International Journal of Environmental Impacts
Vol. 7, No. 2, June, 2024, pp. 221-232
Journal homepage: http://iieta.org/journals/ijei

Environmental Literacy and Responsibility Level of Students in the Geography Education Study Program in Universitas Negeri Semarang as Prospective Teachers

Edi Kurniawan[1], Zacky Setiawan Saputra[1], Muhammad Akhyar[2*]

[1] Department of Geography, Faculty of Social Sciences Universitas Negeri Semarang, Semarang 50229, Indonesia
[2] Education Science Study Program, Universitas Sebelas Maret, Surakarta 57121, Indonesia

Corresponding Author Email: muhammadakhyar@staff.uns.ac.id

https://doi.org/10.18280/ijei.070207

Received: 17 March 2024
Revised: 5 May 2024
Accepted: 13 May 2024
Available online: 30 June 2024

Keywords:
environmental literacy, environmental responsibility, environmental education, geography prospective teachers, pre-service teachers

ABSTRACT

Environmental issues have become a pressing global concern due to the increasingly consumptive human lifestyle. High levels of environmental literacy and responsibility are essential for reducing the rate of environmental damage, particularly among students studying Geography Education at Universitas Negeri Semarang (UNNES) who are future educators. This study analyzes students' environmental literacy and responsibility in the UNNES Geography Education program. Employing a quantitative approach, the study assessed environmental literacy variables, including indicators of knowledge, competence, affective, behavior, and environmental responsibility variables. A sample of 168 UNNES Geography Education students from semesters 4, 6, and 8 participated in the study, selected using the proportional stratified random sampling method. Data collection methods included tests, questionnaires, observations, and documentation. Data analysis was conducted using descriptive percentage analysis techniques. The study findings indicate that the environmental literacy level of UNNES Geography Education students falls within the moderate category, with an average score of 50.86. Similarly, the level of environmental responsibility is categorized as moderate, with an average value of 82.04.

1. INTRODUCTION

The world is facing increasingly complex, common challenges in environmental degradation and climate change [1-3]. Environmental degradation has become a serious concern and a crucial trending topic for stakeholders from various sectors in many countries worldwide [4, 5]. Issues such as waste management [6, 7], pollution, contamination, and the destruction of terrestrial, aquatic, and atmospheric ecosystems [8], the extinction of biodiversity [9-11], and the increase in carbon emissions [12-14] culminate in global climate change that threatens the sustainability of life on Earth [15-17].

Numerous studies demonstrate that environmental degradation and climate change stem from human activities [18-21]. Attempts to meet human needs have led to uncontrolled actions damaging the environment. Environmental harm escalates due to increasingly consumptive lifestyles and humans [22, 23]. Humans continuously exploit natural resources to improve living standards, diminishing environmental quality [4]. Anthropogenic activities, such as industry, agriculture, construction, and transportation negatively impact ecosystems, climate, resources, and biodiversity [24]. Routine human behaviors like polluting, littering, open excavations, food/plastic waste, and burning plastics also degrade the environment [4, 25].

The increasing complexity of environmental degradation indicates a growing need to enhance public understanding and awareness of environmental science and policies [26]. Public awareness of the environment is a key component in shaping community environmental behavior. Public awareness reflects people's understanding of conditions [27]. Awareness of the environment's quality and sustainability will manifest in environmentally conscious or eco-friendly behaviors [28]. As a result, global awareness has emerged regarding the urgency of environmental education to instill environmental literacy and environmental responsibility [29, 30].

Environmental literacy is an action that departs from an individual's intrinsic concern for the environment [31]. This form of literacy is considered a fundamental component that enables individuals to comprehend their role as agents and contributors to the resolution of environmental issues. It transcends the mere acquisition of factual knowledge regarding environmental concerns. At the same time, it also encompasses developing critical thinking skills, values, attitudes, and behaviors, eventually empowering individuals to engage in problem-solving and environmental action [32]. Attitudes, behavior, cognitive skills, and knowledge are four distinct aspects of this literacy [31]. These four components serve as indicators utilized in measuring the level of environmental literacy.

Environmental responsibility is the attitude of individuals who implement the values of caring for the environment. According to the study [33], environmental responsibility is an action taken to protect the environment by reducing the

negative impact on the environment. Environmental responsibility refers to the daily lifestyle that forms a sustainable function. The measurement of environmental responsibility is based on five main concepts: eco-management, persuasion, consumption or economic action, political action, and legal action [31].

Effective and comprehensive environmental education is necessary to develop environmental literacy and environmental responsibility within society. Environmental education aims to change human mindsets and cultivate individuals sensitive to environmental issues. It represents an educational dimension as an environment-based movement that addresses environmental problems [34]. Building a sense of responsibility for the environment is essential from an early age through formal education because children tend to imitate the things around them easily. In this context, the teacher's role is to provide information, motivation, and examples to increase awareness of studying environmental issues. Teachers play a central role and are responsible for educating and shaping students and the community to have environmental literacy [35]. Therefore, teachers must also possess a high level of environmental literacy [36].

UNNES Geography Education is one of the study programs in the Geography Department, Faculty of Social Sciences. Students in this study program are prepared as prospective geography teachers expected to have high environmental literacy. This is related to the fact that geography is a science that studies geosphere phenomena, including the relationships and effects they have on human life [37]; in other words, geography lessons provide knowledge and skills that are interrelated between social activities and the natural environment.

According to the initial observation results, researchers found that of 20 students in the UNNES Geography Education study program, 45% of students could understand the meaning and concept of environmental literacy well. In contrast, the other 55% only understood it enough. Other results showed that 2% of students had a low concern for the environment, 59% were moderate, and the other 39% were at a high level. The data shows that the level of environmental care for UNNES Geography Education students is still in the good category. Hence, it is necessary to conduct further research to measure the level of environmental literacy and responsibility of prospective geography teachers and how important they are in shaping the character of being responsible for the environment.

Yılmaz [38], Gabriella and Sugiarto [39], Goulgouti et al. [40], Hariyadi et al. [41], Kurniawan and Syifauddin [42], and Nasution [43] have conducted several studies on environmental literacy and responsibility. These studies share similarities in discussing the concepts used in measuring environmental literacy and responsibility. However, there are differences in the discussion regarding indicators, respondents, research sites, and data analysis techniques.

This study aims to analyze the level of environmental literacy and responsibility possessed by UNNES Geography Education study program students as prospective teachers. The results of this study are expected to be a reference for lecturers and leaders of the Department of Geography in making or reviewing policies implemented on the campus for building environmentally literate characters, become materials for students to grow their love for the environment and as a reference for the development of further related research.

2. RESEARCH METHODS

2.1 Research design

This study is a quantitative research employing a survey method. It was conducted at Universitas Negeri Semarang (UNNES), specifically within the Geography Education Study Program, Faculty of Social Sciences. The research utilizes two primary variables: environmental literacy and environmental responsibility. The environmental literacy variable is measured using four main sub-variables from Hollweg et al. [31]: (1) knowledge (cognitive), (2) competencies (cognitive skills), (3) dispositions (affective), and (4) behavior. These four sub-variables are further broken down into more detailed indicators according to the National Environmental Literacy Assessment (NELA). Meanwhile, environmental responsibility is measured using five main indicators from Hollweg et al. [31]: (1) eco-management, (2) persuasion, (3) consumer or economic action, (4) political action, and (5) legal action.

2.2 Participants

The present study engaged students from various semesters within the Geography Education Study Program at the Faculty of Social Sciences, UNNES. The total population comprised 290 students from the 4th, 6th, and 8th semesters. The selection of these particular semesters aimed to represent the majority of the student body, thereby facilitating more comprehensive data collection. The research sample size was calculated using Slovin's formula with a 5% margin of error. Based on this calculation, from a total population of 290 individuals, a sample of 168 students was selected. The sample was then generated using the proportionate stratified random sampling method. This means the sample was chosen proportionally according to the percentage of students from each semester within the population. In detail, they were 52 (4th semester), 57 (6th semester), and 59 (8th semester). The research samples were further analyzed based on gender to obtain more nuanced and detailed research findings.

2.3 Data collection

This study incorporates primary and secondary data. Primary data were collected through direct field research using tests and questionnaires. This study used tests to gather data on the knowledge and cognitive components of the environmental literacy variable. The test questions were multiple-choice items with a scoring scale based on the Guttman Scale, awarding 1 point for a correct answer and 0 points for an incorrect answer. Meanwhile, questionnaires were used to collect data on the affective and behavioral components of the environmental literacy variable and to gather data on the environmental responsibility variable. Likert Scale, ranging from 1-5 points, was utilized to generate the questionnaire.

Secondary data were collected through literature reviews and documentation. These data were derived from previous research results published in journal articles, data from UNNES institutions, and other relevant sources. Secondary data were used to complement the primary data collected.

2.4 Validity test

This study used SPSS to measure the instrument validity

through the Product Moment Correlation analysis. The testing criterion stipulated that any measurement item with a p-value exceeding 0.05 would be considered valid. Out of the 54 measurement items subjected to testing, only three were deemed invalid. After that, their reliability was examined using Cronbach's Alpha. Researchers set the following criterion: a value closer to 1 indicates higher reliability for the measurement item. The results revealed that all measurement items exhibited high to very high levels of reliability, with the affective aspect obtaining a Cronbach's Alpha of 0.907, the behavioral aspect obtaining 0.600, and the environmental responsibility aspect obtaining 0.916.

2.5 Data analysis

Data analysis in this study was conducted using descriptive statistics. This analysis involved describing and presenting the data as they are without generalizing the findings. The analysis was performed using SPSS software—generally, the statistics involved calculating the respondents' scores for each aspect or sub-variable. Subsequently, the scores were summarized, averages were calculated, and scores were computed. To determine the category or level of each indicator and variable, the obtained scores (in %) were compared with the criteria shown in Table 1. The criteria were determined by calculating the range, the number of class intervals, and then determining the length of each class interval [44].

Table 1. Descriptive analysis score criteria

Category	Range Value	
	Environmental Literacy	Environmental Responsibility
Low	12-32	27-63
Moderate	33-52	64-99
High	53-72	100-135

3. RESULTS AND DISCUSSION

UNNES Sekaran campus is administratively located in Sekaran Village, Gunungpati District, Semarang City, Central Java Province. This campus has an area of about 125, 142 ha and is geographically located in a hilly area at about 200 meters above sea level (masl) [45]. UNNES has a vision "to become a conservation-oriented university with an international reputation." Conservation is defined as a university oriented to the principles of conservation of natural resources and socio-cultural values.

Geography Education is a study program from the Department of Geography at the Faculty of Social Sciences, UNNES. This study program has a vision: "The realization of an excellent study program in the field of Geography Education with a conservation perspective and international reputation." Students in this study program are prepared to become educators who are superior, professional, skilled, and sensitive to the values of environmental conservation for teaching Geography. Thus, research related to environmental literacy and responsibility is one of the efforts to analyze the success level of the vision applied.

3.1 Result

The environmental literacy of students in the Geography Education study program at UNNES falls into the "moderate" category, with an average score of 50.86. Among the 168 respondents, 44 students (26.16%) demonstrated high levels of environmental literacy, 118 students (70.24%) were in the moderate category, and 6 students (3.6%) were in the low category. These findings are consistent with several studies that indicate student literacy is not yet optimal and requires further development to cultivate a character that values environmental sustainability [40, 43].

Based on the findings in Table 2, UNNES Geography Education students exhibit greater interest in environmental issues through their actual attitudes and actions compared to their knowledge and competence in identifying, analyzing, and evaluating environmental phenomena in their surroundings. This trend aligns with several studies indicating that affective indicators and environmental care behavior constitute the highest percentages in shaping an individual's environmental literacy, surpassing indicators of knowledge and competence [38, 41, 43]. Specifically, this study reveals that affective indicators account for 76.13%, behavior indicators for 71.15%, knowledge indicators for 54.00%, and competency indicators for 49.71%.

Table 2. Results of environmental literacy level analysis

Environmental Literacy	
High	44 (26.16%)
Moderate	118 (70.24%)
Low	6 (3.6%)
Total of environmental literacy	50.86
Based on Indicator (%)	
Knowledge	54
Competence	49.71
Affective	76.13
Behavior	71.15
Based on Gender (%)	
Male	62.74
Female	67.66

Source: Research Result, 2022

A person's attitudes and behaviors towards the environment are shaped by the surrounding social environment, making it a significant factor influencing the level of environmental literacy among UNNES Geography Education students. Based on these findings, it is evident that students encounter challenges in cultivating an interest in enhancing their general knowledge and competence to identify, analyze, and devise plans for investigating environmental issues. This difficulty stems from a need for more individual interest and awareness, contrasting with the students' tendency to demonstrate high affective and environmental care behavior. This inclination is linked to various factors that shape an individual's attitude, including social interaction, personal experiences, culture, influence from significant others, mass media, educational and religious institutions, as well as internal factors [46].

The data presented in Table 2 indicates that female students exhibit a higher level of environmental literacy in comparison to their male counterparts. This finding aligns with previous research, which suggests that women possess a heightened sensitivity and willingness to engage with environmental issues, consequently leading to a more profound understanding of environmental literacy [47]. However, it is noteworthy that several studies have also posited that male students demonstrate a higher degree of environmental literacy than women, particularly in the domains of affective and

environmental care behavior [38, 40]. However, researchers must emphasize that the gender-based analysis in this study and several other studies was conducted solely to offer more detailed results. There was no intention to underscore gender bias, promote discrimination, or perpetuate gender stereotypes.

Table 3. Results of environmental literacy level analysis

	Semester 4	Semester 6	Semester 8
Environmental Literacy	52.1	49.5	51.07
Based on Indicator (%)			
Knowledge	55.8	49.4	57
Competence	49.43	48.57	50.86
Affective	78.18	73.85	76.48
Behavior	72.9	70.45	70.35
Based on Gender (%)			
Male	65.42	61.18	62.03
Female	68.65	65.73	68.69

Source: Research Result, 2022

Based on the data presented in Table 3 above, students in semester 4 exhibit the highest level of environmental literacy compared to those in semesters 6 and 8. However, the range of values across all three semesters does not indicate a significant difference, as all fall within the "moderate" category. Therefore, it can be concluded that there is no discernible relationship between environmental literacy and a person's level of education [38]. Nevertheless, it is worth noting that most studies with similar discussions suggest that individuals with higher educational levels tend to have higher levels of environmental literacy [40, 47].

Several other studies relevant to the findings of this research include the study by Mandaric and Hunjet [48], which states that the level of education does not significantly influence an individual's environmental concern. Additionally, other studies have found that education level does not affect preferences for green electricity [49], recycling behavior [50], organic food consumption [51], or water conservation [52]. Furthermore, studies by Li et al. [53] and Blake [54] also indicate that education level does not significantly impact an individual's environmental concern and attitudes. A comparison of environmental literacy in semesters 4, 6, and 8 students is presented in Figure 1.

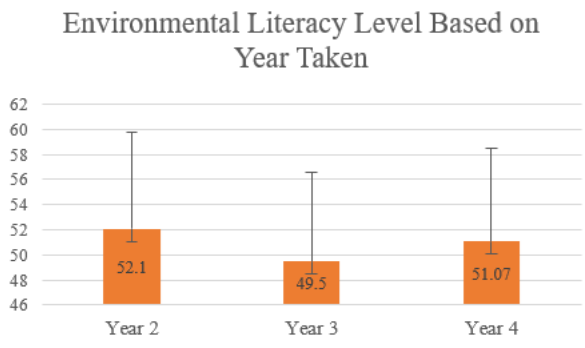

Figure 1. Comparison of environmental literacy levels

The calculations presented in Table 2 indicate that female students in each semester exhibit higher environmental literacy compared to male students. These findings are consistent with the measurements conducted on all respondents. Similarly, across all semesters, affective indicators register the highest percentage, while competence indicators record the lowest percentages in shaping the environmental literacy level of students. These results, per the measurements conducted on all respondents, indicate that students demonstrate more positive outcomes on indicators associated with attitudes and actions. In contrast, indicators related to understanding environmental issues still need to exhibit more optimal results.

3.2 Environmental responsibility

Based on data analysis result, the environmental responsibility of UNNES Geography Education students is in the "moderate" category with an average value of 82.04. Furthermore, 28 students (16.67%) have a level of environmental responsibility in the high category, 116 (69.05%) in the moderate category, and 24 (14.29%) in the low category. This result is in line with several studies that state that students generally show a moderate level of environmental responsibility [39, 55]. The results of the environmental responsibility analysis are shown in Table 4 below.

Table 4. Results of environmental responsibility level analysis

Environmental Responsibility	
High	28 (16.67%)
Moderate	116 (69.05%)
Low	24 (14.29%)
Environmental Responsibility Total	82.04
Based on Indicator (%)	
Eco-management	65.067
Persuasion	60.84
Economic Action or Consumption	67.47
Political Action	51.2
Legal action	57.08
Based on Gender (%)	
Male	58.02
Female	62.10

Source: Research Result, 2022

The majority of UNNES Geography Education students tend to exhibit a higher sense of responsibility for the environment concerning self-awareness compared to activities involving others, particularly in the realm of political and legal action. The data analysis presented in Table 3 reveals that the concept of economic action or consumption emerges as the indicator with the highest percentage. In contrast, the concept of political action registers the lowest percentage in shaping the level of environmental responsibility. This finding resonates with Hosana [56], who suggests that the younger generation is becoming increasingly apathetic towards engaging in political activities due to government policies often detrimental to the environment, inadequate legal protection for public criticism and reporting, and limited means to oversee environmental policy implementation.

The lack of environmental responsibility in political and legal actions contributes to the overall low environmental responsibility among UNNES Geography Education students. On the other hand, the concepts of economic action or consumption and environmental management emerge as the most influential indicators in shaping these students' environmental responsibility levels. This observation aligns with the assertion made by Minarti et al. [57], who suggest that individuals with higher knowledge and affective indicators tend to exhibit more ecological attitudes and behaviors in their

everyday lives, particularly in environmental consumption actions.

Table 4 indicates that female students in UNNES Geography Education exhibit higher environmental responsibility compared to their male counterparts. This finding is consistent with several relevant studies that suggest that women demonstrate greater commitment in all environmental aspects, both in terms of personal initiative and influence on others [58, 59]. However, some studies argue that there is no significant difference in the level of environmental responsibility between women and men due to the relatively small percentage variance; in essence, both genders play a balanced role in fulfilling their environmental responsibilities [60].

Table 5. Results of environmental responsibility level analysis

	Semester 4	Semester 6	Semester 8
Environmental Responsibility	85.31	79.22	81.92
Based on Indicator (%)			
Eco-management	66.73	63.57	65.2
Persuasion	61.92	58.68	61.96
Economic Action or Consumption	68.4	66.73	67.33
Political Action	55.68	54.32	50.76
Legal action	61.48	47.52	55.92
Based on Gender (%)			
Male	65.42	61.18	62.03
Female	68.65	65.73	68.69

Source: Research Result, 2022

Based on the data presented in Table 5, it is observed that students in semester 4 exhibit the highest level of environmental responsibility, followed by those in semester 8 and semester 6. Students across all semester levels demonstrate environmental responsibility within the "moderate" category. These findings suggest that a person's educational level and study duration are relatively independent of their level of environmental responsibility.

Table 4 reveals that female students in semesters 4, 6, and 8 exhibit higher environmental responsibility than males. The overall calculation of the environmental responsibility indicator corroborates this finding. Furthermore, an analysis of the percentage distribution across the various indicators of environmental responsibility indicates that the concept of economic action or consumption holds the highest percentage. In contrast, political action emerges as the indicator with the lowest percentage. A comparison of environmental responsibility levels across each semester is depicted in Figure 2.

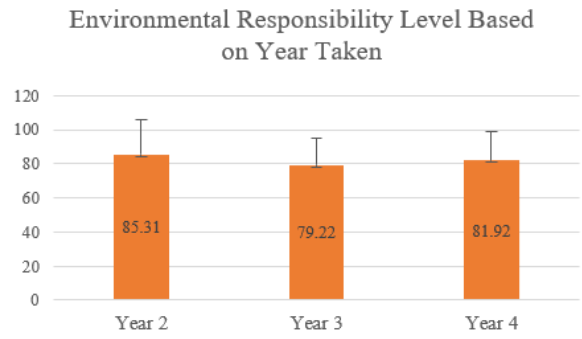

Figure 2. Comparison of environmental responsibility levels

3.3 Discussion between environmental literacy and environmental responsibility in geography education students

Based on the data analysis, it can be determined that most students in the Geography Education Study Program at UNNES exhibit high sensitivity, attitudes, and motivation toward environmental issues. Motivation relates to the willingness and interest of each individual in environmental issues. This interest fosters individuals' sensitivity to adopt attitudes and make environmentally conscious decisions. Overall, the students in the Geography Education Study Program at UNNES have understood and begun to apply the parameters within the affective indicators related to global environmental issues in their daily decision-making. These parameters include biodiversity, human population, natural resources, environmental quality and health, natural disasters and extreme weather, and land use, as established by Hollweg et al. [31].

The Geography Education Study Program students at UNNES show more interest in environmental issues through their attitudes and real actions. The factors shaping a person's attitude are influenced by social interactions, personal experiences, culture, influential individuals, mass media, educational and religious institutions, and intrinsic factors within the individual [46]. This indicates that the students' environmental awareness is associated with the interaction factors within their social environment. Living in a social environment with high environmental awareness can shape their own environmental attitudes. Additionally, personal experiences can be a key factor in forming one's environmental awareness. A person's experience with an object can create an impression that determines their positive or negative attitude towards that object [46].

Azwar's [46] statement is also relevant to Videras et al. [61], who noted that individuals with social ties to others who adhere to pro-environmental norms are likelier to engage in pro-environmental behaviors. This is because humans are inherently social beings. For instance, certain norms are associated with peer groups, and since people tend to seek conformity, they will avoid social nonconformity or seek social approval from others [62]. Additionally, Gifford and Nilsson [63] assert that individuals are significantly influenced by the context in which they live their daily lives. This context can be long-term, such as religion or social class, or more variable, such as trends or changes among close acquaintances. Another example of how social interaction influences environmental behavior is the workplace environment, indicating that a company's environmental strategies (green climate) positively affect employees' intentions and environmentally friendly behaviors [64]. Moreover, childhood to adulthood experiences also shape pro-environmental behaviors and attitudes [65], such as outdoor activities [66], watching films, socializing, or reading stories about the environment [67]. However, it is essential to remember that no single experience raises environmental awareness; instead, it combines several factors [68].

In contrast to their high affective concept mastery in daily life, students in the Geography Education Study Program at UNNES show low competency in mastering knowledge-related skills concerning environmental issues. The students have yet to demonstrate their capabilities as prospective geography educators in identifying, analyzing, and planning investigations into environmental issues related to

biodiversity, human population, natural resources, environmental health, natural disasters and extreme weather, and land use.

Several other studies show similar results, indicating that many pre-service teachers possess environmental literacy at low to moderate levels, particularly in the knowledge aspect. The study by Arif and Maryani [69] at STKIP Pesisir Selatan, West Sumatra, reveals that pre-service teachers in the Geography Education, Mathematics Education, and Information and Communication Education programs have moderate levels of environmental knowledge, with Geography pre-service teachers scoring the highest. Another study by Tuncer et al. [26] revealed that most pre-service teachers in Turkey need more knowledge to be classified as having an acceptable level of environmental knowledge. Less than half of the pre-service teachers in this study (49%) received passing grades based on the NEETF and Roper Starch assessment scale. However, despite their low levels of environmental knowledge, respondents expressed positive attitudes toward the environment and high levels of concern for environmental issues. They also expressed a sense of responsibility towards environmental problems.

Similar results were found in a study by Syahidi et al. [70] in Lombok, Indonesia, indicating that pre-service teachers have moderate environmental knowledge but high attitudes toward the environment. Additionally, research by Karyanto, et al. [71] at Universitas Sebelas Maret, Indonesia, showed that pre-service teachers in the Faculty of Teacher Training and Education have low environmental knowledge but positive attitudes towards the environment. A study by Teksoz et al. [72] concluded that pre-service teachers in Turkey need an acceptable level of environmental knowledge. This means they cannot identify, analyze, investigate, and evaluate environmental issues and the interactions between natural and social systems.

Further, a study by Goulgouti et al. [40] showed that pre-service teachers in Greece have positive attitudes towards the environment but possess moderate levels of environmental knowledge, with limited participation in environmental actions, particularly those related to collective action. A study by Tolppanen et al. [73] revealed that, at best, pre-service teachers in Finland need a more specific understanding of the climate change mitigation impacts of various actions. Their level of knowledge and confidence in their knowledge about climate change mitigation actions could be higher. The low level of knowledge indicates that most pre-service teachers need more clarification about the impact of climate change mitigation actions.

The results of this study, along with several other studies mentioned above, indicate that many pre-service teachers need to possess strong environmental literacy, particularly in the knowledge aspect. Knowledge and skills in addressing environmental issues are fundamental to developing environmental awareness. Therefore, it is crucial to incorporate environmental-related materials into the teaching and learning process. Enhancing cognitive knowledge and skills about the environment can serve as a foundation for individuals to protect natural sustainability and solve environmental problems.

Mastery of environmental knowledge and competence is fundamental for geography teachers. This aligns with the responsibility of Geography Education programs, which are part of higher education institutions tasked with facilitating pre-service teachers' social and environmental awareness development in their daily lives [74]. High environmental knowledge and understanding enable geography teachers to apply knowledge to real-world geographic phenomena.

Regarding environmental responsibility, the analysis in this study indicates that students in the Geography Education Study Program at Universitas Negeri Semarang have begun to adopt positive environmentally responsible lifestyles. This includes using eco-friendly products and reducing excessive energy, chemical consumption, and fossil fuels in their daily lives. Economic action and consumption concepts focus on environmental issues, including natural resource conservation, environmental quality and health, global warming that triggers extreme climate change and natural disasters, and land conservation [31].

Higher levels of knowledge and affective indicators influence ecological attitudes and behaviors in daily environmental consumption actions [57]. This study's results show that consumption action and eco-management have higher percentages than other concepts in measuring environmental responsibility. This correlates with the high average percentages of affective and knowledge indicators in environmental literacy. This is supported by Julina [75], who stated that environmental knowledge and understanding influence consumer attitudes in their environmental responsibility.

3.4 Enhancing environmental literacy pre-service teacher

Students enrolled in the Geography Education program at UNNES already exhibit an awareness of and concern for the environment, albeit requiring further enhancement. This challenges higher education institutions to develop learning activities that center on environmental concerns for prospective teacher candidates. Fischer et al. [76] asserted that to enhance the impact of Education for Sustainable Development (ESD) while bolstering the education sector's capacity to address intricate socio-environmental challenges, the pivotal role of teachers and teacher education cannot be overstated. UNESCO/UNEP designated the enhancement of environmental education as the "priority of priorities" in 1990. Throughout the same decade, various conferences and international agreements underscored the imperative of reorienting teacher training and education to support environmental sustainability [77, 78]. The Global Action Programme also outlined a priority key action area explicitly aimed at "strengthening the capacity of educators, trainers, and other change agents to become learning facilitators for ESD" [79].

Several other researchers also stress the urgency of environmental literacy for pre-service teachers. In schools, teachers play a pivotal role in the success of environmental education. As reflected in the curriculum, inadequate knowledge, skills, and attitudes of teachers toward the environment may result in a lower quality of students' environmental literacy [26, 80]. Students are more likely to develop higher environmental literacy when their teachers possess extensive knowledge, concern, attitudes, and responsibility toward the environment [26, 81, 82]. The teacher's role is critical as they shape and interpret the curriculum through pedagogical methods and assessments in teaching. Therefore, it can be asserted that cultivating future teachers with strong environmental literacy is a prerequisite for nurturing educators who are both capable and willing to design and implement high-quality environmental education

in schools [83-85].

However, the importance of the teacher's role in environmental education still encounters challenges. Currently, only a handful of programs in universities in Indonesia are dedicated to strengthening students' concern for the environment [86]. Therefore, educational institutions must devise strategies to enhance environmental awareness through various educational innovations and methodologies [87]. After their initial training, teacher education institutions must ensure that future educators are proficient in teaching environmental education. This necessitates high-quality teacher education programs to equip prospective teachers with the requisite knowledge, attitudes, and skills to educate younger generations on environmental issues effectively [88].

Continuous professional development is essential for pre-service teachers to build strong environmental literacy [89]. Throughout their teacher education journey, pre-service teachers should be encouraged to develop a keen interest in environmental issues, particularly those about their local context. Moreover, fostering a sense of agency in addressing ecological, social, and cultural environmental challenges is crucial, which can be facilitated by adopting various approaches to environmental issues, such as systems thinking and integrated problem-solving [90]. Furthermore, enhancing environmental literacy among pre-service teachers requires curriculum adjustments and innovative pedagogical approaches. Universities should consider integrating concepts related to the environment and methodologies to teach them in inclusive curricula [69, 91].

The urgency of fostering environmental literacy among teachers is becoming increasingly evident within the Geography Education Program. This imperative is rooted in nurturing future geography teachers who demonstrate daily heightened social and environmental awareness [74]. As students within the Geography Education program are groomed to assume roles as geography educators, their preparedness to comprehend environmental issues is crucial. This readiness equips them to serve as role models in educational settings, guiding and inspiring students through teaching and learning activities.

Geography is the science of sustainability [92]. Geography is a discipline that holds a great responsibility in teaching the science of environmental sustainability [93]. Geography also studies the relationship between humans and the environment [94]. The discipline of geography underscores spatial concepts, regionalism, and environmental considerations, including sustainability concepts. Consequently, geography emerges as an integrated field of study that holistically addresses social, economic, and environmental issues [95]. Given its holistic approach, geography inherently intertwines with the principle of sustainability, as it encompasses three crucial facets: understanding geographic space comprehensively, analyzing geographic phenomena, and fostering appreciation and responsibility towards geographic areas [96]. Geography is a cornerstone in sustainability discussions and strongly advocates for sustainable education programs aligned with sustainable development initiatives. Hence, the imperative of nurturing environmental literacy among geography pre-service teachers becomes apparent.

4. CONCLUSIONS

The environmental literacy and responsibility levels of students in the UNNES Geography Education program fall within the "moderate" category. Female students exhibit a greater proficiency in understanding the nuances of environmental literacy and responsibility than their male counterparts. This study reveals no significant influence of education level on the acquisition of environmental literacy and responsibility among Geography Education students. Moreover, students demonstrate a tendency to engage more actively in environmental protection initiatives compared to their knowledge and competence regarding environmental issues. Additionally, students display a heightened sense of responsibility towards the environment when it stems from their self-awareness rather than in activities involving larger groups.

Enhancing environmental literacy and responsibility among Geography Education students is crucial because they represent the future cohort of geography teachers. Qualified individuals with a strong environmental literacy foundation necessitate similarly qualified teachers. To achieve this, a range of diverse and innovative teaching approaches and methods are required to equip prospective teachers with environmental literacy. These approaches include problem-based learning, project-based learning, outdoor education, digital learning, and collaborative, critical, and interactive learning strategies. Additionally, various extracurricular programs augment environmental literacy among prospective teachers. Curriculum developers, program designers, researchers, and authors are expected to develop more effective and efficient curricula and provide diverse resources, such as books or other instructional materials, to foster environmental literacy skills among prospective teachers. Furthermore, prospective teachers are expected to possess environmental literacy and proficient pedagogical skills to impart environmental knowledge to their future students effectively.

This study is confined to geography education students at Universitas Negeri Semarang. Future research endeavors are encouraged to encompass a broader scope, potentially including geography education students from multiple campuses across Indonesia or prospective teacher students from disciplines beyond geography. Additionally, further research is needed to scrutinize environmental literacy among prospective teacher students and explore the correlation between the proficiency of prospective teachers and environmental education.

REFERENCES

[1] Apergis, N., Gozgor, G., Lau. C.K. (2021). Globalization and environmental problems in developing countries. Environmental Science and Pollution Research, 28: 33719-33721. https://doi.org/10.1007/s11356-021-14105-z

[2] Hernanda, T., Wardiono, K., Azhari, A.F., Arlinwibowo, J., Azizah, N., Budiono, A. (2023). The impact of environmental regulation implementation: A meta-analysis. International Journal of Sustainable Development & Planning, 18(10): 3235-3242. https://doi.org/10.18280/ijsdp.181023

[3] Ilham, M.I. (2021). Economic development and environmental degradation in Indonesia: Panel data analysis. Jurnal Ekonomi & Studi Pembangunan, 22(2): 185-200. https://doi.org/10.18196/jesp.v22i2.7629

[4] Kousar, S., Afzal, M., Ahmed, F., Bojnec, S. (2022). Environmental awareness and air quality: The mediating role of environmental protective behaviors. Sustainability, 14(6): 3138. https://doi.org/10.3390/su14063138
[5] Shutaleva, A., Martyushev, N., Nikonova, Z., Savchenko, I., Abramova, S., Lubimova, V., Novgorodtseva, A. (2021). Environmental behavior of youth and sustainable development. Sustainability, 14(1): 250. https://doi.org/10.3390/su14010250
[6] Purwanto, E., Biasini, N., Yulianto, A., Sitompul, C., Gunawan, T. (2023). Environmental awareness and food waste reduction among generation Z in Indonesia. International Journal of Environmental Impacts, 6(3): 101-111. https://doi.org/10.18280/ijei.060302
[7] Rahmanda, B., Njatrijani, R., Fadilllah, R. (2023). Environmental policy in managing E-Waste recycling: Promoting a clean environment in public policy. International Journal of Sustainable Development and Planning, 18(1): 121-126. https://doi.org/10.18280/ijsdp.180112
[8] Garipağaoğlu, N. (2020). The approaches of turkish geographers to environmental issues and studies in the field. Türkiye Araştırmaları Literatür Dergisi, 18(35): 5-45. Retrived from https://talid.org/pdf/751.pdf.
[9] Adebayo, O. (2019). Loss of biodiversity: The burgeoning threat to human health. Annals of Ibadan Postgraduate Medicine, 17(1): 1-3. https://pubmed.ncbi.nlm.nih.gov/31768149/.
[10] Hald-Mortensen, C. (2023). The main drivers of biodiversity loss: A brief overview. Journal of Ecology and Natural Resources, 7(3): 000346. https://doi.org/10.23880/jenr-16000346
[11] Jaureguiberry, P., Titeux, N., Wiemers, M., Bowler, D.E., Coscieme, L., Golden, A.S., Guerra, C.A., Jacob, U., Takahashi, Y., Settele, J., Díaz, S., Molnár, Z., Purvis, A. (2022). The direct drivers of recent global anthropogenic biodiversity loss. Science Advances, 8(45): eabm9982. https://doi.org/10.1126/sciadv.abm9982
[12] Hong, W.O. (2023). Review on carbon footprint of the Palm Oil industry: Insights into recent developments. International Journal of Sustainable Development and Planning, 18(2): 447-455. https://doi.org/10.18280/ijsdp.180213
[13] Kabir, M., Habiba, U.E., Khan, W., Shah, A., Rahim, S., Patricio, R., Ali, L., Shafiq, M. (2023). Climate change due to increasing concentration of carbon dioxide and its impacts on environment in 21st century: A mini review. Journal of King Saud University-Science, 35(5): 102693. https://doi.org/10.1016/j.jksus.2023.102693
[14] Yang, S., Yang, D., Shi, W., Deng, C., Chen, C., Feng, S. (2023). Global evaluation of carbon neutrality and peak carbon dioxide emissions: Current challenges and future outlook. Environmental Science and Pollution Research, 30(34): 81725-81744. https://doi.org/10.1007/s11356-022-19764-0
[15] IPCC. (2023). Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, https://doi.org/10.59327/IPCC/AR6-9789291691647
[16] Mohamad, D., Sanggoro, H.B., Rustendi, I., Pramono, S.A. (2022). The world bank – Environmental and social framework: Expectations and realities of implementing environmental and social safeguards in infrastructure projects in Indonesia. International Journal of Sustainable Development and Planning, 17(1): 225-234. https://doi.org/10.18280/ijsdp.170122
[17] Mohamed, M.J., Omar, A.M., Walusana, A. (2024). The status of awareness about climate change and environmental conservation among higher education students in Mogadishu City, Somalia. International Journal of Sustainable Development and Planning, 19(4): 1539-1545. https://doi.org/10.18280/ijsdp.190430
[18] Maurya, P.K. (2020). An introduction to environmental degradation: Causes, consequence and mitigation. In Environmental Degradation: Causes and Remediation Strategies. https://doi.org/10.26832/aesa-2020-edcrs-01
[19] Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., de Vries, W., de Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Reyers, B., Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. science, 347(6223): 1259855. https://doi.org/10.1126/science.1259855
[20] Yu, L., Lyu, Y., Chen, C., Choguill, C.L. (2021). Environmental deterioration in rapid urbanisation: Evidence from assessment of ecosystem service value in Wujiang, Suzhou. Environment, Development and Sustainability: A Multidisciplinary Approach to the Theory and Practice of Sustainable Development. 23(1): 331-349. https://doi.org/10.1007/s10668-019-00582-3
[21] Zhang, D., Yang, Y., Li, M., Lu, Y., Liu, Y., Jiang, J., Liu, R., Liu, J., Huang, X., Qu, J. (2022). Ecological barrier deterioration driven by human activities poses fatal threats to public health due to emerging infectious diseases. Engineering, 10: 155-166. https://doi.org/10.1016/j.eng.2020.11.002
[22] Onur, A., Sahin, E., Tekkaya, C. (2012). An investigation on value orientations, attitudes, and concern towards the environment: The case of turkish elementary school students. Environmental Education Research, 18(2): 271–297. https://doi.org/10.1080/13504622.2011.614690
[23] Sharma, M., Dawar, S., Kudal, P., Panwar, S., Gupta, N., Patnaik, A. (2023). Unpacking the drivers of sustainable consumption behavior among children: An empirical investigation of key determinants. International Journal of Sustainable Development & Planning, 18(11): 3525-3537. https://doi.org/10.18280/ijsdp.181117
[24] Prodanova, N., Naslednikova, M., Tarasova, O. (2023). Study of the impact of anthropogenic activities on the environment: Problems and prospects of sustainable nature management. E3S Web of Conferences, 420: 04001. https://doi.org/10.1051/e3sconf/202342004001
[25] Manisalidis, I., Stavropoulou, E., Stavropoulos, A., Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: A review. Frontiers in Public Health, 8(14): 1-13. https://doi.org/10.3389/fpubh.2020.00014
[26] 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
[27] Soydan, S.B., Samur, A.Ö. (2017). Validity and reliability study of environmental awareness and attitude scale for preschool children. International Electronic Journal of Environmental Education, 7(1): 78-96. https://doi.org/10.18497/IEJEE-GREEN.65615
[28] Hendryx, M., Ahern, M.M., Zullig, K.J. (2013). Improving the environmental quality component of the county health rankings model. American Journal of Public Health, 103(4): 727-732. https://doi.org/10.2105/AJPH.2012.301016
[29] Roshayanti, F., Wicaksono, A.G.C., Minarti, I.B., Nurkolis. (2020). Integrated learning for improving environmental literacy in high schools. Journal of Physics: Conference Series, 1521: 042020. https://doi.org/10.1088/1742-6596/1521/4/042020
[30] van de Wetering, J., Leijten, P., Spitzer, J., Thomaes, S. (2022). Does environmental education benefit environmental outcomes in children and adolescents? A meta-analysis. Journal of Environmental Psychology, 81: 101782. https://doi.org/10.1016/j.jenvp.2022.101782
[31] 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, 122. https://cdn.naaee.org/sites/default/files/inline-files/envliteracyexesummary.pdf.
[32] Taimur, S., Sattar, H. (2020). Education for sustainable development and critical thinking competency. In Quality Education, 238-248. https://doi.org/10.1007/978-3-319-95870-5_64
[33] Truelove, H.B., Gillis, A.J. (2018). Perception of pro-environmental behavior. Global Environmental Change, 49: 75-185. https://doi.org/10.1016/j.gloenvcha.2018.02.009
[34] Putra, N.S., Sukma, H.N., Setiawan, H. (2021). Level of environmental literacy of students and school community in green open space: Is there any difference between both of them? Jurnal Pendidikan IPA Indonesia, 10(4): 627-634. https://doi.org/10.15294/jpii.v10i4.31083
[35] Tosun, E.K., Gursakal, S. (2016). Environmental literacy levels of the classroom teachers in Turkey. The Online Journal of New Horizons In Education, 6(3): 33-59. https://doi.org/10.12973/eu-jer.11.4.2357
[36] Dada, D., Eames, C., Calder, N. (2017). Impact of environmental education on beginning preservice teachers' environmental literacy. Australian Journal of Environmental Education, 33(3): 201-222. https://doi.org/10.1017/aee.2017.27
[37] Commission of Geography Education. (2016). International Charter on Geographical Education. Retrived from https://www.Igu-Cge.Org/Wp-Content/Uploads/2019/03/IGU2016engver25Feb2019.
[38] Yılmaz, M.A. (2021). A study on environmental literacy levels of social studies teacher candidates. Review of International Geographical Education (RIGEO), 11(1): 21-42. https://doi.org/10.33403/rigeo.840387
[39] Gabriella, D.A., Sugiarto, A. (2020). Kesadaran dan Perilaku Ramah Lingkungan Mahasiswa Di Kampus. Jurnal Ilmu Sosial Dan Humaniora, 9(2): 260-275. https://doi.org/10.23887/jish-undiksha.v9i2.21061
[40] Goulgouti, A., Plakitsi, A., Stylos, G. (2019). Environmental literacy: Evaluating knowledge, affect, and behavior of pre-service teachers in Greece. Interdisciplinary Journal of Environmental and Science Education, 15(1): 4531. https://doi.org/10.29333/ijese/6287
[41] Hariyadi, E., Maryani, E., Kastolani, W. (2020). Analisis Literasi Lingkungan Pada Mahasiswa Pendidikan Geografi. Gulawentah: Jurnal Studi Sosial, 6(1): 1-16. https://doi.org/10.25273/gulawentah.v6i1.6685
[42] Kurniawan, E., Syifauddin, M. (2021). Environmental knowledge, environmental value, and environmental behavior of santri at pesantren. Turkish Journal of Computer and Mathematics Education, 12(8): 235-247. https://turcomat.org/index.php/turkbilmat/article/view/2790.
[43] Nasution, R. (2021). Analisis tingkat literasi lingkungan mahasiswa FKIP universitas mulawarman dengan transformasi skor nela (National Environmental Literacy Assessment). Jurnal Ilmiah Biosmart (JIBS), 1(1): 38-51. https://doi.org/10.30872/jibs.v1i1.423
[44] Sudjana, N. (2011). Penilaian hasil proses belajar mengajar. Bandung: Remaja Rosdakarya.
[45] Prihanto, T. (2018). Green campus management based on conservation program in universitas negeri semarang. Engineering International Conference (EIC 2017), AIP Conference Proceedings, 1941, 020024. https://doi.org/10.1063/1.5028082
[46] Azwar, S. (2015). Sikap manusia: Teori dan pengukurannya. Pustaka Pelajar.
[47] Timur, S., Timur, B., Karakas, A. (2014). Investigating pre-service teachers' knowledge and behaviors. Anthropologist, 17(1): 25-35. https://doi.org/10.1080/09720073.2014.11891411
[48] Mandaric, D., Hunjet, A. (2023). Does the education level of consumers influence their recycling and environmental protection attitudes? Evidence from Croatia. Naše Gospodarstvo / Our Economy, 69(4): 51-61. https://doi.org/10.2478/ngoe-2023-0023
[49] Ek, K., Soderholm, P. (2008). Norms and economic motivation in the Swedish green electricity market. Ecological Economics, 68(1-2): 169-182. https://doi.org/10.1016/j.ecolecon.2008.02.013
[50] Ayalon, O., Brody, S., Shechter, M., (2014). Household waste generation, recycling and prevention. Organisation for Economic Co-operation and Development, 219-245. https://doi.org/10.1787/9789264214651-11-en
[51] Hoang, H.C., Chovancova, M., Hoang, T.Q.H. (2020). The interactive effect of level of education and environmental concern toward organic food in Vietnam. Journal of Distribution Science, 18(9): 19-30. https://doi.org/10.15722/jds.18.9.202009.19
[52] Grafton, R.Q. (2014). Household behaviour and water use. Organisation for Economic Co-operation and Development, pp. 149-181. https://doi.org/10.1787/9789264214651-9-en
[53] Li, Y., Yang, D., Liu, S. (2024). The impact of environmental education at Chinese Universities on college students' environmental attitudes. PLoS ONE, 19(2): e0299231. https://doi.org/10.1371/journal.pone.0299231
[54] Blake, D.E. (2001). Contextual effects on environmental attitudes and behavior. Environment and Behavior,

33(5): 708-725. https://doi.org/10.1177/00139160121973205
[55] Nastuti, R., Lefita, L. (2020). Hubungan Pengetahuan Lingkungan Terhadap Perilaku Ramah Lingkungan Mahasiswa Stkip Ydb Lubuk Alung. Jurnal Kepemimpinan Dan Pengurusan Sekolah, 5(2): 155-162. https://doi.org/10.34125/kp.v5i2.541
[56] Hosana, P. (2014). Partisipasi Politik Dari Ide Hingga Praktik Gerakan Sejuta Relawan Pengawas Pemilu Legislatif 2014 Di Jawa Timur. Skripsi. Surabaya: Universitas Airlangga. http://repository.unair.ac.id/id/eprint/16648.
[57] Minarti, I.B., Roshayanti, F., Wicaksono, A.G.C. (2017). Hubungan Antara Pengetahuan Lingkungan Dengan Sikap Peduli Terhadap Lingkungan Pada Siswa Sma Di Semarang. Seminar Nasional Hasil Penelitian (Snhp)-Vii Lembaga Penelitian Dan Pengabdian KepadaMasyarakat Universitas Pgri Semarang, 896-900. https://prosiding.upgris.ac.id/index.php/LPPM2017/LPPM2017/paper/viewFile/2094/2409.
[58] Barnas, S., Ridwan, I.M. (2019). Perbedaan Gender dalam Pengetahuan, Sikap dan Perilaku Mahasiswa Pendidikan Fisika. DIFFRACTION: Journal for Physics Education and Applied Physics, 1(2): 1328. https://doi.org/10.37058/diffraction.v1i2.1328
[59] Ichsan, I.Z., Sigit, D.V., Miarsyah, M. (2018). Learning environment: Gender profile of students' pro-environmental behavior (PEB) based on green consumerism. Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah, 3(2): 97-107. https://doi.org/10.24042/tadris.v3i2.3358
[60] Kumurur, V. (2008). Pengetahuan, Sikap dan Kepedulian Mahasiswa Pascasarjana Ilmu Lingkungan Terhadap Lingkungan Hidup Kota Jakarta. Ekoton, 8: 1–24. https://ejournal.unsrat.ac.id/v3/index.php/EKOTON/article/view/267.
[61] Videras, J., Owen, A.L., Conover, E., Wu, S. (2012). The influence of social relationships on pro-environment behaviors. Journal of Environmental Economics and Management, 63(1): 35–50. https://doi.org/10.1016/j.jeem.2011.07.006
[62] Farrow, K., Grolleau, G., Ibanez, L. (2017). Social norms and pro-environmental behavior: A review of the evidence. Ecological Economics, 140: 1–13. https://doi.org/10.1016/j.ecolecon.2017.04.017
[63] Gifford, R., Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. International Journal of Prychology, 49(3): 141-157. https://doi.org/10.1002/ijop.12034
[64] Norton, T.A., Zacher, H., Parker, S.L., Ashkanasy, N.M. (2017). Bridging the gap between green behavioral intentions and employee green behavior: The role of green psychological climate. Journal of Organizational Behavior, 38(7): 996-1015. https://doi.org/10.21831/reid.v9i1.53505
[65] Chawla, L. (1999). Life paths into effective environmental action. The Journal of Environmental Education, 31(1): 15-26. https://doi.org/10.1080/00958969909598628
[66] Palmer, J.A. (1993). Development of concern for the environment and formative experiences of educators. Journal of Environmental Education, 24(3): 26-30. https://doi.org/10.1080/00958964.1993.9943500
[67] Eagles, P.F., Demare, R. (1999). Factors influencing children's environmental attitudes. Journal of Environmental Education, 30(4): 33-37. https://doi.org/10.1080/00958969909601882
[68] Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of pro-environmental sensitivity. The Journal of Environmental Education, 29(3): 11-21. https://doi.org/10.1080/00958969809599114
[69] Arif, M., Maryani, E. (2023). Analysis of environmental literacy profile Indonesian students at STKIP Pesisir Selatan, West Sumatera. Jurnal Geografi, 15(2): 259-271. https://doi.org/10.24114/jg.v15i2.47745
[70] Syahidi, K., Jufri, A.W., Doyan, A., Rokhmat, J., Sukarso, A.A. (2023). Environmental literacy of prospective science teacher in Lombok Indonesia. Proceedings of the 2nd International Conference on Science Education and Sciences, pp. 234-240. https://doi.org/10.2991/978-94-6463-232-3_24
[71] Karyanto, P., Riyadi, I.P., Prayitno, B.A. (2018). The ecological literacy of prospective teacher at Sebelas Maret University. Journal of Education and Learning (EduLearn), 12(2): 287-296. https://doi.org/10.11591/edulearn.v12i2.8057
[72] Teksoz, G.T., Boone, J.W., Tuzun, O.Y., Oztekin, C. (2014). An evaluation of the environmental literacy of preservice teachers in Turket through Rasch analysis. Environmental Education Research, 20(2): 202-227. https://doi.org/10.1080/13504622.2013.768604
[73] Tolppanen, S., Claudelin, A., Kang, J. (2021). Pre-service teachers' knowledge and perceptions of the impact of mitigative climate actions and their willingness to act. Research in Science Education, 51: 1629-1649. https://doi.org/10.1007/s11165-020-09921-1
[74] Frank, D.J., Meyer, J.W. (2007). University expansion and the knowledge society. Theory and Society, 36(4): 287-311. https://doi.org/10.1007/s11186-007-9035-z
[75] Julina. (2013). Determinan Perilaku Pembelian Ekologis dan Konsekuensinya Terhadap Lingkungan: Perspektif Konsumen di Kota Pekanbaru Berdasarkan Kolektivisme, Perhatian Terhadap Lingkungan, Efektivitas Konsumen, dan Kesediaan Membayar. Kutubkhanah Jurnal Penelitian Sosial Keagamaan, 16(2): 115-126. https://ejournal.uin-suska.ac.id/index.php/Kutubkhanah/article/view/226/212.
[76] Fischer, D., King, J., Rieckmann, M., Barth, M., Büssing, A., Hemmer, I., Lindau-Bank, D. (2022). Teacher education for sustainable development: A review of an emerging research field. Journal of Teacher Education, 73(5): 509-524. https://doi.org/10.1177/00224871221105784
[77] UNESCO (United Nations Educational, Scientific and Cultural Organisation). (1997). Declaration of Thessaloniki. Retrived from www.unnesco.org.
[78] UN (United Nations). (1992). Conference on environment and sustainable development. Retrived from https://www.un.org/en/conferences/environment/rio1992.
[79] UNESCO (United Nations Educational, Scientific and Cultural Organization). (2014). Roadmap for implementing the Global Action Programme on education for sustainable development. UNESCO

Publishing. Retrived from https://unesdoc.unesco.org/ark:/48223/pf0000230514.
[80] Wilke, R.J. (1985). Mandating preservice enviromental education teacher training: The Wisconsin experience. The Journal of Environmental Education, 17: 1-8. https://doi.org/10.1080/00958964.1985.9941392
[81] Saribas, D., Teksoz, G., Ertepinar, H. (2014). The relationship between environmental literacy and selfefficacy beliefs toward environmental education. Procedia - Social and Behavioral Sciences, 116: 3664-3668. https://doi.org/10.1016/j.sbspro.2014.01.820
[82] Yavetz, B., Goldman, D., Pe'er, S. (2009). Environmental literacy in pre-service teachers in Israel: A comparison between students at the onset and end of their studies. Environmental Education Research, 15: 393-415. https://doi.org/10.1080/13504620902928422
[83] Cutter, A., Smith, R. (2001). Gauging primary school teachers' environmental literacy: An issue of 'priority'. Asia Pacific Education Review, 2: 45-60. https://doi.org/10.1007/BF03026290
[84] McKeown-Ice, R. (2000). Environmental education in the United States: A survey of preservice teacher education programs. The Journal of Environmental Education, 32: 4-11. https://doi.org/10.1080/00958960009598666
[85] Tran, H.U., LePage, B.A., Fang, W.T. (2022). Environmental literacy and teaching activities of preschool teachers in Vietnam, European. Journal of Educational Research, 11(4): 2357-2371. https://doi.org/10.12973/eujer.11.4.2357
[86] Erna, M., Alimin, M., Lee, H., Suryawati, E., Albeta, S. W., Priyambada, G. (2023). Enhancing Indonesian college students' views of social responsibility of scientists and engineers: The enact model intervention. EURASIA Journal of Mathematics, Science and Technology Education, 19(3): em2240. https://doi.org/10.29333/ejmste/13000
[87] McKeown, R., Hopkins, C. (2002). Weaving sustainability into pre-service teacher education programs. In: W.L. Filho (Ed.) Teaching sustainability at Universities-Towards curriculum greening. Frankfurt am Main: Peter Lang, pp. 251-272.
[88] Alvarez-Garcia, O., Sureda-Negre, J., Comas-Forgas, R. (2015). Environmental education in pre-service teacher training: A literature review of existing. Journal of Teacher Education for Sustainability, 17(1): 72-85. https://doi.org/10.1515/jtes-2015-0006
[89] Durmus, E., Kinaci, M.K. (2021). Opinions of social studies teacher education students about the impact of environmental education on ecological literacy. Review of International Geographical Education, 11(2): 482-501. https://doi.org/10.33403/rigeo.825516
[90] Yli-Panula, E., Jeronen, E., Vesterkvist, S., Mulari, L. (2023). Subject student teachers' perceptions of key environmental problems and their own role as environmental problem solvers. Education Sciences, 13(8): 779. https://doi.org/10.3390/educsci13080779
[91] Dada, O.D. (2018). Evaluation of environmental literacy of preservice teachers in new zealand. dissertation. The University of Waikato. https://researchcommons.waikato.ac.nz/server/api/core/bitstreams/a761f67a-cc64-4a62-8cb2-c120674a8f20/content.
[92] Meadows, M.E. (2020). Geography education for sustainable development. Geography and Sustainability, 1(1): 88-92. https://doi.org/10.1016/j.geosus.2020.02.001
[93] Miao, S., Meadows, M.E., Duan, Y., Guo, F. (2022). How does the geography curriculum contribute to education for sustainable development? Lessons from China and the USA. Sustainability, 14(17): 10637. https://doi.org/10.3390/su141710637
[94] Nursa'ban, M., Mukminan, M. (2023). The implementation of geography learning with spatial representation using the discrepancy evaluation model. REID (Research and Evaluation in Education), 9(1): 49-64. https://doi.org/10.21831/reid.v9i1.53505
[95] Skarstein, F., Wolff, L.A. (2020). An issue of scale: The challenge of time, space and multitude in sustainability and geography education. Education Sciences, 10(2): 28. https://doi.org/10.3390/educsci10020028
[96] Palacios, F.A., Oberle, A., Quezada, X.C., Ullestad, M. (2017). Geographic education for sustainability: Developing a Bi-national geographical thinking curriculum. In The Power of Geographical Thinking, International Percpectives on Geographical Thinking, pp. 103-119. https://doi.org/10.1007/978-3-319-49986-4_8
[97] McBeth, B., Marcinkowski, T. (2008). National Environmental Literacy Assessment Project: Year 1: National Baseline Study of Middle Grades Students. Final Report. Bethesda, MD: NOAA retrived from https://19january2017snapshot.epa.gov/sites/production/files/documents/masternela_year1report_081208_.pdf.

APPENDIX

Sample test questions on knowledge and competency

1. Excessive use of air conditioners (AC) in daily life can damage the atmosphere, leading to accelerated global warming on the Earth's surface. This is because:

a. AC produces CO_2, a greenhouse gas that can damage the ozone layer in the Earth's atmosphere
b. AC produces nitrogen oxides that can damage the ozone layer located in the Earth's atmosphere
c. AC produces CFCs, also known as Freon, which can attack the ozone layer located in the Earth's atmosphere
d. AC produces Hydrofluorocarbons as a component of greenhouse gases that trigger acid rain
e. AC produces O_2, which causes the thinning of the troposphere and damages the ozone layer in the earth's atmosphere

2. As a maritime country, Indonesia possesses abundant marine resources that are rich in biodiversity. Unfortunately, many human activities have recently disrupted the marine ecosystem, especially coastal waters. Which human activities indicate potential damage to the coastal ecosystem:

a. Creating conservation zone areas for the coast
b. Clearing mangrove forests to establish fish and shrimp farms
c. Dredging river estuaries to reduce sediment materials carried from upstream
d. Developing educational tourism in mangrove forests

e. Not establishing economic centers such as ports and fish loading docks for fishermen

3. What efforts can be made to preserve the mangrove ecosystem?

a. Developing mangrove forest tourism
b. Integrating mangrove forests with other plants
c. Reforesting mangroves
d. Creating fish farms around mangrove forests
e. Conducting reclamation to protect mangrove forests from wave impact

Sample instrument for environmental responsibility

1. I bring my bag or basket when shopping at the market (supermarket).
2. I use the vacant land around my house to plant various plants.
3. I always dispose of trash in the appropriate place.
4. I share information about ongoing global environmental issues through my social media.
5. I reprimand family members or friends who litter.
6. I write my views on the importance of environmental conservation on personal social media and mass media.
7. I encourage family members and friends to recycle waste into items of high economic value.