the concept of environmental education for prospective teachers.

Haskel-Ittah (2022) found that developing learners' environmental literacy and environmental education should cover the understanding development about the ecological system. It should also include the causal correlation between the attitudes and behaviors toward the environment and develop responsible behaviors. Then, Saribas et al. (2017) found that environmental education covered ecological principles and environmental problems by teaching the environmental issues as the classroom discussion material. Environmental education is important for learners at all educational levels. Several studies have shown that students' environmental literacy is still low due to a lack of intention to know and learn about environmental problems and an environment in schools that can provide direct learning experiences by interacting with the environment. The previous studies also found some schools that did not provide a learning experience to interact directly with the environment (Abu-Hola, 2009; Cunningham, 2008; Istikomayanti et al., 2016; Sukarno, 2014; Sontay et al., 2015). Someone is said to be environmentally literate if they know what they will do for their environment. Kusumaningrum (2019) revealed that environmental literacy education should be instilled in children, especially in formal education environments. This integration will of course be related to conformity with the curriculum that applies in the formal education environment (schools). Therefore, prospective elementary school teacher students master the concept of environmental education for elementary school.

The measurement of environmental literacy in previous studies is always evolving and becoming more specific. The learning carried out by the researchers has an impact on the ability of prospective teachers in each component of environmental literacy. Changes in the awareness of students' environmental literacy increase along with the increase in their sense of responsibility with increasing age. In addition, the environmental literacy ability of prospective teachers has developed following the level of awareness about the surrounding environment and their caring attitude towards the environment. Chapman et al. (2001) found that the low environmental awareness of teaching students correlated theoretically with environmental education. Esa (2010) reported that insufficient environmental knowledge of learners and teachers contributed to intense pro-environmental behaviors. Gwekwerere (2014) found the importance of pre-service teachers' participation in environmental initiation to empower and motivate learners to adopt the sustainable pro-environmental options to change their knowledge into action. Environmental literacy cannot be separated from reliable behavioral performance toward the environment because the individual's environmental literacy is reflected in his behavior toward the environment (Hollweg et al., 2011; Yavetz et al., 2009).

The environmental literacy skill measurement was done with multiple choice (cognitive aspect with a score for a correct answer was one and an incorrect answer was zero). Then, the other aspect was measured with the Likert scale (Jacob et al., 2020; Kroufek et al., 2015; Mashfufah et al., 2018). This measurement was considered appropriate and able to reveal the environmental literacy of teacher candidates. Some studies added in-depth interviews to obtain more comprehensive information and describe ecological, cognitive, and literacy awareness. The integrated environmental education implementation significantly influenced the pre-service teachers' environmental literacy skills. Various learning approaches can develop environmental literacy in pre-service teachers, namely Engineering Science and Mathematics (STEM), Science Technology Society (STS), and the project citizen approach.

Vicente-Molina et al. (2013) and Otto et al. (2017) revealed that people should improve their environmental knowledge before being literate with the ecological challenges. It was in line with Mashfufah et al. (2018) the researcher found that ecological knowledge was not limited to learners but for all community levels, even a leader. It was essential to regulate the decision and create a program to empower the environmentally friendly habits of their community. The practice of caring for the environment can be realized by the more pre-service teachers who have information related to

environmental literacy, the more people who are aware of and care about the environment. With environmental literacy awareness, the contribution of pre-service teachers will impact students' motivation and actions on environmental awareness. Following Gwekwerere (2014), the findings point to facts about real environmental actions that have a lasting impact on students for a long time since they graduate. Most pre-service teachers in this study considered their excellent knowledge and intention to participate in environmental initiation as average. Based on the literature analysis of the studies that have been disclosed, the development of environmental literacy skills can be applied to other classes in the prospective teacher education curriculum by developing or modifying components and indicators of environmental literacy measurement according to conditions, research subjects, and research settings that allow.

The implementation of environmental learning to develop environmental literacy can be applied in the pre-service teacher school curriculum. Teachers have a greater potential to influence, set an example, and become a figure in the context of protecting the environment. Further researchers can carry out learning that develops environmental awareness and measures environmental literacy specifically. Lecturers can use various learning models to strengthen the environmental literacy skills of prospective elementary school teacher students. Lecturers can equip students with knowledge, skills and attitudes to care for the environment. Lecturers can facilitate student-teacher candidates to carry out learning activities for elementary students by mastering the concept of environmental education.

Conclusion

Based on the meta-analysis in this study, it can be concluded that the development of environmental literacy is very important for pre-service teachers. Measurement of environmental literacy components can be carried out specifically and measurably according to the environmental awareness of prospective teachers. The urgent need to deal with the situation of global environmental change has underlined the importance of education as a strategy to achieve a new relationship with the environment. From previous studies, it was found that the learning carried out by researchers had an impact on the ability of prospective teachers in each component of environmental literacy. Changes in students' awareness of environmental literacy increase along with an increase in their sense of responsibility with increasing age. With learning that increases environmental literacy, it is hoped that it can redirect the relationship between humans and the environment to

increase awareness, knowledge, and responsibility for the environment in order to understand the basic principles of interacting in the ecosystem.

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References

- Abu-Hola, I. (2009). An Islamic Perspective on Environmental Literacy. *Education*, 130(2). Retrieved from <https://rb.gy/a94jak>
- Ali, M., Ardi, M., & Tahmir, S. (2018). Penerapan Pendidikan Lingkungan Hidup Di Perguruan Tinggi Dengan Model Outdoor Learning. *UNM Environmental Journals*, 1(3), 77. <https://doi.org/10.26858/uej.v1i3.8072>
- Amini, R. (2015). Outdoor based environmental education learning and its effect in caring attitude toward environment. *Jurnal Pendidikan IPA Indonesia*, 4(1), 43-47. <https://doi.org/10.15294/jpii.v4i1.3500>
- Atasoy, E., & Ertürk, H. (2008). A field study about environmental knowledge and attitudes of elementary school students. *Journal of Education Faculty*, 10(1), 105-122. Retrieved from <https://rb.gy/1wkqtv>
- Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, 27(1), 14-25. <https://doi.org/10.1016/j.jenvp.2006.12.002>
- Barber, M., & Mourshed, M. (2007). *How the world's best performing systems come out on top*. Retrieved from <https://bibliotecadigital.mineduc.cl/handle/20.500.12365/17300>
- Bay, E., Gündoğdu, K., & Kaya, H. I. (2010). The perceptions of prospective teachers on the democratic aspects of the constructivist learning environment. *Electronic Journal of Research in Educational Psychology*, 8(2), 617-642. Retrieved from <https://www.redalyc.org/pdf/2931/29312200209.pdf>
- Buethel, C., & Smallwood, J. (1987). Teachers' environmental literacy: Check and recheck, 1975 and 1985. *The Journal of Environmental Education*, 18(3), 39-42. <https://doi.org/10.1080/00958964.1987.9942738>
- Chapman, D., & Sharma, K. (2001). Environmental attitudes and behavior of primary and secondary students in Asian cities: An overview strategy for implementing an eco-schools programme. *Environmentalist*, 21, 265-272. <https://doi.org/10.1023/A:1012996016601>
- Cheong, I. (2005). Educating pre-service teachers for a sustainable environment. *Asia-Pacific Journal of Teacher Education*, 33(1), 97-110. <https://doi.org/10.1080/1359866052000341151>
- Cunningham, D. D. (2008). Literacy Environment Quality in Preschool and Children's Attitudes Toward Reading and Writing. *Literacy Teaching and Learning*, 12(2), 19-36. Retrieved from <http://files.eric.ed.gov/fulltext/EJ899638.pdf>
- Decoster, J. (2009). *Meta-Analysis Notes*. Retrieved from <https://www.stat-help.com/Meta%20analysis%202009-06-01.pdf>
- Desjean-Perrotta, B., Moseley, C., & Cantu, L. E. (2008). Preservice Teachers' Perceptions of the Environment: Does Ethnicity or Dominant Residential Experience Matter? *The Journal of Environmental Education*, 39(2), 21-32. <https://doi.org/10.3200/JOEE.39.2.21-32>
- Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop scientific literacy. *Jurnal Pendidikan IPA Indonesia*, 8(2), 279-287. <https://doi.org/10.15294/jpii.v8i2.19261>
- Erdogan, M., & Ok, A. (2011). An assessment of Turkish young pupils' environmental literacy: A nationwide survey. *International Journal of Science Education*, 33(17), 2375-2406. <https://doi.org/10.1080/09500693.2010.550653>
- Ernst, J., & Theimer, S. (2011). Evaluating the effects of environmental education programming on connectedness to nature. *Environmental Education Research*, 17(5), 577-598. <https://doi.org/10.1080/13504622.2011.565119>
- Esa, N. (2010). Environmental knowledge, attitude and practices of student teachers. *International Research in Geographical and Environmental Education*, 19(1), 39-50. <https://doi.org/10.1080/10382040903545534>
- Fakhriyah, F., Rusilowati, A., & Susilaningih, E. (2021). Argument-Driven Inquiry Learning Model: A Systematic Review. *International Journal of Research in Education and Science*, 7(3), 767-784. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1308141.pdf>
- Farwati, R., Permanasari, A., Firman, H., & Suhery, T.

- (2018). Integrasi problem based learning dalam stem education berorientasi pada aktualisasi literasi lingkungan dan kreativitas. *Seminar Nasional Pendidikan IPA Tahun 2021*, 1(1), 198–206. Retrieved from <http://conference.unsri.ac.id/index.php/semnasi/pa/article/view/688>
- Frick, J., Kaiser, F. G., & Wilson, M. (2004). Environmental knowledge and conservation behavior: Exploring prevalence and structure in a representative sample. *Personality and Individual Differences*, 37(8), 1597–1613. <https://doi.org/10.1016/j.paid.2004.02.015>
- García-Carmona, A. (2018). The Nature of Scientific Practice and Science Education: Rationale of a Set of Essential Pedagogical Principles. *Science and Education*, 27(5), 435–455. <https://doi.org/10.1007/s11191-018-9984-9>
- Garcia, M. N. Z., & Cobar-Garcia, M. R. (2018). The Environmental Literacy of Elementary School. *Journal of Nature Studies*, 17(2), 10–29. Retrieved from https://www.journalofnaturestudies.org/files/JNS17-2/10-29_Garcia_Environmental_Literacy_Elementary.pdf
- Gayford, C. G. (2002). Environmental literacy: Towards a shared understanding for science teachers. *Research in Science & Technological Education*, 20(1), 99–110. <https://doi.org/10.1080/02635140220130957>
- Goldman, D., Yavetz, B., & Pe'er, S. (2014). Student Teachers' Attainment of Environmental Literacy in Relation to Their Disciplinary Major during Undergraduate Studies. *International Journal of Environmental and Science Education*, 9(4), 369–383. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1048076.pdf>
- Green, C., Medina-Jerez, W., & Bryant, C. (2016). Cultivating environmental citizenship in teacher education. *Teaching Education*, 27(2), 117–135. <https://doi.org/10.1080/10476210.2015.1043121>
- Gwekwerere, Y. (2014). Pre-service teachers' knowledge, participation and perceptions about environmental education in schools. *Australian Journal of Environmental Education*, 30(2), 198–214. <https://doi.org/10.1017/ae.2015.15>
- Haskel-Ittah, M. (2022). Explanatory black boxes and mechanistic reasoning. *Journal of Research in Science Teaching*. <https://doi.org/10.1002/tea.21817>
- Hattie, J. A. C., Brown, G. T. L., & Keegan, P. J. (2003). A National Teacher-Managed, curriculum-based assessment system. *International Journal of Learning*, 10, 771–778. Retrieved from <https://rb.gy/142uix>
- Hoekstra, A. Y., & Wiedmann, T. O. (2014). Humanity's unsustainable environmental footprint. *Science*, 344(6188), 1114–1117. <https://doi.org/10.1126/science.1248365>
- Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). *Developing a framework for assessing environmental literacy*. Washington, DC: North American Association for Environmental Education.
- Hungerford, H. R. (2009). Environmental Education (EE) for the 21st Century: Where Have We Been? Where Are We Now? Where Are We Headed? *The Journal of Environmental Education*, 41(1), 1–6. <https://doi.org/10.1080/00958960903206773>
- Istikomayanti, Y., Suwono, H., & Irawati, M. H. (2016). Experiential learning group investigation as effort to develop environmental literacy ability at 5th Grade Students of Madrasah Ibtidaiyah. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 2(1), 57–71. <https://doi.org/10.22219/jpbi.v2i1.3372>
- Jacob, S., Nguyen, H., Garcia, L., Richardson, D., & Warschauer, M. (2020). *Teaching computational thinking to multilingual students through inquiry-based learning* (Vol. 1, pp. 1-8). IEEE. Retrieved from <https://ieeexplore.ieee.org/abstract/document/9272487/>
- Kadir, A. (2016). Perbandingan Pengetahuan Lingkungan dan Sikap Peserta Didik Dalam Penerapan Model Pembelajaran SETS dan Konvensional. *Jurnal Hasil-Hasil Penelitian*, 11(2), 1–18. <https://dx.doi.org/10.31332/ai.v11i2.451>
- Karimzadegan, H., & Meiboudia, H. (2012). Exploration of environmental literacy in science education curriculum in primary schools in Iran. *Procedia-Social and Behavioral Sciences*, 46, 404–409. <https://doi.org/10.1016/j.sbspro.2012.05.131>
- Kitchenham, B., & Charters, S. (2007). *Guidelines for performing systematic literature reviews in software engineering*. UK.
- Kollmuss, A., & Agyeman, J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, 8(3), 239–260. <https://doi.org/10.1080/13504620220145401>
- Kroufek, R., Çelik, C., & Can, Ş. (2015). The Comparison of Environmental Literacy of Czech and Turkish pre-service primary teachers using Elsa Scale. *Turk. Online J. Educ. Technol*, 8, 557–560. Retrieved from <https://rb.gy/lx3713>
- Kusumaningrum, A. (2019). Professional Development of a Teacher in the ICT Era. *KnE Social Sciences*. Retrieved from <https://knepublishing.com/index.php/Kne-Social/article/view/3902>
- Kusumaningrum, D. (2018). Literasi lingkungan dalam kurikulum 2013 dan pembelajaran IPA di SD. *Indonesian Journal of Natural Science Education*, 1(2), 545

- 57-64. <https://doi.org/10.31002/nse.v1i2.255>
- Lee, H., Chang, H., Choi, K., Kim, S.-W., & Zeidler, D. L. (2012). Developing character and values for global citizens: Analysis of pre-service science teachers' moral reasoning on socioscientific issues. *International Journal of Science Education*, 34(6), 925-953. <https://doi.org/10.1080/09500693.2011.625505>
- Liefländer, A. K., Fröhlich, G., Bogner, F. X., & Schultz, P. W. (2013). Promoting connectedness with nature through environmental education. *Environmental Education Research*, 19(3), 370-384. <https://doi.org/10.1080/13504622.2012.697545>
- Liu, S.-Y., Yeh, S.-C., Liang, S.-W., Fang, W.-T., & Tsai, H.-M. (2015). A national investigation of teachers' environmental literacy as a reference for promoting environmental education in Taiwan. *The Journal of Environmental Education*, 46(2), 114-132. <https://doi.org/10.1080/00958964.2014.999742>
- Mashfufah, A., Nurkamto, J., Sajidan, S., & Wiranto, W. (2018). Environmental literacy among biology pre-service teachers: A pilot study. *AIP Conference Proceedings*, 2014(1), 1-10. <https://doi.org/10.1063/1.5054444>
- McBride, B. B., Brewer, C. A., Berkowitz, A. R., & Borrie, W. T. (2013). Environmental literacy, ecological literacy, ecoliteracy: What do we mean and how did we get here? *Ecosphere*, 4(5), 1-20. <https://doi.org/10.1890/ES13-00075.1>
- Mumpuni, K. E., Susilo, H., & Rohman, F. (2013). Potensi tumbuhan lokal sebagai sumber belajar biologi. In *Proceeding Biology Education Conference: Biology, Science, Environmental, and Learning* (Vol. 11, No. 1, pp. 825-829). Retrieved from <https://jurnal.uns.ac.id/prosbi/article/view/7922>
- Nurcahyani, D., Yuberti, Irwandani, Rahmayanti, H., Ichsan, I. Z., & Rahman, M. M. (2021). Ethnoscience learning on science literacy of physics material to support environment: A meta-analysis research. *Journal of Physics: Conference Series*, 1796(1), 1-10. <https://doi.org/10.1088/1742-6596/1796/1/012094>
- Onel, N., & Mukherjee, A. (2016). Consumer knowledge in pro-environmental behavior: An exploration of its antecedents and consequences. *World Journal of Science, Technology and Sustainable Development*, 13(4), 328-352. <https://doi.org/10.1108/WJSTSD-01-2016-0004>
- Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change*, 47, 88-94. <https://doi.org/10.1016/j.gloenvcha.2017.09.009>
- Öztürk, N., & Teksöz, G. (2016). The Impact of Affective Constraints on Shaping Environmental Literacy: Model Testing Using Mediator and Moderator Variables. *International Electronic Journal of Environmental Education*, 6(2), 54-75. Retrieved from <https://dergipark.org.tr/en/download/article-file/225615#page=4>
- Pratama, A. Y., Marpaung, R. R., & Yolida, B. (2020). Pengaruh literasi lingkungan terhadap environmental responsibility siswa kelas XI SMA Negeri 2 Bandar Lampung. *Jurnal Bioterdidik: Wahana Ekspresi Ilmiah*, 8(1), 56-65. <https://doi.org/10.23960/jbt.v8.i1.07>
- Roth, C. E. (1992). *Environmental literacy: its roots, evolution and directions in the 1990s*. Retrieved from <http://files.eric.ed.gov/fulltext/ED348235.pdf>
- Saptono, S., & Hidayah, I. (2020). Scientific creativity: a literature review. *Journal of Physics: Conference Series*, 1567(2), 1-10. <https://doi.org/10.1088/1742-6596/1567/2/022044>
- Saribas, D., Kucuk, Z. D., & Ertepinar, H. (2017). Implementation of an environmental education course to improve pre-service elementary teachers' environmental literacy and self-efficacy beliefs. *International Research in Geographical and Environmental Education*, 26(4), 311-326. <https://doi.org/10.1080/10382046.2016.1262512>
- Sontay, G., Gökdere, M., & Usta, E. (2015). A comparative investigation of sub-components of the environmental literacy at the secondary school level. *Journal of Turkish Science Education*, 12(1), 19-28. Retrieved from <http://tused.org/index.php/tused/article/view/336>
- Sukarno, F. M. (2014). *Implementasi Model Pembelajaran Investigating, Evaluating Environmental Issue and Action (IEEIA) untuk Membangun Literasi Lingkungan Siswa SMP*. Universitas Pendidikan Indonesia.
- Sümen, Ö. Ö., & Çalisici, H. (2016). Pre-Service Teachers' Mind Maps and Opinions on STEM Education Implemented in an Environmental Literacy Course. *Educational Sciences: Theory and Practice*, 16(2), 459-476. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1101170.pdf>
- Taufiqi, H. M. (2016). *Religius Parenting; Hypnoteaching and Hypnotherapy for Brilliant Kids*. Malang: CV Media Sutra Atiga.
- Teksöz, G., & Ertepinar, H. (2010). *Environmental Literacy, Pre-Service Teachers, And A Sustainable Future*. Retrieved from <https://api.semanticscholar.org/CorpusID:15450>

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- Tuncer, G., Tekkaya, C., Sungur, S., Cakiroglu, J., Ertepinar, H., & Kaplowitz, M. (2009). Assessing pre-service teachers' environmental literacy in Turkey as a mean to develop teacher education programs. *International Journal of Educational Development*, 29(4), 426–436. <https://doi.org/10.1016/j.ijedudev.2008.10.003>
- Vicente-Molina, M. A., Fernández-Sáinz, A., & Izagirre-Olaizola, J. (2013). Environmental knowledge and other variables affecting pro-environmental behaviour: comparison of university students from emerging and advanced countries. *Journal of Cleaner Production*, 61, 130–138. <https://doi.org/10.1016/j.jclepro.2013.05.015>
- Yavetz, B., Goldman, D., & Pe'er, S. (2009). Environmental literacy of pre-service teachers in Israel: a comparison between students at the onset and end of their studies. *Environmental Education Research*, 15(4), 393–415. <https://doi.org/10.1080/13504620902928422>
- Zsóka, Á., Szerényi, Z. M., Széchy, A., & Kocsis, T. (2013). Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. *Journal of Cleaner Production*, 48, 126–138. <https://doi.org/10.1016/j.jclepro.2012.11.030>