INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 08 Issue 06 June 2025

DOI: 10.47191/ijmra/v8-i06-46, Impact Factor: 8.266

Page No. 3458-3466

Metacognitive Skills and Scientific Literacy Level Among STEM Students

Norein C. Cabasa[1], Nick C. Pañares[2]

[1]Southern de Oro Philippines College, Cagayan de Oro City, Philippines

[2]DepEd Region 10 Cagayan de Oro City, Philippines

ABSTRACT: Metacognition to students is recognizing their ability to understand, plan, create, and evaluate their learning strategies. This study aimed to delve into the level of metacognitive skills and scientific literacy level among STEM students. Additionally, it investigated the significant relationship between these metacognitive skills and their scientific literacy level in terms of nominal, functional, conceptual/procedural and multidimensional. It also identified which independent variables singly or in combination influence the scientific literacy level. The study utilized correlational and causal designs to determine the association of the variables. A total of 178 samples from the three (3) large schools in the districts were selected as respondents through stratified sampling. There were two instruments used in the study, an adapted and a researcher made, both validated by the in-house experts of Southern de Oro Philippines College. The researcher treated the data through descriptive statistics such as Mean and Standard Deviation (SD), then, inferential statistics like Pearson Product Moment Correlation Coefficient and Multiple Linear Regression. Results showed that students are highly aware of their planning skills. There is a disparity in the scientific literacy level of students. Most of them are only at a functional level. Among the metacognitive skills, mental scripting showed a strong relationship to scientific literacy. However, there is no predictor among these variables. Hence, in this study metacognitive skills do not influence much with their ability to understand and apply scientific concepts and principles. It is recommended that teachers need to help students organize their scientific thinking for guidance and feedback.

KEYWORDS: mental scripting, metacognitive, scientific literacy

I. INTRODUCTION

Science serves as a fundamental means of comprehending the natural world. The students who enlisted in the Science, Technology, Engineering and Mathematics (STEM) strand in Senior High School are focused on Science and have acquired a profound understanding of scientific principles. They master essential scientific processes such as observation, measurement, inference, prediction, and communication. These STEM students, in the Senior High School level, demonstrate exceptional proficiency in Science and Mathematics due to their rigorous curriculum, which emphasizes these disciplines. Empirical observations indicate that STEM students exhibit higher levels of engagement, participation, and determination compared to their peers. This is attributed to the strong foundation established during their earlier educational stages. Their ability to work independently and competently is a testament to their comprehensive grasp of scientific concepts and methodologies.

However, to become proficient in the aforementioned processes, students should possess a comprehensive understanding of the requisite scientific concepts and knowledge, which serve as essential tools. Therefore, teachers encourage students to recognize their cognitive abilities, engage in self-directed learning, and evaluate their performance. Main (2021) posited that adopting a metacognitive mindset entails the belief that learning is attainable if one is open to the idea. These students excel in metacognitive skills such as planning, reflective practices, and mental scripting due to their capacity for independent learning. Thus, enhancing metacognitive skills supports students in their higher order thinking skills' abilities. Through nurturing these skills, teachers can better prepare students for the complexities of the modern world.

In addition, when students become metacognitive individuals, according to Stebner et al. (2020), they can work independently and competently on their own because they develop a heightened awareness of their own knowledge. They are able to evaluate their performance and take deliberate steps to enhance their learning. Based on various observations in the field, the researcher aimed to investigate the relationship between these metacognitive skills and the levels of scientific literacy. The scientific literacy has been the focus of several studies for so many years. This study exhibited how these metacognitive skills lead up to the development of scientific literacy and its influence in the practices of education in the field.

Metacognitive Skills and Scientific Literacy Level Among STEM Students

According to Shahzadi and Nasreen (2020), scientific literacy is important in our current situations. They highlighted in their study that the application of knowledge in everyday life to solve problems is a sign of scientific literacy. STEM students are adept at problem solving and demonstrate advanced critical thinking skills. This capability enables them to navigate and address complex issues effectively, showcasing the profound associations of scientific literacy on their cognitive and practical abilities.

Hence, this study aimed find out if there was correlation between metacognitive skills and the scientific literacy level among STEM students. The focus was on STEM which was due to their distinctive abilities and skills, with most, if not all, being independent learners. Additionally, the study examined whether the various metacognitive skills, such as planning, reflective practices and mental scripting, exhibit different levels. Furthermore, the research explored the extent of the scientific literacy of the students across nominal, functional, conceptual or procedural, and multidimensional levels. Given the observed issue in the field where most students are aware of their skills that enhance learning, the researcher sought to identify if these metacognitive skills were associated with their scientific literacy levels. Understanding this relationship could provide valuable insights into effective educational practices that promote both metacognitive development and scientific literacy.

Lastly, McGuire and McGuire (2024) affirmed that students are significantly empowered as learners when metacognitive strategies are employed, as they become capable of self-directed learning. This autonomy enables them to enhance their learning abilities independently. As students master these metacognitive skills, their academic progress is expected to improve substantially. Consequently, this study determines whether this correlation holds true for scientific levels. To assess scientific literacy, the Bybee Scale was utilized. Shahzadi and Nasreen recommended four (4) scientific literacy levels at the school level, which will be considered in this investigation.

This study was anchored to the Theory of Metacognition of John Flavell, often described as “thinking about thinking”. According to Thenmozhi (2019), the concept of metacognition encompasses both the knowledge and control of oneself and the control of cognitive processes. Through metacognition, students become experts in their thinking, enabling them to achieve positive outcomes. Main (2021) postulated that students engage in metacognition by reflecting on what they are learning and identifying their knowledge goals. This self-awareness and regulation are critical for academic success and lifelong learning.

The ability of students to regulate their thinking processes through their skills such as planning, reflective practices, and mental scripting is grounded in John Flavell’s Metacognition Theory. This theory helps students develop their own knowledge and learning capacity. Additionally, this study utilized Bybee’s Scale concept of scientific literacy levels, as referenced by Shahzadi and Nasreen. This concept is significant for identifying the specific literacy levels of STEM students, measuring how advanced they are in Science. According to their study, scientific literacy encompasses four (4) functional levels, which are elaborated as follows:

Nominal Level (NL): At this level, students can recognize scientific terms, but they may still exhibit misunderstandings, information gaps, and incomplete knowledge. They tend to develop scientific concepts because they cannot connect ideas. The Functional Level (FL) in this case, the students know how to use a scientific term because they use scientific materials, examples are dictionaries and science books, but they might not always apply these terms correctly. They can define scientific terms and pick up technical science vocabulary, but they lack the depth in connecting these terms for better understanding. The Conceptual/Procedural Level (CL/PL) on one hand, the students start connecting ideas, making sense of scientific principles, and understand how different concepts work together. They can use these learned principles in a practical way. While on the other hand, the Multidimensional Level (ML) the students begin to see the bigger picture of how Science and Technology shape everyday life and society. This level allows the students to harness what they have learned and apply it in the real setting. They exercise exploration on the significance and ask deeper questions about the impact of their learned ideas, concepts, principles, laws, and theories.

These unlike levels help teachers measure STEM students’ progress in understanding Science. The Philippines' Science competencies served as a guide to harness and sharpen the skills of these students and may be able to process the knowledge effectively and gain a competitive edge among peers. This kind of assessment is essential because the Philippines has consistently ranked low in the Programme for International Student Assessment (PISA). The Education experts are working on solutions to improve these results, while the Department of Education has introduced various programs, including those focused on English, Mathematics and Science, to help students strengthen their academic foundation. With these they may be able to meet the demands of promoting critical thinking skills and enhancing students’ 21st century competencies in preparation for PISA.

The 2023 PISA results, as reported by Chi (2023) of the Philippine Star, that Philippines remained consistent with previous rankings. The country scored below the average in the 2022 assessment, with scores of 355 in Mathematics, 347 in Reading, and 373 in Science. This reflects a 2.2% improvement in Mathematics, a 6.9% improvement in Reading, and 0.8% decline in Science proficiency compared to 2018. Among the three subjects, Science proficiency showed a decrease in percentage, highlighting the need for targeted interventions to enhance scientific literacy among students.

II. METHODOLOGY

This study utilized the correlational and causal design because the goal of the study was to find out if there is a relationship between metacognitive skills and scientific literacy level of the STEM students. According to the study of Devi (2022), a correlational design is utilized to explore the relationships between two or more variables within a single group, which may occur at different levels. This non-experimental design assesses the relationship between multiple variables, without aiming to establish cause-and-effect. In correlational research, the investigator examines associations between variables without exerting control or manipulation over them. The correlation indicates the strength and direction of the relationship between variables, which can be either positive or negative.

On the other hand, causal research, investigates the foundational cause-and-effect relationships between two or more variables. Researchers usually observe the effects that changes in one variable have on another. By examining these relationships, researchers gain valuable insights into the mechanisms driving the phenomena under study. Hence, this study used these two designs for the associations of the variables used (Dovetail, 2023).

The study utilized descriptive statistics and inferential statistics. In which the use of Mean and Standard Deviation for problems 1 and 2 were categorized as descriptive statistics. Then, problems 3 and 4 were inferential statistics. Pearson Product Moment Correlation Coefficient was used for problem 3. While, in problem 4, the Multiple Linear Regression was utilized.

III. RESULTS AND DISCUSSION

Problem 1. What is the level of metacognitive skills of STEM students in terms of:

1.1 planning;
1.2 reflective practices; and
1.3 mental scripting?

Table 1: Overall Metacognitive Skills

Indicators	Mean	SD	Description	Interpretation
Planning	3.25	0.516	Strongly Agree	Highly Aware
Reflective Practices	3.06	0.651	Agree	Aware
Mental Scripting	3.17	0.658	Agree	Aware
Overall	**3.16**	**0.608**	**Agree**	**Aware**

Note: 3.25 – 4.00 Highly Aware, 2.50 – 3.24 Aware, 1.75 – 2.49 Less Aware, 1.00 – 1.74 Least Aware

Table 1 presents the Summary on Metacognitive Skills. It has an overall Mean of 3.16 with SD = 0.608, described as Agree and interpreted as Aware. This implies that students demonstrate awareness of the metacognitive skills. While students recognize the importance of metacognitive strategies such as planning, reflective practices, and mental scripting. They may not be fully utilizing them at an advanced level. The SD of 0.608 indicates a moderate level of variation in responses. Some students may be highly engaged in metacognitive strategies, while others may struggle to apply them consistently.

Moreover, students exhibit the highest level of awareness in planning, which means they strongly agree that they engage in activities such as setting goals, which is defining clear objectives for what they want to achieve in their studies, strategizing, which is choosing appropriate study methods, organizing materials, and breaking down tasks into manageable steps, and preparing for learning tasks, which is reviewing content ahead of time, managing time effectively, and ensuring they have the necessary resources.

On the other hand, *Reflective Practices*, has the lowest Mean of 3.06 with SD = 0.651, which is described as Agree and interpreted as Aware. This reveals that the students are slightly doing their best on evaluating themselves after activities. Though they are aware that they need to share strategies with their peers, and need to work closely with the other students, they may have lessened their strategies in order to succeed. The relatively low mean score for Reflective Practices suggests that students are aware of its importance but may not be applying it consistently or effectively.

Furthermore, *Mental Scripting*, has Mean of 3.17 with SD = 0.658, described as Agree and interpreted as Aware. When students rehearsing scenarios, responses, and actions before they happen, they are exercising the mental scripting. It plays a crucial role in shaping thoughts, behaviors, and decision making. For students, awareness of mental scripting can significantly impact their academic performance, social interactions, and emotional well-being.

Güner and Erbay (2021) emphasized that students with metacognitive skills
solve problems accurately by employing various strategies and continuously verifying their solutions. Effective problem-solving requires self-monitoring and cognitive regulation, but some students struggle to comprehend their own thought processes. Those

with advanced metacognitive control can transfer past experiences to new challenges, highlighting the importance of fostering metacognitive skills for better problem-solving.

Problem 2. What is the level of the scientific literacy of the STEM students?

Table 2 on the next page shows the Scientific Literacy Level. Among the respondents, 42.13% or 75 students have Satisfactory performance, with a Mean = 20.00 and SD = 10.74 which is interpreted as Functional, the second level of the scientific literacy. This indicates that most respondents are capable of using a scientific dictionary, though they often do so without proper contextual understanding. While they can accurately define scientific terms and acquire technical vocabulary, their application may lack depth and precision. Notably, 31.47% or 56 of the students performed at a Very Satisfactory level with a Mean = 33.00 and SD = 2.26, classified as Conceptual/Procedural, the third level of scientific literacy. This suggests that these students can grasp and connect scientific concepts, actively engaging in the meaning-making process. Their familiarity with scientific principles and techniques reflects an emerging ability to integrate and apply scientific knowledge effectively.

Table 2: Scientific Literacy Level

Scale	Range	Frequency	Percentage	Mean	SD	Description	Interpretation
4	40 - 52	46	25.84	46.00	15.26	Outstanding	Multidimensional
3	27 - 39	56	31.47	33.00	2.26	Very Satisfactory	Conceptual/Procedural
2	14 - 26	75	42.13	20.00	10.74	Satisfactory	Functional
1	01 - 13	1	0.56	7.00	23.74	Fairly Satisfactory	Nominal
Total		**178**	**100%**	**30.74**	**10.66**		

Note: 40 – 52 Multidimensional, 27 - 39 Conceptual/Procedural, 14 – 26 Functional, 01 - 13 Nominal

Moreover, out of all the respondents, 46 students or 25.84% achieved an Outstanding performance in scientific literacy, with a Mean score of 46.00 and SD= 15.26. These students fall into the Multidimensional category, the highest level of scientific literacy. It means that these students do not just memorize scientific facts, but they truly understand them. They grasp fundamental principles, see how science and technology impact daily life, and even recognize their broader societal implications. More than that, they actively analyze, interpret, and apply their scientific knowledge to real-world situations. Their ability to make meaningful connections between concepts shows that their learning is not limited to textbooks; they think critically, ask deeper questions, and engage thoughtfully with science in ways that make a difference.

This finding highlights the importance of fostering a dynamic and analytical approach to Science education, where students move beyond rote learning and develop the skills to navigate the complexities of Science in everyday life. Students who reach this level of proficiency can critically evaluate the role of Science in society and its far-reaching impact on technological advancements and everyday life. Their understanding goes beyond memorization they can analyze, question, and apply scientific principles in meaningful ways.

However, despite the strong presence of students at the Multidimensional level of scientific literacy, a small yet significant 0.56% (1 respondent) remains at the Nominal level, with a Mean score of 7.00 and SD of 23.74. This is categorized as Fairly Satisfactory, the lowest among the four scientific literacy levels. While these students can recognize scientific terms, their understanding tends to be fragmented—marked by misconceptions, gaps in knowledge, and an incomplete grasp of fundamental concepts. Their ability to explain scientific principles is still in its early stages, reflecting a basic, surface-level comprehension that lacks deeper analysis and real-world application.

This highlights the need for targeted teaching strategies to help bridge these conceptual gaps and strengthen foundational scientific literacy. Ensuring students develop a more cohesive and well-rounded understanding of scientific concepts is essential for fostering critical thinking and higher-order reasoning.

In line with this, Anakara (2021) found a significant gap between students' Nominal and Multidimensional literacy levels, with the lower levels being more prevalent. While students show competence in recalling basic facts (functional level) and understanding concepts (structural level), many struggle when it comes to critically analyzing information, applying knowledge in real-world contexts, and engaging in higher order thinking all of which define multidimensional scientific literacy.

Metacognitive Skills and Scientific Literacy Level Among STEM Students

Problem 3. Is there a significant relationship between the metacognitive skills and scientific literacy level of the STEM students?

Table 3: Test of Correlation Between the Metacognitive Skills and Scientific Literacy Level

Variable	r-value	p-value	Level of Correlation	Interpretation
Planning	0.0762	0.3120	Very Weak Positive Correlation	Not Significant
Reflective Practices	0.0609	0.4194	Very Weak Positive Correlation	Not Significant
Mental Scripting	0.1529	0.0419	Very Weak Positive Correlation	Significant

Note: ± 0.80 to ± 1.00 Very Strong Positive Correlation, ± 0.60 to ± 0.79 Strong Positive Correlation, ± 0.40 to ± 0.59 Moderate Positive Correlation,

± 0.20 to ± 0.39 Weak Positive Correlation, ± 0.00 to ± 0.19 Very Weak Positive Correlation,

Table 3 exhibits Test of Correlation Between the Metacognitive Skills and the Scientific Literacy Level. The correlation between planning and scientific literacy yielded a computed r-value of 0.0762 and a p-value of 0.3120, indicating a very weak correlation that is not statistically significant. This suggests that while students who engage in planning their learning, may exhibit marginally higher scientific literacy, the effect is minimal. Given the weak correlation and lack of statistical significance, it is likely that this relationship is due to chance rather than representing a genuine causal effect. This implies that students who engage in planning do not necessarily have higher scientific literacy levels. This is because, while planning is generally an important metacognitive skill, it may not directly contribute to scientific literacy unless it is actively applied to problem solving and conceptual understanding.

In addition, scientific literacy is strongly linked to the ability of the students to solve problems using logical reasoning and scientific methods. However, if the students plan only their studies but do not engage in problem solving tasks, they may not improve in scientific literacy. It is considerable that students need deep conceptual knowledge and not just memorized definitions.

Accordingly, Glaze (2018) highlighted, scientific literacy as a profound understanding and thorough knowledge of scientific concepts and processes, highlighting its essential role in education. Rather than simply memorizing facts or isolated information, scientific literacy requires critical thinking, data analysis, and the application of scientific principles to real world challenges. This expanded perspective aligns with the primary objective of science education: to empower learners with the skills and knowledge necessary to navigate and make meaningful contributions in an increasingly science driven world.

Reflective Practices has a computed r- value of 0.0609, with computed p-value of 0.4194, which has a strength of Very Weak Correlation and interpreted as not significant. This means that students who engage in reflection have slightly higher scientific literacy, but the effect is very minimal the same as planning. This indicate that there is no real association. This implies that reflection is not enough to improve scientific literacy.

Moreover, there is a need to simply encourage students to think about their learning experiences which does not guarantee that they will develop a deeper understanding of scientific concepts or improve their ability to apply scientific reasoning. Perhaps students need structured guidance on how to reflect effectively like the teachers giving them feedback. The teachers can provide targeted feedback to help students refine their thinking, correct misconceptions, and build stronger connections between scientific principles. Constructive feedback can guide students toward more meaningful insights and a deeper understanding of scientific processes.

Furthermore, Broderick (2023), emphasized the imperative role of Science
educators in cultivating scientific comprehension of students, critical analysis of technological benefits and drawbacks, and appreciation for the scientific community. To achieve a holistic vision of scientific literacy, a recalibration of Science education is necessary. Ensuring that all students receive a robust scientific education is fundamental to preparing them as informed and engaged citizens in the 21st century.

For Mental Scripting, it registered a computed r-value of 0.1529 with computed p-value of 0.1419, which has a strength of Very Weak Positive Correlation and interpreted as statistically significant. This reveals that students who engage in mental scripting tend to have higher scientific literacy. Then, this relationship is likely real and not due to chance. Although the correlation remains relatively weak, mental scripting emerges as the sole metacognitive skill that demonstrates a quantifiable influence on scientific literacy. Mental scripting involves the cognitive process of mentally rehearsing concepts, anticipating potential outcomes, and systematically structuring scientific reasoning. Through engaging in this practice, students may develop a deeper understanding of scientific principles, improve their ability to apply knowledge in novel contexts, and enhance their overall scientific literacy.

Hence, it is imperative that educators integrate mental scripting strategies such as self-questioning, thought experiments, and structured problem-solving into their instructional methods. These approaches can facilitate metacognitive engagement, reinforce conceptual comprehension, and ultimately contribute to the development of scientifically literate individuals.

Metacognitive Skills and Scientific Literacy Level Among STEM Students

According to González et al. (2020), learning is more than just absorbing information it is about understanding how we think, process, and apply knowledge. A key part of this is metacognition, or the ability to reflect on our own learning and make adjustments when needed. When students develop strong metacognitive skills, they can assess their understanding, recognize what study methods work best for them, and adapt their approach to different learning challenges. This self-awareness helps them become more independent and confident in their abilities, giving them the tools to take control of their academic journey. It also makes them more resilient, instead of getting discouraged by mistakes. They can reflect, adjust, and improve. With actively practicing metacognitive strategies, students not only enhance their learning but also build essential problem-solving and critical thinking skills that will serve them well beyond the classroom.

Problem 4. Which of the independent variables singly or in combination influence the scientific literacy level of the STEM students?

Table 4: Multiple Linear Regression Analysis on Metacognitive Skills and Scientific Literacy Level

Model Coefficients – Scientific Literacy Level

Predictor	Estimate	SE	t	p
Constant	19.9722	7.414	2.694	0.008
Planning	0.0713	0.390	0.183	0.855
Reflective Practices	-0.1468	0.390	-0.376	0.707
Mental Scripting	0.5336	0.297	1.194	0.075

Note: Models estimated using sample size of N=178

Table 4 shows the Multiple Linear Regression Analysis on Metacognitive Skills and Scientific Literacy Level. It is hypothesized that the three (3) predictors will be associated positively with the Scientific Literacy Level. Results show that the model overall is weak, as seen in the low R^2 value as shown in the table of which 2.42% of the variation in Scientific Literacy Level is explained by these predictors. The constant value (19.9722, $p = 0.008$) suggests that, even in the absence of strong metacognitive skills, students still have a baseline level of scientific literacy. While the significance of the constant ($p < 0.05$) means there are likely other factors outside these metacognitive skills that contribute significantly to scientific literacy.

Moreover, planning has almost no influence on scientific literacy levels of the students, because the extremely high p-value (0.855) suggests that ability of the students to plan their learning, does not significantly impact their ability to understand and apply scientific concepts. While planning is useful, scientific literacy might depend more on active engagement with scientific content rather than just organizing how to study it.

On one hand, reflecting on one's learning does not significantly enhance scientific literacy. Thus, the slightly negative coefficient suggests that more reflection might even be counterproductive though not significant, because the p-value (0.707) is too high to confirm any real effect. Students who engage in excessive reflection may get stuck in overanalyzing their learning process rather than actively engaging with scientific concepts. They may also lack the necessary feedback mechanisms to translate reflection into improved understanding.

On the other hand, mental scripting shows the strongest positive relationship with scientific literacy, although it is not statistically significant at the 0.05 level. Mental scripting likely helps students internalize scientific concepts, anticipate problems, and make connections between ideas, which are key components of scientific literacy.

Although mental scripting is not statistically significant, it appears to be the most promising metacognitive skill for improving scientific literacy. Thus, teachers could emphasize activities that encourage students to mentally structure their scientific thinking, such as predicting experiment outcomes, creating concept maps, engaging in thought experiments and using self-questioning strategies before solving problems.

Perry et al. (2018) provided substantial evidence that students achieve better academic outcomes when they actively engage in metacognitive processes. In the context of scientific literacy, developing metacognitive skills allows students to think critically, evaluate scientific information, and apply problem-solving strategies effectively. When these skills are explicitly taught in educational settings, they enhance the ability of the students to analyze and interpret scientific concepts, leading to improved performance in science-related subjects.

Consequently, incorporating metacognitive strategies into science instruction provides a significant advantage by fostering deeper comprehension, promoting inquiry-based learning, and strengthening the ability of the students to transfer knowledge to new scientific contexts. This conclusion is further supported by Bae and Kwon (2019), who demonstrated that metacognitive skills can be applied across different domains and emphasized the importance of student-teacher interactions in nurturing these skills.

The model presents the results of a regression analysis, which examines the relationship between a set of independent variables and a dependent variable. The Correlation Coefficient ($R = 0.155$), where R represents the overall correlation between the predicted values and the actual values of the dependent variable. With $R = 0.155$, the correlation is very weak, indicating that the independent variables have little influence on the dependent variable. This suggests that changes in the independent variables do not lead to substantial or predictable changes in the dependent variable. The Coefficient of Determination ($R^2 = 0.0242$) R^2, measures the proportion of variation in the dependent variable that can be explained by the independent variables. A value of 0.0242 (2.42%) suggests that the regression model explains only a very small fraction of the variation in the dependent variable. The Adjusted R^2 (0.00733), accounts for the number of predictors in the model and adjusts for overfitting. This suggests that some predictors may not be relevant or contribute little to explaining variations in the dependent variable. The F-Statistic ($F = 1.44$) tests whether the independent variables, as a group, significantly explain variations in the dependent variable. An F-value of 1.44 is quite low, indicating that the model does not explain a significant portion of the variance. The p-Value ($p = 0.234$) determines whether the overall regression model is statistically significant. A p-value of 0.234 is much greater than the common significance threshold (0.05 or 0.01), meaning the model is not statistically significant. This implies that there is no strong evidence to suggest that the independent variables have a meaningful impact on the dependent variable.

IV. CONCLUSIONS

Based on the findings, the following conclusions were drawn:

1. The students are aware of their learning abilities.
2. Most of the students lacked in depth and proper context in learning the scientific concepts because they are only accurate on describing scientific terms.
3. Students engage in mental rehearsal and mental exercises like exploring ideas, concepts, or scenarios without physical experimentation. Allowed them to test hypotheses, analyze potential outcomes, and deepen their understanding of abstract concepts.
4. Various factors, such as teaching methods, access to educational resources, and students' interest in science, are the other factors that are not considered in the study which significantly influence their scientific literacy levels.

V. RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations are proposed to promote metacognitive skills and improve scientific literacy for STEM students:

1. Teachers may motivate students to regularly reflect on their planning skills to improve their learning efficiency. Provide opportunities for them to refine their strategies through guided practice and feedback.
2. Teachers may strengthen the application of students on scientific concepts by incorporating more problem-solving tasks, real world applications, and critical thinking exercises to deepen their scientific literacy.
3. Teachers may stimulate students to practice mental rehearsal for stronger scientific comprehension such as guided visualization and predict and reflect. Then, allow them to receive constructive feedback which will guide them toward more meaningful insights.
4. Students organize their scientific thinking, like predicting outcomes, creating concept maps, engaging in thought experiments, and using self-questioning before solving problems with the help of the teachers. Then, engage in scientific materials to enhance scientific comprehension.

REFERENCES

1) Altindağ, M., & Senemoğlu, N. (2013b). Metacognitive Skills scale. DergiPark (Istanbul University). https://dergipark.org.tr/tr/pub/hunefd/issue/7789/101825
2) Anakara, H. R. S. (2021). Assessment of biological literacy levels among Third-Grade Secondary School students in Medina. International Education Studies, 14(7), 47. https://doi.org/10.5539/ies.v14n7p47
3) Bae, Haesol and Kwon, Kyungbin (2019). Developing Metacogitive Skills Through Class Activities: What Makes Students Use Metacognitive Skills
4) Broderick, Nicola (2023). Exploring Different Visions of Scientific Literacy in Irish Primary Science Education: Core Issues and Future Directions
5) Chi, C. (2023). Philippines still lags behind world in math, reading and science. PISA 2022. Philstar.com. https://www.philstar.com/headlines/2023/12/06/2316732/philippines-still-lags-behind-world-math-reading-and-science-pisa-

6) Devi, Barkha, Devi, Ranjita, Pradhan, Shrijana, Giri, Doma, Lepcha, Nazung and Basnet, Shakeela (2022). Applicationof Correlational Research Design in Nursing and Medical Research. https//:doi:10.17605/OSF.IO/YRZ68
7) Dori, Yehudit Judy, Avargil, Shirly, Kohen, Zehavit and Saar, Liora (2018). Context-Based Learning and Metacognitive Prompts for Enhancing Scientific Text Comprehension
8) Dovetail Editorial Team (2023). What is Causal Research Design? https://dovetail.com/research/causal-research/
9) Glaze, A. L. (2018). Teaching and Learning Science in the 21st Century: Challenging Critical Assumptions in Post – Secondary Science. Sciences, 8(1), 12. https://doi.org/10.3390educsci 8010012
10) González, J. M. M., Requena, B. E. S., & Ariza, M. D. H. (2020). Difficulties and expectations of future education professionals in the learning of the mind
11) Map. Mind Brain and Education, 14(4), 341–350. https://doi.org/10.1111/mbe.12258
12) Güner, P. & Erbay, H. N. (2021). Metacognitive skills and problem-solving. International Journal of Research in Education and Science (IJRES), 7(3), 715-734. https://doi.org/10.46328/ijres.1594
13) Gürler, S. A. (2022). Relationship between scientific literacy and the attitude towards reading scientific texts: A study on primary school teacher candidates. International Journal of Progressive Education, 18(5), 117–132. https://doi.org/10.29329/ijpe.2022.467.7
14) Hameed, Hajara Abdul and Cheruvalath (2021). Metacognitive Skills Inventory (MSI): Development and Validation
15) Johnston, C. (2017). Reflective practice. Teaching Business & Economics, 21(1), 19-21.
16) Kuhn, D. (2022). Metacognition matters in many ways. Educational Psychologist, 57(2), 73-86.
17) Langdon, J., Botnaru, D. T., Wittenberg, M., Riggs, A. J., Mutchler, J., Syno, M., & Caciula, M. C. (2019). Examining the effects of different teaching strategies on metacognition and academic performance. Advances in physiology education, 43(3), 414-422.
18) Main, Paul I. (2021). Metacognitive Strategies in the Classroom
19) McGuire, S. Y., & McGuire, S. (2024). Teach students how to learn: Strategies you can incorporate into any course to improve student metacognition, study skills, and motivation.
20) Nobutoshi, M. (2023). Metacognition and reflective teaching: a Synergistic Approach to fostering critical thinking skills. Research and Advances in Education, 2(9), 1-14.
21) Onah, D. F., Pang, E. L., & Sinclair, J. E. (2018). A metacognitive instructional approach and self-reflection: reflective practice from a computer science perspective. In INTED2018 Proceedings (pp. 9882-9888). IATED.
22) Özenç, M., & Çarkit, C. (2021). The relationship between functional literacy and problem-solving skills: A study on 4th-grade students. Participatory Educational Research, 8(3), 372–384. https://doi.org/10.17275/per.21.71.8.3
23) Perry, Jerry, Lundie, David, and Golder, Gill (2018). Metacognition in Schools: What does the Literature Suggest About the Effectiveness of Teaching Metacognition in Schools?
24) Pisano, Vincent R., Dolenc, K., PlojVirtic, M. (2020). Historical Foundations of Physics & Applied Technology as dynamic Frameworks in Pre-service. STEM. Foundations of Science, 26(3), pages 727-756. https://doi.org/10.1007/s10699-020-09662
25) Rivas SF, Saiz C and Ossa C (2022) Metacognitive Strategies and Development of Critical Thinking in Higher Education.Front. Psychol. 13:913219.
26) Rizkia, Andini Maulida and Zulfiani Zulfiani (2021). Fostering metacognitive skill: A Means to Improve Sudents' Academic Achievement. https://doi.org/10.21009/biosferjpb.19839
27) Sagun, Richard Deanne and Maricar Prudente (2021). Applying the Plan-do-study-Act (PDSA) Action Research Model to Re-structure the Science Classroom Conforming to the Metacognitive Orientation Standards. Pages 61-77
28) Shahzadi, Iram and Nasreen, Abida (2020). Assessing Scientific Literacy Level Among Secondary School Science Students of District Lahore. Bulletin of Education and Research Vol. 42, No. 3, pages 1-21
29) Stanton, J. D., Halmo, S., Carter, R. J., AYamini, K., & Ososanya, D. (2024). Opportunities for Guiding Development: Insights from First-Year Life Science Majors' Post-Pandemic Use of Metacognition. Proceedings.,2083–2084. https://doi.org/10.22318/icls2024.354960
30) Stebner, Ferdinand, Schuster, Corinna, Weber, Xenia-Lea, Greiff, Samuel, Leutner, Detlev and Wirth, Joachim (2022). Transfer of Metacognitive Skills in Self-regulated Learning: Effects on Strategy Application and Content Knowledge Acquisition. Vol. 17, pages 715-744.
31) Sword, R. (2024b, February 16). Metacognition in the Classroom: Benefits & Strategies. The Hub | High Speed Training. https://www.highspeedtraining.co.uk/hub/metacognition-in-the-classroom/
32) Thenmozhi, C. (2019). Models of Metacognition. Shanlax International Journal of Education, vol. 7, no. 2, pp. 1-4.

33) Wilson, John, Draper, Claire, Fomarino, Laura, Li, Menghua, Sabri, Tala and Shi, Yan (2023). Metacognitively ALERT in Science: Literature Synthesis of a Hierarchical Framework for Metacognition and Preliminary Evidence of its Viability. Pages 1-37