The Mediating Effect of Student Environmental Literacy on the Relationship between Factors of Academic Performance and Engagement in Science

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ABSTRACT

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| **Aims:** To determine the significance of the mediating effect of student environmental literacy on the relationship between factors of academic performance and student engagement among junior high school students in a public high school  **Study design:** Quantitative, non-experimental, correlational study  **Place and Duration of Study:** Department of Education, Baganga, Davao Oriental, Philippines during the school year 2022-2023  **Methodology:**  A total of 286 students were calculated as a sample from the entire population of 998 using Slovin's formula with a 5% margin of error. The 286 students were chosen using stratified random sampling. Data were collected using adapted and researcher-made survey questionnaires. **For the environmental literacy,** a 63-item researcher-made questionnaire, based on Gheith (2019). For s**tudent engagement,** a 20-item adapted questionnaire from Veiga (2016) was used. For f**actors of academic performance,** a 23-item adapted questionnaire from Shahzadi and Ahmad (2011). Responses for all three instruments were categorized using a five-point scale ranging from Very High (4.20-5.00) to Very Low (1.00-1.79). Moreover, the adapted questionnaires were reviewed by the research advisor and expert validators. Pilot tests with 30 students (5 per grade level) was conducted to establish validity and reliability. Revisions were made based on feedback and pilot test results before final data collection.  **Results:** High levels of all three variables and significant relationships between academic performance factors and both student engagement and environmental literacy, as well as between environmental literacy and student engagement were found. It also found partial mediation, meaning academic performance factors influenced student engagement both directly and indirectly through environmental literacy.  **Conclusion:** Fostering environmental literacy directly boosts student engagement and acts as a key pathway for academic performance factors to influence engagement. The results supported the Environmental Education Theory (EET), which emphasizes using the environment as a learning context to enhance environmental literacy and improve academic outcomes. |

*Keywords: Student environment literary, academic performance, engagement in science, Mediating effect, academic outcomes.*

1. INTRODUCTION

In developing nations such as the Philippines, education has always played a central role in human capital formation. Despite reforms, the Philippine educational system still faces access, equity, and quality challenges. The Philippines participated the Programme for International Student Assessment (PISA) of the Organisation for Economic Cooperation and Development (2018) [1] evaluating students' skills in reading, mathematics, and science across countries, as part of the Quality Basic Education reform plan and a step towards globalizing the quality of Philippine basic education (DepEd, 2019) [2]. According to recent results from the PISA, students from the Philippines are still among the least proficient in the world in math, reading, and science. The country's performance in 2018 did not significantly improve as measured by the most current PISA 2022 test results (Chi, 2023) [3].

In PISA 2022, particularly in science, the results are alarming. The Filipino students’ mean score in science performance is one of the lowest among PISA-participating countries and economies, which is ranked 78 out of 80. Meanwhile, the percentage of low performers in science (below proficiency Level 2) is one of the highest among PISA-participating countries and economies (77.2%, rank 4 out of 80) (Education GPS - OECD, 2022) [4]. In November 2023, Vice President Sarah Duterte, who also serves as the Secretary of the Department of Education, anticipated the poor results of the PISA. She emphasized that the PISA scores do not solely reflect the state of the educational system but also serve as a broader indicator of collective efforts, financial investments, and societal dedication to improving learning outcomes and securing a better future for the youth (Mangaluz, 2023) [5].

The evolution of science education has been driven by technological advancements, the integration of proficiency-focused approaches in K-12 curricula, and the emergence of innovative school systems. These dynamic changes are expected to significantly influence various aspects of learning, particularly in enhancing student engagement and academic performance throughout the educational process. In the Philippines, science education faces several challenges, including those encountered by science teachers and the influence of student, family, and classroom-related factors on science learning (Collates et al., 2022; Bernardo et al., 2023) [6,7]. Amidst these challenges, teachers have demonstrated adaptability in navigating the "new normal" of education, taking on a crucial role in fostering supportive and engaging learning environments for science education (Arietta et al., 2020; Adaro et al., 2022) [8,9].

Student engagement has three dimensions which are behavioral, emotional, and cognitive. Behavioral engagement refers to students’ participation in academic and extracurricular activities. Emotional engagement refers to student’s positive and negative reaction to peers, teachers and school. While cognitive engagement talks about student’s thoughtfulness and willingness to master difficult skills (Fredericks, et al., 2004). Research indicates that engagement plays a crucial role in shaping student academic outcomes, but this relationship needs further examination in the context of science education (Fredricks et al., 2004).

Likewise, environmental literacy and engagement in science are closely connected, as environmental issues and sustainability are increasingly relevant and important topics in the scientific community. Theories of self-efficacy and social cognition (Bandura, 1986) suggest that an increased understanding of environmental issues could enhance student motivation and engagement, potentially influencing academic performance.

The ability of students' environmental literacy is very influential in learning at school (Panjaitan et al., 2021) [10]. In addition, the study conducted by Yeh et al., (2021) [11] reported that the students with higher scores in environmental literacy were able to proffer better environmental problem-solving strategies, analyze environmental problem-solving solutions incisively, and present multiple plans. However, prior studies suggest a connection between environmental knowledge and academic performance, particularly in science-related disciplines (Ardoin et al., 2020). A study found that students who were more engaged in nature-related activities, such as outdoor education and environmental stewardship, had higher levels of environmental knowledge and attitudes. The researchers suggest that engagement in nature-related activities can help to build students' environmental literacy. Moreover, studies in environmental education highlight how engagement increases when students find learning relevant to their real-world experiences (Ernst & Monroe, 2004).

Several studies were conducted about factors of academic performance and engagement in science. However, the researcher was not coming across with similar studies in the locale. It is in this context that the researcher was interested to determine the significance of the mediating effect of student environmental literacy on the relationship between factors of academic performance and student’s engagement.

This study aimed to determine the significance of the mediating effect of student environmental literacy on the relationship between factors of academic performance and student engagement among junior high school students in a public high school in Baganga, Davao Oriental. Specifically, this study sought answers to the following objectives. First was to identify the level of agreement among respondents regarding factors of academic performance, which include *study habits*, *learning skills*, *hard work*, *academic interaction*, and *home environment.* Second was to assess the level of agreement regarding student engagement, focusing on *cognitive*, *affective*, *behavioral*, and *agency* aspects. Third was to measure the level of agreement about environmental literacy, looking at *attitudes*, *knowledge*, and *behavior*. Fourth was to determine the significance of the relationship between factors of academic performance and student engagement, academic performance and environmental literacy, and environmental literacy and student engagement, and last was to evaluate the significance of the mediating effect of student environmental literacy on the relationship between academic performance and student engagement.

Further, the following null hypotheses are tested at 0.05 level of significance. First, there is no significant relationship between factors of academic performance and student’s engagement; factors of academic performance and environment literacy; and environmental literacy and student’s engagement. Second, there is no significance of the mediating effect of student environmental literacy on the relationship between factors of academic performance and student’s engagement.

The conceptual framework in Figure 1 shows the independent variable, dependent variable, and mediating variable of the study.

Independent Variable Dependent Variable

PATH C

**Factors of Academic Performance**

**Student Engagement in Science**

PATH A

PATH B

**Environmental Literacy**

Mediating Variable

*Figure 1. Conceptual Framework Showing the Relationship of the Variables*

The independent variable of the study is the *factors of academic performance*, which have its indicators namely: *study skills, learning skills, hardworking, academic interaction, and home environment*. The dependent variable in this study is student engagement, as defined by Reeve et al. (2020) [12]. It is measured across four dimensions: *cognitive engagement*, *affective engagement*, *behavioral engagement*, and *agency engagement*. A mediating variable is used in this study. It is an intermediate variable that acts as a bridge between the independent variable and the dependent variable. In the current study, environmental literacy is the mediating variable that explains the relationship between the factors of academic performance (independent variable) and student engagement in science (dependent variable).

* 1. tHEORETICAL Framework

This study is anchored on the Environmental Education Theory (EET). EET suggests that environmental literacy is developed through cognitive, affective, and behavioral learning experiences. Cognitive experiences involve acquiring knowledge and skills related to environmental concepts, affective experiences involve developing attitudes and values towards the environment, and behavioral experiences involve developing skills to participate in environmental problem-solving and decision-making (Hungerford & Volk, 1990). Research has shown that environmental education programs that incorporate these three components positively affect academic achievement in science and other subjects (Disinger & Roth, 1992; Palmer, 1993). Moreover, EET emphasizes the importance of the environment as a context for learning. Students with opportunities to participate in hands-on environmental learning experiences are more likely to develop environmental literacy and achieve higher academic performance (Palmer, 1993).

In support, Social Cognitive Theory (SCT) provides a framework for understanding the complex relationship between academic achievement factors and science engagement. According to SCT, cognitive processes such as outcome expectations and goals are critical in shaping academic achievement and engagement in science. For example, research has shown that students with positive outcome expectations in science are more likely to be engaged in science and achieve higher academic performance (Pajares, 2002; Schunk, 1995). Moreover, SCT emphasizes the importance of the environment in shaping behavior. Teachers who provide opportunities for active learning, positive feedback, and autonomy support are more likely to foster student engagement in science (Bandura, 1997). Similarly, peers who demonstrate interest and enthusiasm for science can create a supportive environment that enhances academic achievement and engagement in science (Linnenbrink-Garcia & Patall, 2016).

Meanwhile, the socio-ecological systems (SES) framework posits that human-environment interactions are complex and dynamic. Environmental problems are best addressed through an interdisciplinary and systems-based approach that considers social, economic, and ecological factors (Berkes & Folke, 1998). According to the SES framework, environmental literacy involves understanding the interconnections between social, economic, and ecological systems and the impacts of human activities on these systems. Research has shown that students with a strong understanding of socio-ecological systems are likelier to engage in science and environmental problem-solving (Krasny & Delia, 2011; Sterling et al., 2017). Moreover, the SES framework emphasizes the importance of participatory and collaborative approaches to environmental problem-solving, which can foster student engagement in science and environmental stewardship (Schusler et al., 2009).

2. material and methods

**Research Respondents**

The respondents of the study were junior high school students enrolled during the school year 2022-2023 in a secondary school in Baganga, Davao Oriental. A total of 286 students were calculated as a sample from the entire population of 998 using Slovin's formula with a 5% margin of error. The 286 students were chosen using stratified random sampling. In this study, the strata were the different grade levels and sections of junior high school students. Slovin’s formula was likely chosen because it is easy to use, applicable to general population proportion estimations, and practical for cases where the population proportion is unknown. According to the study of Tejada and Punzalan (2012), Slovin’s formula is applicable only when estimating a population proportion and when the confidence coefficient is 95%. Additionally, it is optimal only when the population proportion is suspected to be close to 0.5. Thus, making it suitable for studying junior high school pupils by providing an adequate sample size. In contrast to Cochran's formula, which is ideal for large populations with known proportions and normal distributions, Slovin's formula remains applicable in cases of uncertain or non-normal distribution. While Krejcie and Morgan's table is often utilized to determine sample sizes for large populations, Slovin's formula offers a more precise calculation for specific population sizes.

If a respondent was unavailable during the study, the researcher replaced the respondent by performing simple random sampling from the same stratum. Moreover, the researcher considered the inclusion and exclusion criteria in the selection of the respondents for the study. The respondents were officially enrolled in the locale of the study for the school year 2022-2023, selected during random sampling, voluntarily agreed to participate by completing and signing the assent form, and their parents voluntarily allowed them to participate by completing and signing the Informed Consent Form (ICF).

The researcher secured the Informed Consent Form (ICF) from the respondents' parents or guardians and the Assent Form from the respondents who were aged below 18. The researcher explained the study through the ICF in clear, non-technical language, providing information about its purpose, duration, and any risks or potential benefits. This information was tailored to the individual's level of understanding and presented in a comprehensible manner. The respondents were given the opportunity to ask questions and clarify any concerns they might have had. This step was important to ensure that the respondents fully understood the implications of their participation and could make an informed decision about whether to consent or not. Additionally, the respondents were given five (5) days to consider their decision and were not pressured or coerced into participating. This step ensured that the respondents’ decision was truly voluntary and not influenced by external factors. Furthermore, the respondents were given the opportunity to withdraw their consent at any time, even after they had initially agreed to participate. This step was important to ensure that the respondents' autonomy was respected throughout the entire process.

Lastly, the respondents were informed about any potential changes to the activity that might occur over time and were given the opportunity to provide ongoing consent or withdraw their consent if they chose to do so. It should be noted that since some of the respondents were minors, the researcher asked for the completed ICF from the parents or guardians of the respondents, and the Assent Form was secured from the respondents.

**Research Instruments**

This study used adapted and researcher-made survey questionnaires. **For the environmental literacy,** a 63-item researcher-made questionnaire, based on Gheith (2019) [13], assessed Attitudes, General Environmental Knowledge, Knowledge of Global Environmental Issues, and Behavior. Responses were categorized using a five-point scale ranging from Very High (4.20-5.00) to Very Low (1.00-1.79). For s**tudent engagement,** a 20-item adapted questionnaire from Veiga (2016) [14] measured Cognitive, Affective, Behavioral, and Agency engagement. A five-point scale (Very High: 4.20-5.00 to Very Low: 1.00-1.79) was used for evaluation. For f**actors of academic performance,** a 23-item adapted questionnaire from Shahzadi and Ahmad (2011) [15] explored Study Habits, Learning Skills, Hardworking, Academic Interactions, and Home Environment. A five-point scale (Very High: 4.20-5.00 to Very Low: 1.00-1.79) assessed the impact of these factors. The adapted questionnaires were reviewed by the research advisor and expert validators. A pilot test with 30 students (5 per grade level) was conducted to establish validity and reliability using Cronbach's Alpha. Revisions were made based on feedback and pilot test results before final data collection.

**Design and Procedures**

This quantitative, non-experimental, correlational study investigated the relationship between academic performance and science engagement, mediated by student environmental literacy. Creswell and Hirose (2019) [16] definition of quantitative research guided the study's focus on numerical data and statistical analysis to identify relationships between variables. The correlational design (Field, 2013) [17] was chosen to examine the strength and direction of associations without implying causation. Mediation analysis Hayes, 2018) [18] was employed to explore the indirect effect of academic performance on science engagement through environmental literacy.

Ethical approvals were secured from the University of Mindanao – Ethics and Research Committee (UMERC) and relevant educational authorities, including the Public School Division Superintendent, District Supervisor, and school principal. Stratified random sampling was used to select participants from grade levels and sections. Informed consent and assent were obtained after explaining the study's purpose, risks, and benefits in accessible language. Questionnaires were administered in classrooms, adhering to a 30-minute time limit and explained in both English and the local dialect. Mean, Pearson's r, and mediation analysis using the Sobel Z test were employed for data analysis.

Rigorous ethical considerations were observed throughout the study. UMERC review ensured ethical compliance. Participant voluntariness was emphasized, and confidentiality/anonymity were protected through secure data storage, password protection, and eventual data deletion. COVID-19 protocols were strictly followed during data collection, including mask provision, sanitization, and physical distancing. Grammarly/Turnitin were used to prevent plagiarism, and APA 7th edition citation format was followed. The researcher's potential conflict of interest as a local teacher was acknowledged and addressed by ensuring objectivity and expert validation. School permissions were obtained, and authorship guidelines (Wager & Kleinert, 2011) [19] were adhered to, emphasizing originality, ethical conduct, and accurate data presentation. The study aimed to benefit students and teachers by providing insights into learning enhancement. No significant physical, social, economic, psychological, or emotional risks were anticipated.

3. results and discussion

**Level of** **Factors of Academic Performance**

Academic performance is shaped by a combination of individual traits, environmental contexts, and institutional factors. The results in Table 1 revealed that the level of *factors of academic performance* of students in learning science is interpreted as high, with an overall mean rating and standard deviation (SD) of 4.00 and 0.543, respectively.

Table 1. Level of Factors of Academic Performance

|  |  |  |  |
| --- | --- | --- | --- |
| Indicators | x̄ | SD | Descriptive Level |
| Study Habit | 4.00 | 0.601 | High |
| Learning Skills | 3.99 | 0.641 | High |
| Hardworking | 3.95 | 0.681 | High |
| Academic Interaction | 3.79 | 0.732 | High |
| Home Environment | 4.29 | 0.775 | Very High |
| Overall | 4.00 | 0.543 | High |

This means that the indicators related to the factors of academic performance are frequently demonstrated. It can also be observed from the table that the indicator of *home environment* obtained the highest mean score of 4.29, descriptively defined as Very High. Subsequently, the indicators *study habits* follow with a mean score of 4.00; *learning skills* with a mean score of 3.99; *hardworking* with a mean score of 3.95; and lastly, *academic interaction* with a mean score of 3.79 which are all descriptively refer to as High. The very high rating of *home environment* is suggestive to its highly significant impact on students' academic performance. This claim is supported by various authors (Fuentes & Victoria, 2024) [20] who highlighted that a supportive home environment characterized by parental involvement, socioeconomic status, and access to resources increases interest and gives the necessary support for grasping difficult scientific concepts. Parents significantly increase their children's academic performance in science by creating and maintaining a positive home environment in which love, hard work, and excellence are encouraged to bring out the best in their children's academic performance.

The high level of *study habits* highlighted the importance of effective study habits, particularly time management and a conducive learning environment, in achieving academic success. This assertion aligned with several studies (Nair & Kulkarhi, 2020; Bin Abdulrahman et al.,2021; Camangyan, 2023; Mulaudzi, 2023) [21-24] suggesting that strong study habits played a positive and crucial role in improving academic performance in science. Time management enabled students to prioritize tasks, follow structured routines, and avoid cramming, leading to better comprehension and retention. A positive learning environment fostered motivation and focus, while distractions, such as noisy surroundings and unmanageable use of social media, can significantly hinder performance, with students losing focus of their study time (Hendrix, 2024; Walck-Shannon et al., 2021; Al-Adwan et al.,2020) [25-27].

Furthermore, the high descriptive level for *learning skills* indicated the significant impact that these skills have on students' academic performance in science. This observation was supported with prior study suggesting learning skills as a strong predictor of academic performance (Almoslamani, 2022) [28]. Learning skills such as active listening, effective notetaking, organizational abilities, metacognition, and critical thinking were more likely to grasp complex scientific concepts and excel in exams and practical assignments, which is supported by studies of various authors (Tus et al., 2020; Al-Ghazo, 2023; Brown-Schmid et al., 2023; Salame et al., 2024; Reyes, 2024) [29-33] who found that these skills increase student’s listening comprehension, memory retention, and further boost their academic performance in science.

In addition, the high level of the indicator *hardworking* implied the high extent to which hard work is one of the keys to academic performance and success. This supported the idea of the authors, Huang & Lee (2020), Sulaiman et al., (2023), and Trinh (2023) [34-36], who found that students identified as “hard workers” had significantly higher GPAs and proven to promote greater persistence and resilience, which are essential for navigating academic challenges and recovering from setbacks. Further, the high score in *academic interaction* aligned with the findings of Li (2023) [37], who emphasized the importance of teacher-student relationship and peer relationship in enhancing student’s academic performance. Students reported that they feel more motivated, engaged, and connected to the learning process when they have positive relationships with their teachers and peers, which constructively influences attitudes toward academic pursuits and overall performance. Positive academic interactions promoted the development of communication, collaboration, and critical thinking skills, necessary for academic performance and future professional success.

**Level of Student Engagement**

Student engagement is routinely conceptualized as the extent of a student’s active and productive involvement in a learning activity. Presented in table 2 are the level of student engagement in terms of cognitive, affective, behavioral, and agency among students in learning science. The results of the analysis indicated that the level of *student engagement* in science were interpreted as High, with an overall mean score of 3.42 and SD of 0.673. This means that the indicators related to the student engagement were frequently established.

Table 2. Level of Student Engagement

|  |  |  |  |
| --- | --- | --- | --- |
| Indicators | x̄ | SD | Descriptive Level |
| Cognitive | 4.00 | 0.637 | High |
| Affective | 3.87 | 0.719 | High |
| Behavioral | 2.46 | 1.238 | Low |
| Agency | 3.36 | 0.776 | Moderate |
| Overall | 3.42 | 0.673 | High |

The table also revealed that the highest mean score obtained was the *cognitive* with a mean score of 4.00, followed by *affective* with a mean score of 3.87 which were all descriptively defined as High level. The indicator *agency* was rated as Moderate obtaining a mean score of 3.36. Lastly, the indicator *behavioral* descriptively rated as Low with a mean score of 2.46.

The analysis results established that the indicator *cognitive* obtained the highest mean value indicating that students are deeply involved in the mental processes related to scientific concepts, theories, and practices. This claim supported with Wilson et al. (2021) [38] study, which underscores the significance of cognitive engagement in enhancing scientific literacy and critical thinking. The research suggested that fostering cognitive engagement begins with a transition to student-centered learning, where educators focus on incorporating students' interests and goals into the educational process. Teachers were encouraged to actively enhance cognitive engagement by tailoring instructional strategies to prioritize and address these aspects effectively. In addition, the indicator *affective* is also rated high. This result revealed that students show strong emotional and motivational involvement in science. High affective engagement denoted that students have a significant interest and enjoyment in science, which correlates with their motivation to learn and persist in science-related activities, which is consistent with the studies of Mai et al. (2023), Membiela et al. (2023), Wood (2019), and Lee et al. (2019) [39-42].

Moreover, the indicator of *agency* obtained a moderate rating, reflecting an average level of student ownership and active participation in their learning processes in science. Research by Eshach & Fried (2019) [43] suggested that promoting student agency leads to greater involvement in scientific practices and persistence in science-related fields. Increasing the consistency and quality of teacher-student interactions, providing more opportunities for student-led activities, and promoting a growth mindset can enhance agency and subsequently improve student engagement and achievement in science. This claim is supported by Mojica et al. (2020) [44], which highlights that teacher-student interactions were crucial in promoting agency in science.

The findings for *behavioral engagement* revealed low scores, which at first glance might suggest disengagement among the respondents. However, it is essential to note that the research questionnaire employed negatively phrased items to assess behavioral engagement. The questions, such as "I deliberately disturb classes," "I am rude toward teachers,” “I am distracted in the classroom, and “I am absent from school without a valid reason/I am absent from classes while in school” were intentionally designed to identify disengaged behaviors. Lower scores on these items in fact reflect positive behavioral engagement, as they indicate that students reported minimal disruptive or negative behaviors in class.

Specifically, the low score observed here signify that the respondents exhibited a high level of positive behavioral engagement, characterized by minimal class disturbances, respectful behavior toward teachers, and consistent attendance. This finding is in line with Nazamud-din et al. (2020) [45] results, who found that students perceived themselves as engaged when attending classes on time, actively participating in group discussions, raising hands when asking questions, and seeking clarification on topics they found challenging.

**Level of** **Environmental Literacy**

Environmental literacy emphasized the critical role of cognitive and practical skills, particularly the ability to apply scientific reasoning in identifying and addressing environmental issues. It was a fundamental component of literacy development and played a pivotal role in shaping 21st-century education.

The overall level of environmental literacy in terms of attitudes, knowledge, and behavior among students was shown in Table 3, revealing a high level of the science learning environment (x̄ = 3.95, SD = 0.417). The data showed that the overall level of *environmental literacy* among the participants were High, with an overall mean score of 3.95 and overall SD of 0.417. This result indicated that the indicators related to environmental literacy are oftentimes manifested. The indicator *knowledge* obtained the highest mean score of 4.01, followed by *attitudes* with 3.95, and *behavior* with 3.90. All these indicators were descriptively rated as High. This high level of environmental literacy implied that the students possessed substantial attitudes, knowledge, and behaviors conducive to understanding and addressing environmental issues.

Table 3. Level of Environmental Literacy

|  |  |  |  |
| --- | --- | --- | --- |
| Indicators | x̄ | SD | Descriptive Level |
| Attitudes | 3.95 | 0.457 | High |
| Knowledge | 4.01 | 0.494 | High |
| Behavior | 3.90 | 0.489 | High |
| Overall | 3.95 | 0.417 | High |

The findings revealed a high level of *environmental knowledge* among participants, indicating their extensive understanding of environmental concepts. This was consistent with the study by Park et al. (2021) [46], which emphasized the importance of knowledge in cultivating positive environmental attitudes and behaviors. Su et al. (2020) [47] also highlighted that enhancing environmental knowledge through education was critical for encouraging sustainable practices, such as water conservation, renewable energy adoption, and sustainable tourism.

Similarly, the high level of *environmental attitudes* highlighted the crucial role of environmental education in shaping responsible decisions and actions. This aligned with the research of Liu et al. (2020) [48], which demonstrated that students exhibited a very extensive level of environmental literacy, particularly in their attitudes toward the environment and their awareness of environmental issues. These findings suggested that environmental education programs effectively imparted critical knowledge and fostered positive attitudes, both of which are essential for promoting environmentally responsible behavior in young learners.

The high descriptive level of *behavior* underscores its critical role in measuring environmental literacy, reflecting how well students apply their knowledge and attitudes towards sustainable actions. The findings supported the conclusions of Zhang et al. (2020) [49], who emphasized that environmental education and direct experiences in nature played a vital role in fostering pro-environmental behaviors. These behaviors, shaped by environmental literacy, were found to contribute to sustainability and promote equity within society. The results highlighted the significance of integrating education and nature-based experiences to develop environmentally responsible actions that benefit both society and the environment.

**Significant Relationship between Factors of Academic Performance**

**and Student Engagement**

Student engagement and academic performance were closely linked, especially in science education. Various factors, including study habits, learning skills, academic interaction, hard work, and academic interaction, influence this relationship. Understanding these factors was crucial for improving science education outcomes and promoting student success.

Presented in Table 4. was the correlation between measures of factors of academic performance and student engagement. Data revealed that the correlation obtained an overall r-value of 0.588 with an overall p-value of less than 0.001, which is lower than the 0.05 level of significance. This suggested that increased student engagement was likely lead to better academic performance and achievement. Thus, the null hypothesis of no significant relationship between factors of academic performance and student engagement was rejected.

Table 4. Significance of the Relationship between Factors of Academic Performance

and Student Engagement

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factors of Academic Performance | Student Engagement | | | | Overall |
| Cog | Aff | Behvl | Age |
| Study Habits | 0.533\*\* | 0.514\*\* | 0.188\*\* | 0.482\*\* | 0.489\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |
| Learning Skills | 0.484\*\* | 0.570\*\* | 0.244\*\* | 0.571\*\* | 0.544\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |
| Hardworking | 0.556\*\* | 0.528\*\* | 0.247\*\* | 0.509\*\* | 0.533\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |
| Academic Interactions | 0.500\*\* | 0.582\*\* | 0.306\*\* | 0.560\*\* | 0.576\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |
| Home Environment | 0.266\*\* | 0.427\*\* | -0.055 | 0.234\*\* | 0.219\*\* |
| <.001 | <.001 | 0.373 | <.001 | <.001 |
| Overall | 0.582\*\* | 0.659\*\* | 0.228\*\* | 0.586\*\* | 0.588\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |

*Legend:*

*Cog – Cognitive \*p-value < 0.05 – signficant*

*Aff – Affective \*\*p-value < 0.01 – very significant*

*Behvl – Behavioral*

*Age – Agency*

It was shown in the table that factors of academic performance were significantly correlated with student engagement, as the p-value was less than 0.001. The overall Pearson’s r-values for the factors were as follows: study habits (0.489), learning skills (0.544), hard work (0.533), academic interactions (0.576), and home environment (0.219). Thus, the two variables indicated statistically significant relationships. Furthermore, the data revealed that student engagement was positively correlated with the factors of academic performance, as the p-value was less than 0.001. The indicators showed the following Pearson’s r-values: cognitive engagement (0.582), affective engagement (0.659), behavioral engagement (0.228), and agentic engagement (0.586). This confirmed that the two variables had statistically significant relationships.

The correlation between the measures of factors of academic performance and observed student engagement revealed a significant relationship. This finding aligned with the study of Reeve et al. (2020) [50], it was found that both emotional and cognitive engagement could serve as moderators of behavioral and agentic engagement. Specifically, behavioral and agentic engagement strongly predicted students’ academic progress when emotional and cognitive engagement were high (e.g., enthusiastic effort and strategic initiative). Conversely, behavioral and agentic engagement weakly predicted academic progress when emotional and cognitive engagement were low (e.g., disinterested effort and impulsive initiative). Similarly, Boheim et al. (2020) [51] supported these findings, noting that observable positive behaviors in the classroom could serve as indicators of high engagement, which ultimately contributed to increased academic performance in science. This suggested that increased student engagement was linked to improved academic performance and achievement.

**Significant Relationship between Factors of Academic Performance**

**and Environmental Literacy**

Environmental literacy has been acknowledged as a vital aspect of education, not only to promote environmental conservation but also to improve academic achievement. Table 5 presented the correlation between measures of factors of academic performance and environmental literacy.

Table 5. Significance of the Relationship between Factors of Academic Performance

and Environmental Literacy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Factors of Academic Performance | Environmental Literacy | | | Overall |
| Att | Knw | Behvr |
| Study Habits | 0.386\*\* | 0.350\*\* | 0.498\*\* | 0.474\*\* |
| <.001 | <.001 | <.001 | <.001 |
| Learning Skills | 0.450\*\* | 0.406\*\* | 0.535\*\* | 0.534\*\* |
| <.001 | <.001 | <.001 | <.001 |
| Hardworking | 0.403\*\* | 0.441\*\* | 0.462\*\* | 0.502\*\* |
| <.001 | <.001 | <.001 | <.001 |
| Academic Interactions | 0.516\*\* | 0.476\*\* | 0.541\*\* | 0.589\*\* |
| <.001 | <.001 | <.001 | <.001 |
| Home Environment | 0.305\*\* | 0.265\*\* | 0.283\*\* | 0.327\*\* |
| <.001 | <.001 | <.001 | <.001 |
| Overall | 0.519\*\* | 0.488\*\* | 0.579\*\* | 0.609\*\* |
| <.001 | <.001 | <.001 | <.001 |

*Legend:*

*Att – Attitude* \*p-value < 0.05 – signficant

*Knw – Knowledge* \*\*p-value < 0.001 – highly significant

*Behvr – Behavior*

It was shown in the table that the correlation obtained an overall r-value of 0.609 with an overall p-value of less than 0.001, which is lower than the 0.05 level of significance. This implied that environmental literacy improves academic performance. Thus, the null hypothesis of no significant relationship between factors of academic performance and environmental literacy was rejected.

The correlation shown in table 5 revealed that there is a significant relationship between the factors of academic performance and environmental literacy since the p-value is less than 0.001. The indicator *study habits* obtained an overall r-value of 0.474, *learning skills* with 0.534, *hardworking* with 0.502, *academic interactions* with 0.589, and *home environment* with 0.327. Furthermore, data revealed that environmental literacy is significantly correlated with the factors of academic performance since the p-value is less than 0.001 and the indicators revealed the following r-values: *attitudes* with 0.519*, knowledge* with 0.488*,* and *behavior* with 0.579.

The study revealed that environmental literacy positively impacted academic performance by deepening students’ understanding of scientific concepts and improving their critical thinking skills. Previous research (Chen et al., 2020) [52] also demonstrated a correlation between environmental literacy and better performance in STEM subjects, emphasizing the interdisciplinary benefits of environmental education. These findings suggested that fostering environmental literacy could enhance academic achievement across various subjects, underscoring the importance of integrating environmental education into the curriculum to support holistic student development. Teachers were encouraged to leverage these insights to create strategies that improve both academic and environmental outcomes.

**Significant Relationship between Environmental Literacy**

**and Student Engagement**

Environmental literacy fosters student engagement in science by connecting learning to real-world issues, promoting hands-on experiences, and empowering students to address environmental challenges. The results presented in Table 6 illustrated the significant relationship between measures environmental literacy and student engagement. Based on the results in Table 6, it was evident that the two variables, environmental literacy and student engagement is statistically correlated since the p-value is less than 0.001, which is lower than the 0.05 level of significance. Thus, the null hypothesis of no significant relationship between environmental literacy and student engagement is rejected.

Table 6. Significance of the Relationship between Environmental Literacy and Student Engagement

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Environmental Literacy | Student Engagement | | | | Overall |
| Cog | Aff | Behvl | Age |
| Attitudes | 0.533\*\* | 0.514\*\* | 0.188\*\* | 0.482\*\* | 0.489\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |
| Knowledge | 0.484\*\* | 0.570\*\* | 0.244\*\* | 0.571\*\* | 0.544\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |
| Behavior | 0.556\*\* | 0.528\*\* | 0.247\*\* | 0.509\*\* | 0.533\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |
| Overall | 0.582\*\* | 0.659\*\* | 0.228\*\* | 0.586\*\* | 0.588\*\* |
| <.001 | <.001 | <.001 | <.001 | <.001 |

*Legend:*

*Cog – Cognitive* \*p-value < 0.05 – signficant

*Aff – Affective* \*\*p-value < 0.001 – highly significant

*Behvl – Behavioral*

*Age – Agency*

The p-value of less than 0.001 for the indicators of environmental literacy is lower than the 0.05 level of significance, indicating that environmental literacy is positively correlated with student engagement in science. Furthermore, the overall r-value for the indicators—*attitudes*, *knowledge*, and *behavior*—is 0.489, 0.544, and 0.533, respectively. Also, the data revealed that student engagement is significantly correlated with environmental literacy since the obtained p-value is less than 0.001, and the overall r-value for the indicators *cognitive*, *affective*, *behavioral* and *agency* is 0.582, 0.659, 0.228, and 0.586, respectively. The correlation between environmental measures and student engagement revealed a significant relationship.

In support of this, Frensley et al. (2022) explored how fulfilling students' basic psychological needs specifically competence, autonomy, and relatedness, affects their engagement and environmental literacy in a residential environmental education (EE) setting. Based on their findings, when students feel competent, autonomous, and related, they tend to be more engaged in their learning experiences. Moreover, the researchers also discovered that higher student engagement leads to better environmental literacy outcomes, making students develop a deeper understanding, awareness, and concern for environmental issues. The study provided empirical evidence that engaging students by fulfilling their psychological needs improves their learning and environmental literacy.

On the other hand, Sachitra and Kaluarachchi (2018) examined the environmental literacy, interest in environmental issues, and engagement in environmental activities among undergraduate students in Sri Lanka. The findings revealed a low level of environmental literacy among the students, while their interest in environmental issues and engagement in environmental activities was moderate. Likewise, the results indicated that environmental literacy and interest significantly predicted perceived environmental engagement, meaning that students with greater knowledge and interest in environmental issues were more likely to participate in environmental activities. These findings highlight the need for enhanced environmental education programs in Sri Lankan universities to improve students' awareness and encourage more proactive environmental behavior. By strengthening environmental literacy, schools and universities can foster a greater commitment to sustainability among students, ultimately influencing their attitudes and actions toward the environment.

This result examined the connection between environmental literacy and student engagement using the socio-ecological systems (SES) framework. The SES framework highlighted the complexity of human-environment interactions and supported an interdisciplinary, systems-based approach to addressing environmental challenges. Environmental literacy, as outlined by this framework, involved understanding the interconnections among social, economic, and ecological systems and the effects of human activities on these systems. Previous research demonstrated a positive correlation between environmental literacy and student engagement, showing that students with a strong grasp of socio-ecological systems were more likely to engage in science and environmental problem-solving (Manyani et al., 2024) [53]. Additionally, the SES framework emphasized the importance of participatory and collaborative approaches, which fostered engagement in environmental stewardship and problem-solving. This study highlights the need to integrate SES-based environmental literacy education to improve student engagement and address real-world environmental issues.

**Mediation Analysis of the Three Variables**

The regression analysis result of the variables in the criteria of the presence of a mediating effect of environmental literacy on the relationship between factors of academic performance and student engagement in science was shown in Table 7. Data were analyzed with the linear regression method as input to the med graph. Mediation analysis developed by Baron and Kenny (1986) [54] is the mediating effect of a third variable in the relationship between two variables. There were three steps to be met for a third variable to be acting as a mediator. In Table 7, these are categorized as Steps 1 to 3. In step 1, factors of academic performance as the independent variable (IV) significantly predicts student engagement, which is the dependent variable (DV) of the study. In step 2, factors of academic performance significantly predict environmental literacy, the mediating variable (MV). In step 3, environmental literacy significantly predicts student engagement.

Table 7. Regression Analysis Result of the Variables in the Criteria of the Presence of Mediating Effect

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Indirect and Total Effects | | | | | | | | |
|  | | | | 95% C.I. (a) | |  | | |
| Type | Effect | Estimate | SE | Lower | Upper | β | z | p |
| Indirect | FAP ⇒ EL ⇒ SE | 0.243 | 0.0491 | 0.147 | 0.339 | 0.196 | 4.95 | < .001 |
| Component | FAP ⇒ EL | 0.467 | 0.0376 | 0.393 | 0.541 | 0.609 | 12.42 | < .001 |
|  | EL ⇒ SE | 0.520 | 0.0965 | 0.331 | 0.709 | 0.322 | 5.39 | < .001 |
| Direct | FAP ⇒ SE | 0.485 | 0.0741 | 0.340 | 0.630 | 0.391 | 6.55 | < .001 |
| Total | FAP ⇒ SE | 0.728 | 0.0620 | 0.606 | 0.849 | 0.588 | 11.73 | < .001 |

Furthermore, because the three steps (paths a, b and c) are significant, further mediation analysis through medgraph is necessary, including the Sobel z test to assess the significance of mediation effect. To further understand the mediating effect of environmental literacy on the relationship between factors of academic performance and student engagement, whether full mediation, partial mediation, or no mediation. If the direct effect of factors of academic performance becomes non-significant when the mediator - environmental literacy, is included in the model, full mediation will be attained. It means that the mediator variable mediates all the effects. Moreover, partial mediation occurs if the direct effect of factors of academic performance on student engagement remains significant even when the mediator is included in the model, indicating that both direct and indirect paths are contributing to the total effect. Given that the direct effect of factors of academic performance on student engagement (B = 0.485, p < .001) remains significant even after accounting for the indirect effect through environmental literacy, therefore partial mediation is attained.

Furthermore, Figure 2 reveals the result of the computation of mediating effects. The Sobel test resulted to a z-value of 11.73 with a p-value of 0.001, which is significant at 0.05 level. This implies that there is a partial mediating effect, as it is likely that the original direct effect of factors of academic performance on student engagement in science has been reduced upon the addition of environmental literacy. The Sobel z-value indicates that the addition of environmental literacy reduces the effect of factors of academic performance on student engagement in science.

A diagram of a triangle

Description automatically generated

*Figure 2.* Med Graph showing the Variables of the Study

Moreover, the figure also indicates the results of the computation of the effect size in the mediation test conducted between the three variables. The effect size measures how much of the effect of factors of academic performance on student engagement can be attributed to the indirect path. The indirect effect value of 0.196 is the beta of factors of academic performance towards student engagement. The direct effect value of 0.391 is the beta of factors of academic performance towards student engagement with environmental literacy included in the regression. The total effect value of 0.588 is the amount of the original beta between factors of academic performance and student engagement that now goes through environmental literacy (a \* b, where “a” refers to the path between Factors of Academic Performance ⇒ Student Engagement and “b” refers to the path between Environmental Literacy ⇒ Student Engagement). The ratio index is computed by dividing the indirect effect by the total effect; in this case, 0.196 over 0.588 equals 0.333. It seems that about 33.4 percent of the total effect of factors of academic performance on student engagement goes through environmental literacy, and about 66.6% of the total effect is either direct or mediated by other variables not included in the model.

Moreover, this study sought to evaluate the significance of students’ environmental literacy as a mediating factor in the relationship between factors of academic performance and student engagement in science among junior high school students. The mediation analysis comprised the path between factors of academic performance and environmental literacy, path between factors of academic performance student engagement, and path between environmental literacy and student engagement. The results reveal partial mediation and significant direct effects, offering insights for existing and future research on factors influencing academic performance and student engagement. This indicates that environmental literacy partially mediates the relationship between academic performance factors and student engagement, and that the factors of academic performance have both a direct effect on student engagement and an indirect effect through environmental literacy. It implies that while environmental literacy is important for increasing engagement through diverse and relevant learning experiences, the various factors of academic performance also have a direct and crucial role in encouraging student engagement. Additionally, factors like access to educational resources, teacher quality, and student motivation were found to significantly influence both academic performance and student engagement in science.

1. **CONCLUSION:**

This study examined the mediating role of student environmental literacy in the relationship between academic performance factors and student engagement. Results showed high levels of all three variables and significant relationships between academic performance factors and both student engagement and environmental literacy, as well as between environmental literacy and student engagement. Crucially, the study found partial mediation, meaning academic performance factors influence student engagement both directly and indirectly through environmental literacy. Therefore, all null hypotheses were rejected. These findings highlight the importance of fostering environmental literacy, as it directly boosts student engagement and acts as a key pathway for academic performance factors to influence engagement. This supports Environmental Education Theory (EET), which emphasizes using the environment as a learning context to enhance environmental literacy and improve academic outcomes.

**Recommendation**

Based on the findings of the study, the researcher proposed a series of recommendations aimed at enhancing student engagement, learning practices, and environmental literacy. It is suggested that the Department of Education (DepEd) confront the challenges associated with low behavioral engagement and academic interaction by advocating for the implementation of active learning methodologies, such as inquiry-based and project-based learning. These approaches have been demonstrated to mitigate disruptive behaviors, including class disturbances and absenteeism, which are indicative of low behavioral engagement. Furthermore, DepEd should prioritize the development of personalized learning strategies and the enhancement of teacher training programs to bolster student-teacher interactions, particularly in contexts beyond the traditional classroom environment.

School heads should integrate environmental literacy into school curricula, as it is crucial for enhancing both education and sustainability. Schools are encouraged to adopt interdisciplinary teaching methodologies that merge academic performance components with environmental literacy, exemplifying this by incorporating relevant environmental topics into subjects such as social studies, mathematics, and economics. Such strategies not only highlight the relevance of students' learning but also facilitate broader applications of knowledge. Interactive and experiential learning methods like project-based learning, outdoor field trips, and hands-on activities (e.g., recycling programs or school gardens) can actively engage students while strengthening their critical thinking skills.

Additionally, fostering peer collaboration through group activities, projects, and peer tutoring can enhance academic interaction among students. Establishing formal teacher-student interaction opportunities outside the classroom, such as advisory periods and mentorship programs, will further support student development. Strengthening the home-school connection by initiating parent engagement programs can also reinforce students' study habits and time management skills.

Teachers should encourage critical thinking, curiosity, and self-advocacy in the classroom to help students develop cognitive skills and agency. Creating collaborative and inquiry-based learning environments can enhance students' understanding of global environmental issues while fostering positive classroom behavior. Encouraging students to participate in environmental actions will reinforce their sense of responsibility and engagement. Additionally, teachers should work with parents and school administrators to reinforce the importance of attendance and participation. Encouraging student ownership of behavior through student-led agreements can instill accountability and a sense of responsibility in students. Recognizing the importance of early exposure to environmental concepts is vital for nurturing lifelong awareness and action.

Future researchers should explore other variables besides environmental literacy to determine their mediating effect on the correlation between student engagement and academic performance in science. Investigating additional factors could provide a more comprehensive understanding of how various elements influence student engagement and academic success.

As climate change and environmental challenges mount, establishing environmental literacy in formal education equips future generations with the knowledge and skills necessary to confront global environmental issues. These targeted strategies aim to improve academic performance, foster lifelong learning, and cultivate environmental stewardship among students, creating a more engaged and environmentally aware educational environment.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare(s) that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

**CONSENT**

As per international standard or university standard, Participants’ parental written consent has been collected and preserved by the author(s). Moreover, ethical consideration was part of the study.

Ethical Approval:

Ethical approvals were secured from the University of Mindanao – Ethics and Research Committee (UMERC) and relevant educational authorities, including the Public School Division Superintendent, District Supervisor, and school principal.

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