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Environmental literacy profile of Muhammadiyah senior and vocational high school students in Malang Raya, East Java: What's interesting?

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ABSTRACT

Senior and vocational high school students need to have strong environmental literacy (EL) to face environmental challenges and support the achievement of SDGs. High EL levels, supported by spiritual values, encourage students to make wise, environmentally friendly decisions and become agents of environmental conservation. Muhammadiyah schools play an important role in this regard through subjects that integrate religion and life. However, there has been no mapping of spirituality-based EL profiles among Muhammadiyah students in Malang Raya. This study aims to analyze the spirituality-based EL profile of Senior and Vocational High School Muhammadiyah students in Malang Raya. Using a cross-sectional survey approach, EL data from 584 students in grades X, XI, and XII in nine Muhammadiyah schools were collected and analyzed based on gender, class, and parental education. The results showed that there was no significant difference in EL between male and female students, as well as between classes. However, parental education, especially fathers and mothers who did not attend school, had a significant effect, although the effect was small to moderate. These findings suggest that life experience and parenting factors may influence students' EL, and that educational environment factors require further exploration to fully understand their influence.

Keywords: Environmental literacy, Muhammadiyah, spirituality, students, sustainability

INTRODUCTION

Environmental problems in Indonesia are increasingly worrying (Case et al., 2007; Kurniawan & Managi, 2018), even have a detrimental impact on people's lives (Fadli et al., 2019). These environmental problems include deforestation (Austin et al., 2019; Islam et al., 2016; Petrenko et al., 2016; Tacconi et al., 2019), water pollution (Belinawati et al., 2018; Garg et al., 2018; Luo et al., 2019), air pollution (EoF team, 2019; Greenstone & Fan, 2019; Kusumaningtyas & Aldrian, 2016; Madsen, 2015; WHO, 2018), pollution by pesticides, soil pollution, and decreased soil fertility (Aktar et al., 2009; Anschell & Salamanca, 2021; Jeefoo et al., 2023; Kopittke et al., 2019; Win et al., 2020; Xuan et al., 2024). Environmental problems can be overcome, or at least reduced, by increasing public awareness of the importance of environmental quality and preservation. Public awareness of environmental quality and preservation will be realized in environmentally friendly insights (Hendryx et al., 2013; Hendryx & Ahern, 2008), built on environmental literacy (EL).

Environmental literacy is crucial as it equips individuals with the knowledge and skills to make informed decisions regarding environmental issues, promoting sustainable practices and responsible stewardship of natural resources. This understanding fosters proactive engagement in addressing global challenges such as climate change, biodiversity loss, and pollution, ensuring a healthier planet for future generations. Integrating environmental literacy into education systems prepares students to effectively tackle future environmental challenges, cultivating a society that values and

protects the environment (Israilova et al., 2023; Rofiqi, 2024; Zhang & Deng, 2024).

In fact, it is hoped that environmental problems will decrease with the increasing spread of environmental education in various educational institutions, especially with the increasing number of institutions implementing pro-environmental programs (Olsson, 2018; Schüßler et al., 2019; Steg & Vlek, 2009; Szczytko et al., 2018; Ulutas & Köksalan, 2017). Environmental education materials have been included in the curriculum in almost all countries (Afandi, 2013; Hudson, 2001; Sawitri, 2016). Specifically in Indonesia, as local content in regular educational institutions or integrated into subject materials (Adisendjaja & Romlah, 2008; Muhaimin, 2015; Steele et al., 2015; Sudjoko, 2014). Innovation in learning so that students' environmental competence and environmental literacy can be even better must continue to be encouraged (Farwati et al., 2017), especially in religious-based schools (Hadi et al., 2020; Husamah et al., 2020; Mardiani et al., 2021a), including in Muhammadiyah schools (Samidjo et al., 2023).

Muhammadiyah schools have spiritual excellence because they have Islamic and Muhammadiyah subjects which are an integration of religion with life (Aini et al., 2024; Hamami & Nuryana, 2022; Hamzah et al., 2021; Ridlo & Hafidz, 2024). Since its inception, Muhammadiyah education has implemented an integrative holistic education system and practice that places student as the subject and center of the education process (Datuk & Arifin, 2024; Sutarman et al., 2017; Widodo et al., 2019). Integrative holistic education includes educational systems and practices that have also been developed in Muhammadiyah education, including the integrity between theory and practice and unity between various education centers (schools, families, communities and social life, including environmental issues) (Romadhonie, 2023; Umami, 2018).

Encouraging EL strengthening is essential to reduce environmental impact and move towards a more sustainable future. Educational institutions play a vital role in training future generations who have a vital role in protecting the environment in the future (Heyl et al., 2013). Implementation of EL is an important requirement for environmental pollution prevention studies and environmentally friendly attitudes for sustainability (Akkor & Gündüz, 2018). Educational institutions should not forget their educational/ formative goals. In this context, it is necessary to pay attention to how to be and how to interact with the environment to achieve changes in students. EL influences and guides a person in relation to the reality of the environment (Ibáñez et al., 2020).

To effectively fulfill their roles, educational institutions must thoroughly understand their primary stakeholders: the students (Sousa et al., 2021). In this study, we propose to study or map students' environmental literacy as a basis for developing an appropriate environmental learning model. We also intend to analyze whether students' demographic characteristics affect these variables. In line with this, individual environmental literacy, as well as their academic background knowledge, are potential factors that can help address these environmental challenges (Arshad et al., 2020).

Previous researchers have had an intense focus on environmental literacy and various other competencies that support efforts to realize the Sustainable Development Goals, especially in higher education (Husamah, 2023; Husamah et al., 2022b, 2022a, 2022c; Husamah, Rahardjanto, et al., 2024; Husamah, Suwono, et al., 2023, 2024; Rahardjanto & Husamah, 2024). It is also realized that the urgency of efforts to map environmental literacy in Islamic boarding schools has been carried out (Hadi et al., 2020; Husamah et al., 2020; Mardiani et al., 2021a).

Previous researchers have paid intensive attention to environmental literacy and various

other competencies that support efforts to achieve the Sustainable Development Goals (SDGs), especially in higher education. For example, Indriyani et al (2020) highlighted the importance of environmental literacy in 21st-century education. In addition, Fajeriadi et al (2024) analyzed that the improving environmental literacy among students is necessary to be able to face global challenges such as climate change and environmental degradation. Another study by Faizah et al (2023) discussed the influence of literacy and knowledge levels on students' environmental awareness. These studies show that environmental literacy and related competencies play a crucial role in supporting the SDGs at the higher education level. However, researchers and various other researchers have not focused much on mapping the environmental literacy profile of senior high and vocational school, especially in Muhammadiyah schools.

Muhammadiyah schools are not only grounded in strong religious principles but also uniquely address contemporary challenges, such as environmental literacy, which distinguishes them from other religious-based schools (Manalu, 2023; Ridlo & Hafidz, 2024; Setiawan et al., 2022; Zuhdi et al., 2023). While many schools emphasize doctrinal teachings, Muhammadiyah schools integrate Islamic values with environmental awareness through programs like the Muhammadiyah Environmental Movement (*Gerakan Lingkungan Hidup Muhammadiyah*). These initiatives focus on practical applications, such as waste management and conservation, aligning education with global sustainability goals. However, challenges persist, including disparities in environmental literacy due to limited teacher training and resources (Syarif & Setiawati, 2024; Zaman et al., 2021). Unlike other religious schools, Muhammadiyah schools provide a holistic education that not only nurtures spirituality but also prepares students to address ecological and societal issues, making them a model of integrative education for a sustainable future (Hamami & Nuryana, 2022).

Knowing the EL profile of senior high and vocational school students is important because students are the next generation who will face various environmental challenges in the future (Berame et al., 2022; Kurdiati & Fathurohman, 2024; Mebane et al., 2023). Senior high and vocational school students are at a critical age, they begin to build awareness, understanding, and concern for environmental issues. Students' EL profiles can provide an overview of the extent to which they have ecological knowledge, environmental expectations, cognitive skills, and behaviors (Szczytko et al., 2019), needed to actively participate in environmental conservation efforts (Meilinda et al., 2017; Putra et al., 2021; Stern et al., 2022; van de Wetering et al., 2022).

Several researchers have attempted to map the EL levels of Senior High (focuses on general academic education to prepare students to continue on to college) and Vocational School (emphasizes practical vocational education to prepare students to enter the workforce directly) students. Some researchers conducted an initial survey (Gustria & Fauzi, 2019; Mahinay et al., 2023; Maknun et al., 2017; Muhlis et al., 2022; Prasetiyo et al., 2020), and there are also those who apply certain treatments followed by measuring environmental literacy aspects in students (Angreani et al., 2022; Parwati et al., 2021). There are also researchers who try to look at environmental literacy from its status as an Adiwiyata school (Maghfiroh et al., 2024; Nurwidodo et al., 2020).

However, we have not found any research that focuses on senior high and vocational schools in Muhammadiyah institutions, especially in Malang Raya. In fact, this information and data are important as an effort to serve Muhammadiyah's da'wah in the fields of education and the environment. Therefore, this first survey is certainly something new (pioneer) and will be a baseline and reference

for interested parties. In this regard, this study aims to analyze the EL of senior high and vocational school students with a Muhammadiyah background in Malang Raya, as an educational area/city. We review it from the aspects of Gender, class, and class status.

This information is very useful especially for education developers in higher education in designing effective learning strategies to improve students' environmental literacy, especially in Muhammadiyah schools. By understanding the environmental literacy profile, targeted interventions can be carried out, such as strengthening the environmental education curriculum, developing extracurricular activities based on the environment (in line with the Pancasila Student Profile Strengthening Project/P5), and fostering students' concern and responsibility for local and global environmental issues. Thus, senior high and vocational school students can be prepared to become a generation that has the awareness, knowledge, and skills to contribute to environmental conservation efforts in the future.

METHOD

Research design and participants

This cross-sectional survey study aims to collect environmental literacy data on students of Muhammadiyah Senior High and Vocational School in Malang Raya. The data collection process until publication is planned to be carried out in August 2024-July 2025. The target respondents are senior high school, senior Islamic school, and vocational school students with a Muhammadiyah background in Malang Raya, each of which is represented by three schools, namely Muhammadiyah High School 1 of Malang, Islamic High School 1 of Malang, and Muhammadiyah Vocational School 1 of Malang (Malang City). The schools are Muhammadiyah High School 3 of Batu, Islamic High School of Batu, Muhammadiyah Vocational School 1 of Batu (Batu City); Muhammadiyah Vocational School 1 of Kepanjen, Muhammadiyah Vocational School 3 of Singosari, and Muhammadiyah High School 1 of Kepanjen (Malang Regency). Gender, class, and parents education status are positioned as respondent characteristics whose impact on students' environmental literacy is analyzed in this study. The target population size of this survey is 540 people (60 students per school; or 20 per grade level in each school). Therefore, based on the Krejcie and Morgan Table, the minimum sample size with a 95% confidence level and a 5% margin of error is 513 students. The exclusion criteria in this study were students from public school programs and non-Muhammadiyah private schools, had dropped out, and did not provide complete respondent characteristic information data. After collecting data in the field, we obtained a higher number of respondents, namely 584 people.

Data collection instruments and procedures

The data collection instrument used in this study was the environmental literacy instrument based on spirituality (ELIS) that we have previously developed, has been validated, and published. This instrument consists of five dimensions: ecological knowledge (five items), environmental hope (seven items), cognitive skills (eight items), and behavior (six items). This questionnaire consists of 26 items using a 5-point Likert scale, from not important (score 1) to extremely important (score 5) (Husamah et al., 2022c). Considering that the target respondents are quite large and in line with the principles of sustainable environment, the survey process was carried out online using Google forms.

Data processing and analysis

The survey data were downloaded into comma separated value (CSV) format and checked and labeled by the authors using Microsoft Excel before analysis was conducted. After checking and labeling the data was completed, the data were analyzed using SPSS software. Respondent characteristics data were analyzed using frequency and percentage. Mean

and standard deviation scores were calculated for each item. Differences in gender were analyzed using the t-test, while differences in class, father's education, and mother's education were analyzed using one-way ANOVA. The alpha value set in this study was 5%.

RESULTS AND DISCUSSION

T-Test

The results of the T-Test of the Gender aspect are presented in Table 1, and Table 2. Table 1 shows that in the EL aspect the average for males is 110.3483 with a standard deviation of 10.00867. The average for females is 109.8247 with a standard deviation of 9.17960. Table 2 shows Levene's Test for Equality of Variances showing that the variance of EL shows a difference (p = 0.034), but the p-value for EL is still greater than 0.05, so there is no significant difference. The t-test for EL produces t = 0.648 with p = 0.258, also showing no significant difference between the average EL in males and females.

Table 1. Group statistics for gender aspects.

Group Statistics				
Gender	**N**	**Mean**	**Std. Dev**	**Std. Error Mean**
Male	333	110.3483	10.00867	.54847
Female	251	109.8247	9.17960	.57941

Table 2. Independent samples test (Levene's test for equality of variances) for gender aspects

Independent Samples Test					
Env_Literacy	**Levene's Test for Equality of Variances**		**t-test for Equality of Means**		
	F	**Sig.**	**t**	**df**	**Significance One-Sided p**
Equal variances assumed	4.531	.034	.648	582	.258
Equal variances not assumed			.656	560.111	.256

Meanwhile, Table 3 and Table 4 are the results of the analysis showing that there is no significant difference in the EL variable between men and women. Although the averages of both are slightly different, the p-value obtained from the t-test is greater than 0.05 for both variables, thus not supporting the hypothesis of a difference. The small effect size indicates that the difference does not have a significant impact. Therefore, it can be concluded that both men and women have relatively equal levels of EL in this sample.

Table 3. Independent samples test for gender aspects

	t-test for Equality of Means				
Env_Literacy	**Significance Two-Sided p**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
				Lower	**Upper**
Equal variances assumed	.517	.52365	.80757	-1.06246	2.10976
Equal variances not assumed	.512	.52365	.79783	-1.04346	2.09076

Table 4. Independent samples effect sizes for gender aspects

Independent Samples Effect Sizes				
Env_Literacy	**Standardizer[a]**	**Point Estimate**	**95% Confidence Interval**	
			Lower	**Upper**
Cohen's d	9.66126	.054	-.110	.218
Hedges' correction	9.67374	.054	-.110	.218
Glass's delta	9.17960	.057	-.107	.221

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

Analysis in Table 3 and Table 4 shows that there is no significant difference in EL levels between males and females, although there is a slight difference in the means. A p-value greater than 0.05 in the t-test indicates that the difference is not statistically significant, so the hypothesis that there is a difference between the two groups is not supported by the data. This variation in the means is not strong enough to be considered meaningful in the context of the study, which implies that the gender factor does not affect the EL levels in this sample. This finding provides important insight that the EL levels in males and females tend to be equal, so that other factors beyond gender may be more relevant in determining the EL variable in this context.

The relatively equal EL levels in males and females can be interpreted through a theoretical perspective that emphasizes that psychological or social variables, such as motivation, work environment, or individual experiences, are often more influential than biological or demographic factors such as gender (T. K. V. Kumar, 2020; Landy, 2001; Listopad et al., 2021; Lu et al., 2021; Shukla & Srivastava, 2016). In this context, social-cognitive theory and gender role theory can be used to explain that differences in EL variables may be more influenced by external factors and social learning, which shape individual abilities regardless of gender (Bussey & Bandura, 1999; Eagly & Wood, 2016; Gladstone & Cimpian, 2021; Schneider et al., 2022; Tabassum & Nayak, 2021). That is, in the same environment or under similar conditions, males and females tend to exhibit similar levels of EL because they face comparable demands and expectations (Coyle, 2005; Fang et al., 2023; Getie, 2020; Nunez & Clores, 2017; Vlassoff, 2007). This highlights the importance of considering contextual or situational factors in understanding individual differences in EL variables, rather than relying solely on demographic factors such as gender.

In addition, the small effect size supports the conclusion that the mean difference in EL between males and females is not practically significant. The low effect size suggests that this difference is small and not relevant to influence conclusions about EL levels by gender in this sample. Thus, both males and females have relatively equal levels of EL, so gender is not a major determinant of EL variables in the context of this study.

The fact that gender is not a major determinant of EL variables in the context of this study can be linked to theories that emphasize the influence of situational and contextual factors in shaping individual behavior and characteristics. One relevant theory is the social construction theory, which states that differences in behavior and abilities between males and females are more influenced by experiences and social environments than biological factors. In this study, students participated in a mixed-class learning environment, where males and females were exposed to the same teaching methods, curriculum, and opportunities for interaction. This condition likely contributed to the equality of EL levels between the two groups, as both were exposed to similar educational and social experiences that could shape their environmental literacy. As noted by Azoulay and Gilboa-Schechtman (2022) and Drake et al., (2024) shared experiences in mixed settings tend to minimize gender disparities by providing equal opportunities for learning and development. Thus, the findings suggest that other factors, such as work experience, education, and professional environment, may play a greater role in influencing EL than biological or gender differences. This supports the view that EL is a universally developable ability, influenced more by exposure to similar opportunities, training, and experiences rather than inherent gender distinctions (Ardoin & Bowers, 2020; Bloom & Fuentes, 2019; Husamah, Rahardjanto, et al., 2023; Mardiani et al., 2021b; Nunez & Clores, 2017; Örs, 2022; Sunarto, 2023; Yavetz et al., 2009).

Oneway ANOVA

1. Class aspect

Table 5, Table 6, and Table 7 are a series of one-way ANOVA results for class aspects in relation to EL of senior high and vocational school students with Muhammadiyah backgrounds. Based on Table 6, the F value is 1.936 with a significance value (p) of 0.145. This indicates that there is no significant difference between the average EL among the three classes. Based on Table 7, the results of the analysis show that there is no significant difference in the EL variable between grades 10, 11, and 12. The p value for both ANOVA analyses is greater than 0.05, indicating that the average scores for the two variables are similar among the three classes. The small effect size indicates that the differences do not have a significant impact. Thus, it can be concluded that the three classes have relatively consistent EL levels and do not show statistically significant differences.

Table 5. Descriptive information on class aspects

Env_Literacy	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum
					Lower Bound	Upper Bound	
X Grade	265	109.4302	9.78306	.60097	108.2469	110.6135	77.00
XI Grade	135	109.9630	8.82027	.75913	108.4615	111.4644	94.00
XII Grade	184	111.2391	10.00314	.73744	109.7842	112.6941	94.00
Total	584	110.1233	9.65646	.39959	109.3385	110.9081	77.00

Table 6. Results of one-way ANOVA test of class aspects

ANOVA					
Env_Literacy	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	359.872	2	179.936	1.936	.145
Within Groups	54003.252	581	92.949		
Total	54363.123	583			

Table 7. Results of ANOVA effect sizes for class aspects

Env_Literacy	Point Estimate	95% Confidence Interval	
		Lower	Upper
Eta-squared	.007	.000	.023
Epsilon-squared	.003	-.003	.020
Omega-squared Fixed-effect	.003	-.003	.020
Omega-squared Random-effect	.002	-.002	.010

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.
b. Negative but less biased estimates are retained, not rounded to zero.

The finding that there were no significant differences in EL variables between grades X, XI, and XII suggests that EL levels tend to be stable across grade levels. In the context of cognitive developmental theory, particularly Vygotsky's theory that emphasizes the importance of social and environmental interactions in the development of individual abilities (Fernyhough & Borghi, 2023; Khan et al., 2023; Langford, 2005; Peng & Kievit, 2020; Vasileva & Balyasnikova, 2019), this finding could be interpreted as suggesting that EL as a skill may be more influenced by a uniform learning environment than by educational level (Ares et al., 2024; Drajea & O'Sullivan, 2014; Kumar et al., 2023; Park et al., 2007; Scherer & Siddiq, 2019). If all three grade levels have similar exposure to EL-related content, teaching styles, and learning opportunities, then it is not surprising that their EL levels are similar. This theory highlights that the development of emotional and social skills tends to depend on the context or learning experiences that students encounter—including opportunities to access resources and learning materials—rather than on differences in grade level or age alone (Murano et al., 2021; Sørlie et al., 2021; Valiente et al., 2020; Yu et al., 2023).

The stability of EL levels across grades can

be attributed to Bandura's social learning theory. According to this theory, students learn and develop their skills through observation, interaction, and role models in their environment (Horsburgh & Ippolito, 2018; Mobley & Sandoval, 2008; Proctor & Niemeyer, 2020). If students across these grade levels are given equal opportunities to learn and practice EL through a similar school environment or program, then they will demonstrate relatively consistent levels of EL. These findings also indicate that variables such as age or grade level are not always the primary determinants of EL development, but rather access to an environment that supports EL development is more important. This suggests the importance of consistent teaching approaches and environments that support EL development for all students, regardless of their grade level (Ammar et al., 2021; Brown, 2014; Woodcock et al., 2022; Zheng, 2021).

The stability of Environmental Literacy (EL) levels across grades can be attributed to Bandura's social learning theory, which posits that students develop skills through observation, interaction, and role models in their environment. In the context of this study, the school implements a consistent, experiential learning approach across all grade levels. This includes hands-on activities such as community-based environmental projects, regular field trips to local ecosystems, and collaborative problem-solving tasks related to real-world environmental issues. These activities provide equal opportunities for students to engage with environmental concepts actively, fostering similar EL development regardless of age or grade. This consistency in teaching methods and learning environments ensures that variables like age or grade level are not the primary determinants of EL development; instead, access to supportive and engaging educational experiences plays a more crucial role. Therefore, maintaining uniform, interactive, and practical environmental education programs across all grades is essential for promoting consistent EL development among students (Hayati, 2020; Miterianifa & Mawarni, 2024; Qhutra Nada Salym et al., 2022).

2. Father's education aspect

Table 8, Table 9, and Table 10 are a series of one-way ANOVA results for the aspect of father's education in relation to EL of senior high and vocational school students with a Muhammadiyah background. Based on Table 9, it is known that the average value for each participant group shows variation, with the 'SD' group showing the highest value (113.08) in the EL variable. Overall, the average value of Env_Literacy is 110.12, indicating a relatively good level of proficiency in both of these variables among the participants involved. Based on Table 10, the results of the analysis of variance (ANOVA) show that there is a significant difference between groups in Env_Literacy ($F = 2.332$, $p = 0.041$). This indicates that father's education or educational background has an influence on EL. The effect size measured by Eta-squared for EL is 0.020, indicating that although there is a significant difference, the effect size is relatively small, meaning that the education factor only contributes little to the variability in the measured values.

Table 8. Descriptive information on father's education aspects

Descriptives

Env_Literacy	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Bachelor - Doctorate	11	108.7273	7.21236	2.17461	103.8819	113.5726
Diploma 1-Diploma 3	146	109.0068	9.31850	.77120	107.4826	110.5311
Senior High	101	110.1188	9.31481	.92686	108.2800	111.9577
Junior High	205	109.4927	9.59811	.67036	108.1710	110.8144
Elementary School	26	113.0769	10.92858	2.14327	108.6628	117.4911

Descriptives						
Env_Literacy	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
No school	95	112.5579	10.16954	1.04337	110.4863	114.6295
Total	584	110.1233	9.65646	.39959	109.3385	110.9081

Table 9. One-way ANOVA test results for father's education aspects

ANOVA					
Env_Literacy	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1074.857	5	214.971	2.332	.041
Within Groups	53288.266	578	92.194		
Total	54363.123	583			

Table 10. ANOVA effect sizes results for father's education aspects

ANOVA Effect Sizes[a,b]			
Env_Literacy	Point Estimate	95% Confidence Interval	
		Lower	Upper
Eta-squared	.020	.000	.039
Epsilon-squared	.011	-.009	.031
Omega-squared Fixed-effect	.011	-.009	.031
Omega-squared Random-effect	.002	-.002	.006

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.
b. Negative but less biased estimates are retained, not rounded to zero.

Next, post hoc analysis using the LSD method revealed significant differences in EL values, as in Table 11. Based on the data, it was found between 'D1-d3' and 'Elementary School' ($p = 0.047$), and between 'D1-d3' and 'No School' ($p = 0.005$). These findings indicate that even though individuals have low education, they have better EL skills.

Table 11. Post Hoc Tests using the LSD method for the father's education aspect

Multiple Comparisons						
(I) Father_Edu	(J) Father_Edu	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Bachelor - Doctorate	Diploma 1-Diploma 3	-.27958	3.00213	.926	-6.1760	5.6168
	Senior High	-1.39154	3.04862	.648	-7.3793	4.5962
	Junior High	-.76541	2.97170	.797	-6.6021	5.0712
	Elementary School	-4.34965	3.45358	.208	-11.1327	2.4334
	No school	-3.83062	3.05806	.211	-9.8369	2.1757
Diploma 1-Diploma 3	Bachelor - Doctorate	.27958	3.00213	.926	-5.6168	6.1760
	Senior High	-1.11196	1.24269	.371	-3.5527	1.3288
	Junior High	-.48583	1.03981	.641	-2.5281	1.5564
	Elementary School	-4.07007*	2.04387	.047	-8.0844	-.0558
	No school	-3.55105*	1.26567	.005	-6.0369	-1.0652
Senior High	Bachelor - Doctorate	1.39154	3.04862	.648	-4.5962	7.3793
	Diploma 1-Diploma 3	1.11196	1.24269	.371	-1.3288	3.5527
	Junior High	.62613	1.16728	.592	-1.6665	2.9188
	Elementary School	-2.95811	2.11157	.162	-7.1054	1.1892
	No school	-2.43908	1.37233	.076	-5.1344	.2563

Multiple Comparisons

(I) Father_Edu	(J) Father_Edu	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Junior High	Bachelor - Doctorate	.76541	2.97170	.797	-5.0712	6.6021
	Diploma 1-Diploma 3	.48583	1.03981	.641	-1.5564	2.5281
	Senior High	-.62613	1.16728	.592	-2.9188	1.6665
	Elementary School	-3.58424	1.99891	.073	-7.5103	.3418
	No school	-3.06521*	1.19172	.010	-5.4058	-.7246
Elementary School	Bachelor - Doctorate	4.34965	3.45358	.208	-2.4334	11.1327
	Diploma 1-Diploma 3	4.07007*	2.04387	.047	.0558	8.0844
	Senior High	2.95811	2.11157	.162	-1.1892	7.1054
	Junior High	3.58424	1.99891	.073	-.3418	7.5103
	No school	.51903	2.12518	.807	-3.6550	4.6930
No School	Bachelor - Doctorate	3.83062	3.05806	.211	-2.1757	9.8369
	Diploma 1-Diploma 3	3.55105*	1.26567	.005	1.0652	6.0369
	Senior High	2.43908	1.37233	.076	-.2563	5.1344
	Junior High	3.06521*	1.19172	.010	.7246	5.4058
	Elementary School	-.51903	2.12518	.807	-4.6930	3.6550

*. The mean difference is significant at the 0.05 level.

Based on the information in Table 11, overall it can be said that the results show that the father's educational background plays an important role in determining the level of EL skills in students. Although there is a significant difference, the small effect size suggests that there are other factors that may also influence these results. Further research is recommended to explore other factors that may contribute to the variability in both variables.

This phenomenon can be attributed to several factors: (1) individuals with less formal education may engage more directly with their environment through daily activities such as agriculture, fishing, or other nature-based livelihoods, fostering a deep, experiential understanding of environmental systems and issues. (2) in many communities, environmental knowledge is transmitted through cultural practices and oral traditions, with those having less formal education often relying on this indigenous knowledge, which encompasses sustainable practices and a profound connection to the environment. (3) lower educational attainment does not preclude active participation in community-based environmental initiatives, providing informal education and raising awareness about environmental issues. These findings suggest that EL is not solely dependent on formal education but is significantly influenced by practical experience, cultural context, and community involvement. Therefore, environmental education programs should recognize and integrate these elements to effectively enhance EL across diverse populations (Hanafi et al., 2021; Mukhyati & Sriyati, 2015; Yusliani & Yanti, 2020).

The finding that fathers' educational background has an influence on students' EL proficiency levels can be linked to Pierre Bourdieu's cultural capital theory. According to this theory, parents with higher levels of education tend to have greater cultural capital, which includes knowledge, skills, and attitudes that are transmitted to their children, both directly and indirectly (Claussen & Osborne, 2013; Edgerton & Roberts, 2014; Jæger &

Møllegaard, 2017; Shim, 2010; Sullivan, 2001; Symeou, 2007). Higher paternal education may provide an environment that supports EL development, such as richer learning at home, access to better educational resources, and positive behavioral modeling (Agustri et al., 2023; Barluado et al., 2024; Dong & Chow, 2022; Esmaeeli, 2023; Lau & Richards, 2020; O'Brien et al., 2020). However, due to the small effect size, this effect may not be dominant, suggesting that parental educational background is one of many factors that can influence EL, but not the only determining factor.

To understand the variability of EL more comprehensively, Bronfenbrenner's developmental ecology theory can be a relevant guide. This theory emphasizes that individual development is influenced by various environmental systems, starting from the immediate environment (microsystem) such as family and school, to broader factors such as educational policies and cultural norms (macrosystem) (Crawford, 2020; El Zaatari & Maalouf, 2022; Navarro & Tudge, 2023; Paquette & Ryan, 2001; Tong & An, 2023). Based on these findings, it is suggested that further research identify other factors in the student ecosystem, such as the quality of interactions at school, social support, and individual factors such as motivation and personality, which may play a role in shaping EL. In this way, a more holistic understanding of the factors that support the development of EL in students can be produced, while enriching the literature on the role of family and environmental contexts in the development of emotional and social competence.

3. Aspect of mother's education

Table 12, Table 13, and Table 14 are a series of one-way ANOVA results for maternal education aspects in relation to EL of senior high and vocational school students with Muhammadiyah backgrounds. Based on Table 13, ANOVA for EL shows a statistically significant difference with an F value of 2.483 (p = 0.031). The effect size (Eta-square = 0.021) indicates a small to medium effect. Furthermore, a post hoc analysis using the LSD method revealed a significant difference in EL values, as in Table 15. Based on the data, the post hoc test showed no significant difference between groups at the 0.05 significance level, but S1-S3 vs. SMA approached significance with a p-value of 0.071, indicating that the S1-S3 group had a higher score than the SMA group. The No School group obtained significantly higher scores than the high school (p = 0.011) and middle school (p = 0.005) groups, with mean differences of 3.40 and 3.31, respectively.

Table 12. Descriptive information on maternal education aspects

Descriptives

Env_Literacy	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Bachelor - Doctorate	7	115.8571	8.59125	3.24719	107.9116	123.8027
Diploma 1-Diploma 3	135	110.1407	9.61743	.82774	108.5036	111.7779
Senior High	109	109.1009	9.08493	.87018	107.3761	110.8258
Junior High	214	109.1916	9.55762	.65335	107.9037	110.4794
Elementary School	21	111.8095	10.55282	2.30281	107.0059	116.6131
No school	98	112.5000	10.04346	1.01454	110.4864	114.5136
Total	584	110.1233	9.65646	.39959	109.3385	110.9081

Table 13. Results of one-way ANOVA test of maternal education aspects

ANOVA					
Env_Literacy	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1143.167	5	228.633	2.483	.031
Within Groups	53219.956	578	92.076		
Total	54363.123	583			

Table 14. Results of ANOVA effect sizes of maternal education aspects

ANOVA Effect Sizes[a,b]			
Env_Literacy	**Point Estimate**	**95% Confidence Interval**	
		Lower	**Upper**
Eta-squared	.021	.000	.041
Epsilon-squared	.013	-.009	.033
Omega-squared Fixed-effect	.013	-.009	.033
Omega-squared Random-effect	.003	-.002	.007

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.
b. Negative but less biased estimates are retained, not rounded to zero.

Table 15. Post Hoc Tests using the LSD method for maternal education aspects

Multiple Comparisons						
(I) Mother_Edu	**(J) Mother_Edu**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Bachelor - Doctorate	Diploma 1-Diploma 3	5.71640	3.71965	.125	-1.5893	13.0221
	Senior High	6.75623	3.74145	.071	-.5923	14.1047
	Junior High	6.66555	3.68565	.071	-.5733	13.9044
	Elementary School	4.04762	4.18787	.334	-4.1777	12.2729
	No school	3.35714	3.75410	.372	-4.0162	10.7305
Diploma 1-Diploma 3	Bachelor - Doctorate	-5.71640	3.71965	.125	-13.0221	1.5893
	Senior High	1.03982	1.23563	.400	-1.3870	3.4667
	Junior High	.94915	1.05466	.369	-1.1223	3.0206
	Elementary School	-1.66878	2.25092	.459	-6.0898	2.7522
	No school	-2.35926	1.27342	.064	-4.8604	.1418
Senior High	Bachelor - Doctorate	-6.75623	3.74145	.071	-14.1047	.5923
	Diploma 1-Diploma 3	-1.03982	1.23563	.400	-3.4667	1.3870
	Junior High	-.09067	1.12916	.936	-2.3084	2.1271
	Elementary School	-2.70861	2.28677	.237	-7.2000	1.7828
	No school	-3.39908*	1.33577	.011	-6.0226	-.7755
Junior High	Bachelor - Doctorate	-6.66555	3.68565	.071	-13.9044	.5733
	Diploma 1-Diploma 3	-.94915	1.05466	.369	-3.0206	1.1223
	Senior High	.09067	1.12916	.936	-2.1271	2.3084
	Elementary School	-2.61794	2.19427	.233	-6.9277	1.6918
	No school	-3.30841*	1.17039	.005	-5.6071	-1.0097
Elementary School	Bachelor - Doctorate	-4.04762	4.18787	.334	-12.2729	4.1777
	Diploma 1-Diploma 3	1.66878	2.25092	.459	-2.7522	6.0898
	Senior High	2.70861	2.28677	.237	-1.7828	7.2000

Multiple Comparisons						
(I) Mother_Edu	(J) Mother_Edu	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
No School	Junior High	2.61794	2.19427	.233	-1.6918	6.9277
	No school	-.69048	2.30741	.765	-5.2224	3.8414
	Bachelor - Doctorate	-3.35714	3.75410	.372	-10.7305	4.0162
	Diploma 1- Diploma 3	2.35926	1.27342	.064	-.1418	4.8604
	Senior High	3.39908*	1.33577	.011	.7755	6.0226
	Junior High	3.30841*	1.17039	.005	1.0097	5.6071
	Elementary School	.69048	2.30741	.765	-3.8414	5.2224

*. The mean difference is significant at the 0.05 level.

The analysis revealed that EL scores across students showed significant variability, particularly highlighting the higher performance of the Unschooling mothers group compared to the other groups. The effect sizes indicated that differences in EL across students had small to moderate impacts, which warrants further investigation into educational practices and environmental awareness initiatives across educational levels. The analysis revealed significant variability in EL scores among students, notably with higher performance observed in the group of students whose mothers had no formal schooling. This finding suggests that educational strategies should incorporate experiential learning and community-based environmental education, recognizing the value of practical knowledge and cultural experiences in enhancing students' EL.

The finding that students with unschooled mothers showed higher EL scores than other groups may be related to resilience theory and family role theory. According to resilience theory, individuals who face limitations or challenges in their family environment—such as mothers with low education or no schooling—can develop strong adaptive skills and effective coping strategies as a means of adjustment (Ledesma, 2014; Luthar et al., 2000; MacPhee et al., 2015; Ronen, 2021; Shean, 2015). In this case, unschooled mothers may have a parenting approach that encourages independence, responsibility, or simple living practices that actually strengthen students' emotional skills. Students who are raised in more challenging circumstances may develop higher EL skills because they are required to be more independent and responsible from an early age (Crenshaw, 1991; Guo et al., 2022; Hassan et al., 2022; Makwana et al., 2023; Roy & Giraldo-Garcia, 2018).

The observation that students raised by mothers with lower formal education levels exhibit higher EL skills may be influenced by various factors. In certain communities, mothers without formal schooling often engage in subsistence activities such as agriculture, fishing, or other nature-based livelihoods. These practices necessitate a deep understanding of the environment, which is transmitted to children through daily routines and responsibilities. This experiential learning fosters independence and responsibility from an early age, as children actively participate in sustaining their family's livelihood. Additionally, traditional ecological knowledge, passed down through generations, plays a crucial role in shaping environmental awareness and practices. Therefore, the higher EL skills observed in these students may stem from practical, hands-on experiences and cultural teachings rather than formal educational backgrounds (Myers, 2024; Taylor, 2010; Watson, 2010).

These findings may be associated with gender role and social influence theories, suggesting that mothers with lower educational backgrounds often engage more actively in imparting emotional and social skills through daily interactions. Their communication approaches tend to emphasize empathy and solidarity, which are crucial for developing children's social-emotional competencies. This hands-on involvement and focus on relational values can significantly contribute to the enhancement of students' emotional intelligence and social skills (Christov-Moore et al., 2014; Garcia-Peinado, 2024; Kilby, 2023). The mother's role as the primary source of socialization in the family has the potential to influence children's EL, even if the mother does not have a formal educational background. Symbolic interaction theory also supports this, stating that daily experiences and interpersonal relationships provide meaning to children's character and emotional development (Chen et al., 2020; Eisenberg et al., 2010; Gabatz et al., 2017). These findings suggest the need for further research to explore how informal parenting and educational practices in the home—especially those involving mothers—play a role in the development of students' EL. Additionally, examining the influence of the surrounding environment, including community interactions and local cultural practices, is crucial. Understanding these factors can inform educational initiatives aimed at strengthening EL across various educational levels.

CONCLUSION

The study revealed that among Muhammadiyah senior and vocational high school students, gender and grade level (X, XI, XII) did not significantly influence environmental literacy (EL) levels. However, parental education, particularly that of fathers and mothers, had a notable impact, with students whose parents lacked formal education exhibiting relatively higher EL levels. This suggests that life experiences and parenting styles may play a role in shaping students' EL. Overall, while family factors influence EL, their effects are modest, indicating that other educational environmental factors warrant further investigation.

This study has several limitations that should be acknowledged. The research primarily focused on the influence of parental education on students' EL, without extensively examining other potential contributing factors such as socioeconomic status, access to environmental education resources, or community engagement. The study did not delve into the specific parenting styles or home environments that might affect EL development, leaving a gap in understanding the mechanisms through which parental education impacts students' EL. Additionally, the research was confined to Muhammadiyah senior and vocational high schools, which may limit the generalizability of the findings to other educational contexts or regions. The cross-sectional design of the study provides a snapshot in time, but does not account for changes in EL over time or the long-term effects of various influencing factors. Future research should address these limitations by incorporating a broader range of variables, employing longitudinal designs, and expanding the study population to provide a more comprehensive understanding of the factors influencing environmental literacy among students.

Further research is recommended to explore more deeply the family factors and parenting patterns that can contribute to environmental literacy in students. The role of informal education and home environment in shaping students' EL needs to be studied, especially how students from families with low educational backgrounds can have better environmental literacy. In addition, further research can also expand the focus on the influence of school environment variables, educational curriculum, and environment-based extracurricular programs that can support the development of environmental literacy.

Involving additional variables such as involvement in social activities or environmental communities will provide more comprehensive insights into the factors that influence students' environmental literacy skills. Linking with one of the themes that is also related to environmental issues, namely action competence for sustainability, also needs to be done to see how the two are interrelated or influence each other.

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