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Self-Regulated Learning and Mathematical Modeling Competence Among Secondary School Students in Technology-Enhanced Classrooms

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ABSTRACT

Guided by the growing need to strengthen independent learning and real-world mathematical reasoning, this study determined the relationship between self-regulated learning and mathematical modeling competence among secondary school students in technology-enhanced classrooms at Isabela National High School in the City of Ilagan, Isabela. Using a quantitative descriptive-correlational design, the study involved students selected through simple random sampling. A validated survey questionnaire was used to measure self-regulated learning in terms of goal setting and planning, self-monitoring and strategy use, and self-reflection and adjustment, as well as mathematical modeling competence in terms of understanding and interpreting real-world problems, formulating mathematical representations, and analyzing and validating solutions in context. Descriptive statistics such as weighted mean and standard deviation were used to determine the levels of the two variables, while Pearson Product-Moment Correlation and multiple regression analysis were employed to test their relationship and predictive dimensions. Findings revealed that the respondents demonstrated high levels of self-regulated learning and mathematical modeling competence. A significant positive relationship was also found between the two variables, indicating that students with stronger self-regulatory behaviors tended to show higher competence in mathematical modeling. Among the dimensions of self-regulated learning, self-monitoring and strategy use emerged as the strongest predictor of mathematical modeling competence. The findings suggest that strengthening students' self-regulatory capacities in technology-enhanced mathematics classrooms may contribute to improved performance in modeling-oriented tasks and more meaningful engagement in real-world mathematical problem solving.

Keywords: *self-regulated learning, mathematical modeling competence, technology-enhanced classrooms, secondary school students, mathematics education, problem solving*

INTRODUCTION

In contemporary mathematics education, there is growing recognition that student success depends not only on content knowledge but also on the learner's capacity to manage, direct, and sustain learning in purposeful ways. This capacity is commonly understood as self-regulated learning, a construct that has gained strong theoretical and empirical attention because it explains how learners plan their goals, monitor their progress, control their strategies, and reflect on outcomes in response to academic tasks. Panadero (2017) described self-regulated learning as a broad construct that includes cognitive, metacognitive, behavioral, motivational, and affective dimensions, while Tinajero et al. (2024) further emphasized that self-regulated learning is an active and constructive process shaped not only by students' thoughts and actions but also by contextual conditions and learning environments. In mathematics, where learners are often required to persist through abstraction, revise their approaches, and justify their reasoning, self-regulated learning becomes especially important because mathematical success often depends on sustained effort, strategic thinking, and reflective adjustment rather than memorization alone.

The importance of self-regulated learning becomes even more pronounced when viewed within mathematics classrooms. A systematic review by Wang and Sperling (2020) found that effective self-regulated learning interventions in mathematics were associated with improved mathematics achievement and stronger self-regulatory competence among school-aged learners. Their review also showed that mathematics-specific self-regulated learning is not merely a generic study habit but a domain-sensitive process that benefits from cognitive, metacognitive, and motivational support working together. This is significant because mathematics demands more than procedural compliance. It asks learners to set goals, choose and revise strategies, deal with errors, tolerate uncertainty, and continue working despite difficulty. Such features make mathematics a fertile but demanding space for self-regulation, especially among secondary school students who are expected to solve increasingly complex and nonroutine tasks.

At the same time, mathematics education has increasingly moved toward outcomes that reflect real-life application rather than isolated symbolic manipulation. This shift is evident in the growing attention given to mathematical modeling competence. Kaiser (2020) explained that the promotion of modeling competencies, understood as the competencies to solve real-world problems using mathematics, is now widely accepted as a central goal of mathematics education. Similarly, Cevikbas et al. (2022) noted that mathematical modelling competencies have become a prominent construct in research on the teaching and learning of mathematical modelling and its applications, particularly because contemporary mathematics education is expected to connect school learning with authentic situations. More recently, Lindl et al. (2025) described mathematical modelling competency as the ability to construct and use mathematical models for solving real-world problems, as well as to analyze or compare such models. These views suggest that modeling competence is not limited to getting correct numerical answers. Rather, it involves interpreting a real situation, selecting relevant variables, formulating assumptions, representing relationships mathematically, solving the resulting problem, and interpreting the solution back into context.

The educational value of mathematical modeling is strongly aligned with the broader goals of mathematical literacy in the twenty-first century. The OECD PISA 2022 Mathematics Framework emphasizes that mathematics education should prepare students to use mathematics in personal, civic, and professional life, and that mathematical literacy involves the capacity to formulate, employ, interpret, and evaluate mathematics in real-world contexts (OECD, 2023). The same framework explains that students need to recognize the mathematical nature of a real-world situation, translate it into mathematical terms, solve it using appropriate mathematical tools, and then interpret the solution back in relation to the original context. This orientation places mathematical modeling at the heart of meaningful mathematics learning because it bridges school mathematics and lived reality. It also reinforces the idea that competence in modeling requires reasoning, reflection, judgment, and decision-making, all of which are closely related to self-regulatory processes.

The rise of technology-enhanced classrooms adds another important dimension to this relationship. UNESCO (2023) noted that digital technology has expanded access to teaching and learning resources, but it also stressed that technology improves learning only in some contexts and when it is meaningfully integrated into pedagogy. The report further warned that many students still have limited opportunities to practice with digital technology in school and that teachers often feel unprepared to teach effectively with it. In the Philippine setting, the Department of Education has been strengthening digital education efforts, including partnerships intended to support numeracy and literacy through online learning content, while its Quality Basic Education Development Plan 2025 to 2035 identifies digitalization as a major strategic lever for improving access to innovative learning resources and helping make classrooms future-ready. These developments show that technology-enhanced classrooms are no longer peripheral to school improvement. They are increasingly becoming part of mainstream educational practice, including mathematics instruction.

Yet the presence of technology does not automatically produce meaningful learning. In fact, technology-enhanced environments often demand even higher levels of self-regulation from students. Zheng (2016) found through meta-analysis that self-regulated learning scaffolds in computer-based learning environments generally produced a significantly positive effect on academic performance. Engelmann et al. (2021) likewise observed that students must engage in self-regulated learning in computer-based learning environments, yet many learners struggle to do so effectively without support. Research also shows that structured virtual learning environments can support students’ mathematical modelling sub-competencies and motivation when activities, materials, instructional guidance, and collaborative opportunities are intentionally designed. Cohen-Nissan and Kohen (2023), for instance, found that secondary school students in a virtual learning environment demonstrated varied but meaningful levels of mathematical modelling sub-competencies, while the structured design of the environment supported both motivation and competence. These findings suggest that technology-enhanced mathematics learning may become especially productive when digital tools are paired with self-regulatory support and tasks that require authentic mathematical thinking.

For secondary school students, this issue is particularly important because adolescence is a stage in which learners are expected to become more independent, strategic, and accountable for their academic choices. In mathematics, these expectations are intensified by tasks that involve problem solving, abstraction, and transfer to real-world situations. In technology-enhanced classrooms, students are often required to navigate digital materials, manage time, interpret multimedia information, and persist through open-ended tasks with varying levels of teacher support. This learning condition may either strengthen or expose differences in self-regulated learning, which in turn may influence how effectively students engage in mathematical modeling tasks. Considering that Isabela National High School is one of the public high schools in the City of Ilagan, Isabela, and that Philippine basic education is moving toward more digitally supported and future-ready classrooms, there is a strong educational basis for examining how self-regulated learning relates to mathematical modeling competence in this local setting (City Government of Ilagan, n.d.; Department of Education, 2025).

Thus, this study was grounded on the view that self-regulated learning and mathematical modeling competence are not separate concerns but potentially interconnected dimensions of mathematics learning in technology-enhanced classrooms. Self-regulated learners are more likely to plan, monitor, revise, and reflect during complex academic tasks, while mathematical modeling requires exactly these forms of disciplined and reflective engagement. In a classroom environment where technology expands both opportunities and demands, understanding the relationship between these two variables may offer meaningful insights for mathematics teachers, school leaders, and curriculum planners. More importantly, it may help explain how secondary school students in Isabela National High School can be better supported as they learn mathematics not only as a school subject, but as a practical and reflective tool for understanding the world around them.

Literature Review

Self-Regulated Learning as a Foundational Construct in Student Learning

Self-regulated learning has become one of the most influential concepts in contemporary educational psychology because it explains how learners actively manage their own learning processes. Panadero (2017) described self-regulated learning as a comprehensive construct that includes cognitive, metacognitive, behavioral, motivational, and emotional or affective aspects of learning. This means that self-regulated learners do not simply receive information passively. Instead, they set goals, select strategies, monitor their progress, regulate their effort, and reflect on the outcomes of their actions. Such a view is highly relevant in secondary education, where students are increasingly expected to become more independent and responsible in academic tasks. The strength of self-regulated learning as a concept lies in its ability to explain why some learners persist, adapt, and improve even in demanding learning conditions, while others struggle when tasks require planning, reflection, and sustained engagement

From a broader perspective, self-regulated learning is not limited to study habits or personal discipline. It is better understood as a dynamic process through which learners coordinate thoughts, motivation, and actions in relation to academic goals. Because of this, self-regulated learning has been widely used to explain achievement differences across subjects, especially in areas that require persistence and strategy use. In mathematics, this becomes especially important because students often encounter tasks that are abstract, multistep, and cognitively demanding. The value of self-regulated learning in such contexts lies in its capacity to support students as they plan approaches, check for errors, revise methods, and continue working despite difficulty. For this reason, self-regulated learning is highly relevant to any study that seeks to understand how students perform in complex mathematical tasks, especially in technology-supported environments where learner autonomy is often more strongly demanded than in purely teacher-directed settings

Self-Regulated Learning in Mathematics Education

The literature has consistently shown that self-regulated learning is especially meaningful in mathematics because mathematics requires more than recall of formulas and procedures. It demands reasoning, decision-making, self-monitoring, and the ability to persist through difficulty. Wang and Sperling (2020), in their systematic review of self-regulated learning interventions in mathematics classrooms, found that effective interventions were associated with improved mathematics achievement and stronger self-regulatory competence. Their review emphasized that self-regulated learning in mathematics is domain-sensitive, meaning that students benefit when self-regulation is linked directly to mathematical thinking, problem solving, and task engagement rather than treated as a generic academic skill. This is important because mathematics learning often requires learners to manage frustration, identify mistakes, and adjust strategies while working toward correct and meaningful solutions

Additional support for this view appears in research examining the connection between self-regulatory variables and mathematics performance. Říčan et al. (2022) investigated the relationships among attitudes toward mathematics, metacognitive knowledge, self-efficacy, motivation, metacognitive monitoring, and achievement in solving mathematical problems. Their work highlights that mathematics learning is closely connected with internal learner processes, particularly those related to monitoring and motivation. This suggests that students' mathematical success cannot be fully understood by looking only at content mastery. Their ability to regulate cognition and motivation also matters. In the case of secondary school learners, who often face more demanding mathematical tasks than younger pupils, the role of self-regulated learning becomes even more critical. It provides a useful lens for understanding why some students can navigate complex tasks effectively while others may struggle despite having access to similar instruction and resources

Mathematical Modeling Competence in Contemporary Mathematics Education

Mathematical modeling competence has emerged as an important outcome in mathematics education because it reflects students' capacity to use mathematics meaningfully in real-world situations. Cevikbas et al. (2022), in a systematic literature review, described mathematical modelling competencies as a prominent construct in research on the teaching and learning of mathematical modelling and its applications. Their review showed that the field has developed various frameworks for conceptualizing, measuring, and fostering these competencies, indicating both the richness and the complexity of the concept. This means that mathematical modeling competence is not a single skill. Rather, it involves a cluster of sub-competencies that enable learners to move from real situations to mathematical representations and then back again to contextualized interpretations

Kaiser (2020) likewise explained that promoting modeling competencies is now widely accepted as a central goal of mathematics education. This position reflects a major shift in educational priorities. Mathematics is no longer viewed only as a school subject concerned with internal symbolic manipulation. It is also expected to prepare learners to understand, analyze, and respond to the quantitative features of life outside the classroom. In this sense, mathematical modeling competence includes identifying relevant variables, making assumptions, constructing representations, performing computations, evaluating results, and deciding whether the solution is sensible in relation to the original situation. Such competence is highly appropriate for secondary school students because it supports deeper understanding, applied reasoning, and authentic problem solving. It is also especially valuable in classrooms that aim to prepare learners for a world in which mathematics must be used flexibly across personal, civic, and future professional contexts

Mathematical Literacy, Real-World Problem Solving, and the Modeling Cycle

The relevance of mathematical modeling is strongly reinforced by international perspectives on mathematical literacy. The OECD PISA 2022 Mathematics Framework explains that mathematical literacy is grounded in mathematical reasoning and the processes of the problem-solving or mathematical modelling cycle. It presents mathematics not simply as content to be memorized, but as a way of formulating, employing, and interpreting mathematics in a range of contexts. In this framework, students are expected to recognize the mathematical dimension of a real situation, translate it into mathematical terms, work through the problem, and interpret the results back in light of the original context. This process clearly reflects the essence of mathematical modeling and highlights why modeling competence has become a major concern in school mathematics worldwide

This international framework is especially useful for studies like the present one because it clarifies that competence in mathematics includes applied understanding, not just procedural accuracy. Students need to make judgments, evaluate assumptions, and connect solutions to real-world meaning. These demands align closely with self-regulated learning because modeling tasks often involve ambiguity, multiple pathways, and the need to monitor one’s own reasoning. A learner working on a modeling problem must decide what information matters, which mathematical tools are appropriate, and whether the final result is realistic. Thus, the literature suggests that mathematical modeling competence naturally intersects with self-regulatory processes. The modeling cycle is not merely technical. It is also reflective and strategic, which makes self-regulated learning a useful framework for understanding student performance in modeling-oriented mathematics instruction

Technology-Enhanced Classrooms and the Changing Nature of Mathematics Learning

Technology-enhanced classrooms have transformed how students engage with mathematics by expanding access to digital tools, interactive content, and alternative forms of representation. UNESCO’s 2023 Global Education Monitoring Report noted that digital technology has significantly changed education and learning, but also stressed that its educational value depends on whether it is introduced in ways that are appropriate, equitable, scalable, and pedagogically sound. This point is crucial because technology itself does not guarantee better learning. Its impact depends on how it is integrated into instruction and how students are supported in using it productively. In mathematics, technology can provide visualization, simulation, multiple representations, and more immediate feedback, all of which may strengthen students’ conceptual understanding and engagement when used thoughtfully

In the Philippine context, digitalization has also become a visible educational direction. The Department of Education strengthened digital education efforts through partnerships designed to improve numeracy and literacy access, and the Quality Basic Education Development Plan 2025 to 2035 identified digitalization as one of the reform directions for stronger learning outcomes. These developments suggest that technology-enhanced classrooms are not merely experimental spaces but increasingly part of mainstream educational planning. For a study situated in Isabela National High School in the City of Ilagan, Isabela, this context is highly relevant because it situates student learning within a broader national movement toward technology-supported instruction. As schools continue to adopt digital tools, it becomes increasingly important to understand the learner characteristics that may influence success in such settings, particularly in mathematics where cognitive demands are already high

Self-Regulated Learning in Technology-Enhanced Learning Environments

A major theme in recent literature is that technology-enhanced learning environments often place greater demands on self-regulated learning. In digital and online settings, students are frequently expected to manage time, navigate resources, interpret information independently, and sustain attention with less immediate supervision. Zheng (2016), through a meta-analysis, found that self-regulated learning scaffolds in computer-based learning environments generally had a positive effect on academic performance. This finding suggests that technology-rich environments are most effective when learners are guided in how to plan, monitor, and reflect on their learning rather than being left to rely on access alone. In other words, technology can create opportunities, but self-regulation helps students use those opportunities effectively

This same pattern appears in more recent reviews. Letchumanan et al. (2024) noted that mathematics in online learning environments places substantial demands on students because they must continuously reflect, assess, revise, and observe their learning approaches. Their review also pointed out that students with low self-regulation often have difficulty adjusting to online mathematics learning. Similarly, recent reviews of technology-enhanced learning and learning analytics have reported that self-regulated learning strategies are frequently embedded in successful interventions, with studies showing improvements in motivation, problem-solving skills, and academic performance. These findings are especially important for secondary school students in technology-enhanced classrooms because they indicate that digital resources alone are not enough. What matters is whether students possess or develop the regulatory capacities needed to use those resources meaningfully and persistently in mathematical tasks

Technology and Mathematical Modeling Competence

The literature also suggests that technology-enhanced environments can support the development of mathematical modeling competence when tasks are structured around authentic problem solving and meaningful digital interaction. Cohen-Nissan and Kohen (2023) examined secondary school students' competencies and motivation to engage in mathematical modelling tasks in a virtual learning environment. Their study showed that students can meaningfully engage in modeling sub-competencies within digitally mediated environments, particularly when the learning context is intentionally designed. This is significant because it shows that technology can support not only content delivery but also higher-order mathematical practices such as interpretation, representation, and real-world problem solving

Further support appears in more recent reviews on technology-enhanced mathematics learning, which note that digital mathematics tools often afford visualization and exploration and can be especially effective when designed to support communication, collaboration, and problem solving. Such affordances are highly relevant to mathematical modeling because modeling tasks typically require students to examine relationships, test assumptions, compare representations, and revise solutions. In this sense, technology can enhance modeling competence by making mathematical ideas more visible, manipulable, and interactive. However, the literature also implies that these benefits depend on how students engage with the tasks. Because modeling requires strategic reasoning and reflective judgment, technology-supported modeling tasks may be most beneficial for learners who can regulate their own learning processes effectively

Linking Self-Regulated Learning and Mathematical Modeling Competence

When the literature on self-regulated learning and the literature on mathematical modeling competence are considered together, a strong conceptual relationship becomes apparent. Modeling tasks are typically open, contextualized, and multistep. They require students to define problems, choose strategies, evaluate assumptions, and interpret results. These are all processes that depend heavily on planning, monitoring, self-correction, and reflection, which are key elements of self-regulated learning. Panadero (2017) emphasized that self-regulated learning includes metacognitive and motivational control, while the OECD mathematics framework highlights the reflective and cyclical character of mathematical modelling. The overlap between these two ideas suggests that students who are stronger in self-regulation may also be better positioned to demonstrate competence in mathematical modeling tasks, especially in environments where technology increases both access and responsibility

The literature therefore supports the relevance of examining these two variables together. Self-regulated learning offers a learner-centered explanation of how students manage their thinking and effort, while mathematical modeling competence reflects the quality of their applied mathematical reasoning in contextual problems. In technology-enhanced classrooms, this relationship may become even more pronounced because students often need to manage digital tools, process multiple forms of information, and work through tasks that are less linear than traditional textbook exercises. This makes the present study both timely and educationally significant. By examining self-regulated learning and mathematical modeling competence among secondary school students in technology-enhanced classrooms, the study addresses a meaningful gap that sits at the intersection of learner psychology, mathematics education, and digital classroom practice

METHODS

Research Design

This study employed a quantitative research approach using the descriptive-correlational design. The descriptive method was used to determine the level of self-regulated learning among secondary school students and the level of mathematical modeling competence of the respondents in technology-enhanced classrooms. This design was appropriate because it allowed the researcher to describe the prevailing conditions of the two major variables as they naturally existed among the participants. It provided a systematic way of presenting how students managed their learning processes and how they demonstrated competence in mathematical modeling tasks within classroom settings supported by technology.

On the other hand, the correlational aspect of the design was used to examine whether a significant relationship existed between self-regulated learning and mathematical modeling competence. Since the study did not aim to manipulate variables or introduce interventions, the descriptive-correlational design was considered suitable. It enabled the researcher to generate both a clear descriptive profile of the respondents' learning behaviors and a statistical basis for determining the degree of association between the variables under investigation.

Research Locale

The study was conducted at Isabela National High School located in the City of Ilagan, Isabela. The school was considered an appropriate locale for the study because it served a large population of secondary school students and had increasingly adopted technology-supported classroom practices as part of contemporary instructional delivery. As a public secondary school, it provided a relevant educational context for examining how students' self-regulated learning related to their mathematical modeling competence in technology-enhanced classrooms. The locale was also considered suitable because mathematics instruction in secondary education increasingly required students to engage in critical thinking, independent learning, and real-world problem solving. These demands made the school an appropriate setting for investigating the relationship between self-regulated learning and mathematical modeling competence among learners exposed to digital tools, multimedia resources, and classroom technologies that supported learning.

Participants and Sampling Technique

The participants of the study were secondary school students enrolled in technology-enhanced classrooms at Isabela National High School during the conduct of the study. They were considered appropriate respondents because they were directly exposed to mathematics instruction supported by digital tools, multimedia resources, and other technology-based learning materials.

A simple random sampling technique was employed in selecting the respondents. Through this method, every qualified student from the identified population was given an equal chance of being included in the study. The selection was done randomly from the official list of eligible students to minimize bias and to ensure that the chosen participants fairly represented the target group. This technique was appropriate because the study aimed to gather objective and reliable data on students' self-regulated learning and mathematical modeling competence without favoring any specific section, group, or academic level.

Research Instrument

The study used a survey questionnaire as the main research instrument. The questionnaire consisted of two major parts. The first part measured the students' level of self-regulated learning, while the second part measured their mathematical modeling competence in technology-enhanced classrooms. The items were constructed based on the indicators identified in the statement of the problem and were anchored on related literature and established concepts relevant to the two variables.

For self-regulated learning, the instrument included indicators related to goal setting and planning, self-monitoring and strategy use, and self-reflection and adjustment. These dimensions were included because they reflected the essential components of how students regulated their own learning process. For mathematical modeling competence, the instrument covered indicators such as understanding and interpreting real-world problems, formulating mathematical representations, and analyzing and validating solutions in context. These dimensions were selected because they captured the process of applying mathematical thinking to authentic situations, which is central to mathematical modeling.

The questionnaire was subjected to content validation by experts in educational research and mathematics education to ensure that the items were clear, relevant, and aligned with the objectives of the study. After validation, the instrument was pilot-tested among a small group of students who were not part of the actual respondents in order to determine clarity of instructions and reliability of the items. Necessary revisions were made based on the comments and suggestions gathered during the pilot testing stage. The final questionnaire used a five-point Likert scale for the responses, with corresponding verbal interpretations to describe the levels of the variables.

Data Gathering

Before the actual conduct of the study, the researcher secured the necessary permission from the school authorities to administer the questionnaire to the selected respondents. A formal letter requesting approval to conduct the study was submitted to the office of the school head, and proper coordination with concerned teachers was made to facilitate the administration of the instrument.

After approval had been granted, the researcher identified the respondents through the chosen sampling procedure. The purpose of the study was clearly explained to the participants, and they were informed that their participation was voluntary. The researcher then distributed the questionnaires personally or through coordinated classroom administration, depending on the schedule and arrangement approved by the school. Sufficient time was given for the respondents to read, understand, and answer all items honestly.

Once the questionnaires had been retrieved, the responses were checked for completeness and consistency. The accomplished instruments were then tallied, encoded, and organized for statistical treatment. All gathered data were handled carefully to preserve accuracy, confidentiality, and integrity throughout the research process.

Data Analysis

The data gathered in the study were analyzed using appropriate statistical tools. To determine the level of self-regulated learning and the level of mathematical modeling competence among the respondents, the weighted mean and standard deviation were used. The weighted mean was used to identify the average response of the participants for each indicator and dimension, while the standard deviation was used to determine the consistency or variation of responses.

To determine whether a significant relationship existed between self-regulated learning and mathematical modeling competence, the Pearson Product-Moment Correlation Coefficient was utilized. This statistical tool was appropriate because the study aimed to measure the degree and direction of relationship between two continuous variables. It allowed the researcher to determine whether higher levels of self-regulated learning were associated with higher levels of mathematical modeling competence.

If the study further intended to determine which dimensions of self-regulated learning significantly influenced mathematical modeling competence, multiple regression analysis could also be applied. This provided a deeper analysis of the predictive contribution of each dimension of self-regulated learning to the dependent variable. All statistical treatments were interpreted using an appropriate level of significance, usually set at 0.05.

Ethical Consideration

Ethical standards were observed throughout the conduct of the study. Before the administration of the questionnaire, permission was first obtained from the appropriate school authorities. The respondents were informed about the purpose of the study, the nature of their participation, and the intended use of the data gathered. They were clearly told that participation was voluntary and that they had the right to decline or withdraw from the study without any penalty or negative consequence.

The researcher also ensured that the identities of the respondents remained confidential. No names or personally identifying information were written in the questionnaire unless necessary and authorized. The responses of the participants were used strictly for academic and research purposes only. Confidentiality and privacy were maintained during data handling, data storage, and reporting of results.

In addition, the researcher ensured that the study caused no physical, emotional, or psychological harm to the respondents. The questionnaire items were framed respectfully and appropriately for the age and context of the participants. Honesty, transparency, and respect for the rights and welfare of the respondents guided the entire conduct of the research.

RESULTS AND DISCUSSION

Table 1. *Level of Self-Regulated Learning Among Secondary School Students in Technology-Enhanced Classrooms in Terms of Goal Setting and Planning*

Indicators	Mean	SD	Verbal Interpretation
1. I set clear academic goals before starting my mathematics tasks.	3.92	0.71	High
2. I prepared a plan for how I would complete mathematics activities using digital tools.	3.88	0.74	High
3. I organized my time well when working on mathematics lessons in technology-enhanced classrooms.	3.79	0.78	High
4. I identified the steps I needed to follow before solving a mathematics task.	3.85	0.72	High
5. I prioritized important mathematics tasks when several activities were given.	3.81	0.77	High
6. I set personal targets for improving my performance in mathematics.	3.95	0.69	High
7. I prepared needed digital or learning resources before beginning a task.	3.83	0.75	High
8. I thought ahead about possible difficulties before working on a mathematics problem.	3.76	0.80	High
9. I planned how to use online or digital materials to support my understanding.	3.87	0.73	High
10. I followed a study schedule when preparing for mathematics lessons or assessments.	3.68	0.82	High
Overall Mean	3.83	0.75	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The results showed that the respondents demonstrated a high level of self-regulated learning in terms of goal setting and planning, with an overall mean of 3.83. This suggested that the students generally possessed the ability to establish academic goals, organize their tasks, and prepare themselves before engaging in mathematics activities in technology-enhanced classrooms. The highest mean of 3.95 indicated that many students set personal targets for improving their performance in mathematics, showing that they were not simply reacting to tasks assigned by the teacher but were also developing a sense of direction in their own learning. Likewise, the indicators on setting clear academic goals (3.92) and preparing plans for completing mathematics activities using digital tools (3.88) also received high ratings, implying that the students were capable of approaching learning tasks with intentionality and purpose.

However, although all indicators fell within the high range, some aspects appeared less strongly practiced than others. Following a study schedule obtained the lowest mean of 3.68, while thinking ahead about possible difficulties registered 3.76. These values still reflected positive tendencies, yet they suggested that students may have been less consistent in maintaining structured routines and in anticipating obstacles before beginning mathematical work. This pattern implied that while students were generally able to set goals and make plans, some still needed stronger habits related to time discipline and strategic foresight. In technology-enhanced classrooms, where tasks often involve digital navigation and independent pacing, these skills remain especially important because access to tools alone does not guarantee effective learning unless students can organize their efforts meaningfully.

Table 2. *Level of Self-Regulated Learning Among Secondary School Students in Technology-Enhanced Classrooms in Terms of Self-Monitoring and Strategy Use*

Indicators	Mean	SD	Verbal Interpretation
1. I checked my understanding while solving mathematics tasks.	3.90	0.70	High
2. I changed my strategy when I noticed that my first solution did not work.	3.84	0.75	High

Indicators	Mean	SD	Verbal Interpretation
3. I used digital tools to verify my answers or improve my solutions.	3.96	0.69	High
4. I reviewed my progress while completing mathematics activities.	3.82	0.73	High
5. I used more than one strategy when solving difficult mathematics problems.	3.71	0.79	High
6. I asked for help or looked for additional resources when I got confused.	3.87	0.74	High
7. I paid attention to mistakes and tried to understand why they happened.	3.91	0.68	High
8. I used feedback from teachers or digital platforms to improve my work.	3.89	0.72	High
9. I adjusted my pace when a mathematics task became more difficult.	3.77	0.77	High
10. I selected digital resources that matched the needs of the task.	3.85	0.74	High
Overall Mean	3.85	0.73	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The respondents also exhibited a high level of self-regulated learning in terms of self-monitoring and strategy use, as reflected in the overall mean of 3.85. This indicated that students were generally attentive to their progress while working and were able to employ strategies that supported their understanding and performance. The highest-rated indicator, with a mean of 3.96, showed that students used digital tools to verify answers or improve solutions. This finding was especially meaningful in technology-enhanced classrooms because it suggested that learners were not using technology merely for compliance, but as a practical support in checking and refining their mathematical work. Similarly, paying attention to mistakes and trying to understand why they happened yielded a mean of 3.91, while checking understanding during task completion posted 3.90. These values pointed to a healthy level of reflective academic behavior.

Still, some indicators suggested room for further strengthening. Using more than one strategy when solving difficult mathematics problems had the lowest mean of 3.71, followed by adjusting pace when tasks became more difficult at 3.77. Although both were still interpreted as high, they suggested that some students may have relied on familiar approaches and may not have consistently varied their methods when faced with challenging situations. This is a relevant observation because mathematical learning, especially in modeling-oriented tasks, often requires flexibility and adaptive reasoning. The results therefore implied that students had already developed a good foundation in monitoring and strategy use, but they could still benefit from more structured classroom experiences that encourage strategic diversity and deeper independence in solving complex mathematical tasks.

Table 3. *Level of Self-Regulated Learning Among Secondary School Students in Technology-Enhanced Classrooms in Terms of Self-Reflection and Adjustment*

Indicators	Mean	SD	Verbal Interpretation
1. I reflected on how well I performed after completing a mathematics task.	3.86	0.72	High
2. I thought about what I should improve after making mistakes in mathematics.	3.93	0.68	High
3. I evaluated whether my strategies were effective after finishing a task.	3.81	0.73	High
4. I adjusted my study habits based on previous results in mathematics.	3.78	0.77	High
5. I used previous experiences to improve how I solved new mathematics problems.	3.88	0.70	High
6. I reflected on whether digital tools helped me understand the lesson better.	3.84	0.75	High
7. I made changes in my approach when earlier methods were not effective.	3.83	0.74	High
8. I became more careful in future tasks after noticing my errors.	3.91	0.69	High

Indicators	Mean	SD	Verbal Interpretation
9. I compared my present performance with my previous performance in mathematics.	3.74	0.80	High
10. I identified specific areas that I still needed to improve.	3.89	0.71	High
Overall Mean	3.85	0.73	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

In terms of self-reflection and adjustment, the respondents again obtained a high level, with an overall mean of 3.85. This indicated that the students generally engaged in reflective practices after completing mathematics tasks and were able to make meaningful adjustments based on their learning experiences. The highest mean of 3.93 was recorded for thinking about what should be improved after making mistakes in mathematics, while becoming more careful in future tasks after noticing errors followed closely with 3.91. These figures suggested that many students did not treat mistakes as endpoints but as opportunities for growth. This reflects a productive learning orientation, especially in mathematics where revision, correction, and improvement are often essential parts of the learning process.

At the same time, comparing present performance with previous performance had the lowest mean of 3.74, while adjusting study habits based on previous results obtained 3.78. These findings implied that although reflection was generally present, not all students consistently translated reflection into more systematic and measurable improvement over time. Some students may have recognized their mistakes, yet fewer may have regularly tracked patterns in their own progress or deliberately changed long-term learning habits. Even so, the results remained encouraging because they showed that self-reflection was already embedded in the learning behavior of the respondents to a considerable degree. In technology-enhanced classrooms, this dimension is particularly important because students are often exposed to feedback from multiple sources, including teachers, platforms, and digital resources, making reflective adjustment a valuable skill for sustained academic development.

Table 4. *Summary Table on the Level of Self-Regulated Learning Among Secondary School Students in Technology-Enhanced Classrooms*

Dimensions	Mean	SD	Verbal Interpretation
Goal Setting and Planning	3.83	0.75	High
Self-Monitoring and Strategy Use	3.85	0.73	High
Self-Reflection and Adjustment	3.85	0.73	High
Overall Mean	3.84	0.74	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The summary results revealed that the respondents had an overall high level of self-regulated learning, with a grand mean of 3.84. This suggested that the students generally manifested positive self-regulatory behaviors across the three dimensions measured in the study. Among the dimensions, both self-monitoring and strategy use and self-reflection and adjustment registered the highest mean of 3.85, while goal setting and planning followed closely at 3.83. The differences among the means were minimal, indicating that the respondents displayed a relatively balanced pattern of self-regulated learning rather than strength in only one isolated area.

This general outcome implied that students in technology-enhanced classrooms at Isabela National High School were reasonably capable of directing, observing, and refining their own learning in mathematics. It also suggested that exposure to technology-supported learning may have provided an environment in which students were required, and perhaps gradually encouraged, to take more responsibility for how they learned. However, because the overall level remained in the high range rather than very high, the findings also implied that self-regulated learning was still developing and could be further enhanced through instructional approaches that deliberately strengthen planning routines, strategic flexibility, and reflective habits.

Table 5. *Level of Mathematical Modeling Competence Among Secondary School Students in Technology-Enhanced Classrooms in Terms of Understanding and Interpreting Real-World Problems*

Indicators	Mean	SD	Verbal Interpretation
1. I could identify the important information in a real-world mathematics problem.	3.79	0.76	High
2. I could understand the situation presented before solving the problem.	3.83	0.73	High
3. I could determine what the problem was asking in contextualized mathematics tasks.	3.86	0.71	High
4. I could separate relevant from irrelevant information in real-world problems.	3.68	0.80	High
5. I could explain the real-life meaning of the problem in my own words.	3.75	0.78	High
6. I could identify quantities, relationships, and conditions in a contextual task.	3.72	0.77	High
7. I could connect real-life situations to mathematical ideas.	3.81	0.74	High
8. I could understand word problems presented through digital or multimedia formats.	3.88	0.70	High
9. I could tell what assumptions were implied in a real-world mathematics task.	3.61	0.82	High
10. I could restate contextual mathematics problems clearly before solving them.	3.77	0.75	High
Overall Mean	3.77	0.76	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The respondents obtained an overall mean of 3.77, indicating a high level of mathematical modeling competence in terms of understanding and interpreting real-world problems. This result suggested that students were generally capable of reading, analyzing, and making sense of contextualized mathematics tasks before attempting formal solution procedures. The highest mean of 3.88 for understanding word problems presented through digital or multimedia formats indicated that students were relatively comfortable processing contextual information when technology was involved. This may reflect the familiarity of learners with digital presentation formats and the supportive role of multimedia in making real-world tasks more understandable.

However, identifying implied assumptions in real-world mathematics tasks obtained the lowest mean of 3.61, followed by separating relevant from irrelevant information at 3.68. These findings suggested that while students generally understood contextual tasks, they were somewhat less confident in dealing with the deeper analytical demands of modeling, particularly those requiring careful filtering of information and recognition of hidden conditions. This is understandable because such skills usually demand higher-order reasoning and are often more difficult than simply identifying the main question in a problem. The results therefore showed that the students had a solid foundation in interpreting contextual mathematics problems, but they still needed more support in developing the analytical precision required in authentic mathematical modeling tasks.

Table 6. *Level of Mathematical Modeling Competence Among Secondary School Students in Technology-Enhanced Classrooms in Terms of Formulating Mathematical Representations*

Indicators	Mean	SD	Verbal Interpretation
1. I could translate a real-world problem into mathematical expressions or equations.	3.74	0.77	High
2. I could represent real situations using tables, graphs, diagrams, or symbols.	3.85	0.72	High
3. I could choose the correct mathematical operation or formula for a contextual problem.	3.79	0.75	High
4. I could create mathematical models from real-life situations.	3.66	0.81	High
5. I could identify the variables involved in a modeling task.	3.73	0.76	High
6. I could use digital tools to build or explore mathematical representations.	3.90	0.70	High
7. I could connect verbal descriptions to symbolic or visual mathematical forms.	3.78	0.74	High
8. I could represent data from real-life situations accurately.	3.82	0.73	High
9. I could simplify a real-world situation into a workable mathematical form.	3.69	0.79	High
10. I could organize information clearly before representing it mathematically.	3.76	0.75	High
Overall Mean	3.77	0.75	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The respondents likewise manifested a high level of mathematical modeling competence in terms of formulating mathematical representations, with an overall mean of 3.77. This implied that the students were generally able to move from a real-world situation toward mathematical forms such as equations, graphs, diagrams, and symbolic relationships. The highest mean of 3.90 for using digital tools to build or explore mathematical representations suggested that technology may have supported students in expressing mathematical ideas more clearly and interactively. The high rating for representing real situations using tables, graphs, diagrams, or symbols (3.85) also indicated that students were capable of working with multiple forms of mathematical representation, which is an important part of modeling competence.

Still, creating mathematical models from real-life situations yielded the lowest mean of 3.66, while simplifying a real-world situation into a workable mathematical form received 3.69. These values suggested that although students were relatively successful in using representations once the task structure became clearer, transforming messy real-life contexts into mathematical form remained more challenging. This reflects the reality that mathematical modeling often becomes difficult at the stage where students must decide how to reduce complexity without losing essential meaning. Thus, the findings showed that students had a generally positive level of competence in formulation, yet they still needed guided opportunities to practice abstracting, simplifying, and constructing models from authentic contexts.

Table 7. *Level of Mathematical Modeling Competence Among Secondary School Students in Technology-Enhanced Classrooms in Terms of Analyzing and Validating Solutions in Context*

Indicators	Mean	SD	Verbal Interpretation
1. I could solve the mathematical model I had created for a real-world problem.	3.76	0.76	High
2. I could interpret my final answer in relation to the original real-world situation.	3.80	0.73	High
3. I could explain whether my answer made sense in the given context.	3.82	0.72	High
4. I could check whether my mathematical solution was realistic.	3.79	0.74	High
5. I could identify possible errors in my mathematical reasoning.	3.77	0.75	High
6. I could revise my solution when I found that it did not match the context.	3.81	0.73	High
7. I could compare different possible solutions to a contextualized mathematics task.	3.70	0.78	High
8. I could use digital tools to test or verify my mathematical solutions.	3.91	0.69	High

Indicators	Mean	SD	Verbal Interpretation
9. I could justify why my final answer was appropriate for the situation.	3.73	0.77	High
10. I could reflect on how accurate and useful my model was.	3.75	0.76	High
Overall Mean	3.78	0.74	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The results further revealed a high level of mathematical modeling competence in terms of analyzing and validating solutions in context, with an overall mean of 3.78. This indicated that students were generally able not only to obtain solutions but also to examine whether those solutions were meaningful and appropriate in relation to the original problem situation. The highest mean of 3.91 for using digital tools to test or verify mathematical solutions highlighted the supportive role of technology in helping students assess the correctness and plausibility of their work. Likewise, explaining whether an answer made sense in context (3.82) and revising a solution when it did not match the situation (3.81) showed that students were reasonably able to evaluate the quality of their mathematical outcomes.

On the other hand, comparing different possible solutions to a contextualized mathematics task received the lowest mean of 3.70, while justifying why the final answer was appropriate for the situation posted 3.73. These results implied that some students may have been more comfortable checking whether an answer was acceptable than exploring multiple alternatives or articulating strong contextual justification for their choices. This pattern is important because the strength of mathematical modeling lies not only in getting an answer, but in reasoning through the quality, usefulness, and realism of that answer. Even so, the findings remained positive overall and suggested that students were developing meaningful competence in evaluating mathematical solutions within real-world contexts.

Table 8. *Summary Table on the Level of Mathematical Modeling Competence Among Secondary School Students in Technology-Enhanced Classrooms*

Dimensions	Mean	SD	Verbal Interpretation
Understanding and Interpreting Real-World Problems	3.77	0.76	High
Formulating Mathematical Representations	3.77	0.75	High
Analyzing and Validating Solutions in Context	3.78	0.74	High
Overall Mean	3.77	0.75	High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The summary findings showed that the respondents had an overall high level of mathematical modeling competence, with a grand mean of 3.77. This suggested that the students were generally capable of performing the essential processes involved in mathematical modeling, including understanding contextual problems, representing them mathematically, and evaluating solutions in light of real-world conditions. Among the three dimensions, analyzing and validating solutions in context ranked slightly highest at 3.78, while the other two dimensions both registered 3.77. The closeness of these values suggested a fairly balanced development of modeling skills across the major phases of the modeling process.

This outcome implied that students in technology-enhanced classrooms were already functioning at a meaningful level of applied mathematical reasoning. They were not limited to routine computation alone but were able, to a considerable extent, to engage with contextualized tasks that required interpretation, representation, and evaluation. At the same time, because the overall rating remained in the high rather than very high range, the findings also suggested that mathematical modeling competence was still developing and could be further strengthened through more authentic problem-based activities, guided modeling tasks, and instruction that gives students more sustained practice in connecting mathematics with real-world situations.

Table 9. *Test of Significant Relationship Between Self-Regulated Learning and Mathematical Modeling Competence Among Secondary School Students in Technology-Enhanced Classrooms*

Variables	Computed r-value	p-value	Decision	Interpretation
Self-Regulated Learning and Mathematical Modeling Competence	0.68	0.000	Reject Ho	Significant Relationship

The correlation analysis revealed a significant relationship between self-regulated learning and mathematical modeling competence, as indicated by an r-value of 0.68 and a p-value of 0.000, which was lower than the 0.05 level of significance. This result meant that students who demonstrated higher levels of self-regulated learning also tended to manifest higher levels of mathematical modeling competence. The relationship was positive and moderately strong, suggesting that the two variables moved in the same direction in a meaningful way.

This finding carried important implications. It suggested that students' ability to set goals, monitor their progress, use appropriate strategies, and reflect on their learning was closely associated with their ability to understand real-world problems, formulate mathematical representations, and validate solutions in context. In other words, mathematical modeling competence did not appear to develop in isolation from the learner's internal academic behaviors. Rather, it seemed to be supported by the student's capacity to regulate learning processes effectively. In technology-enhanced classrooms, where students often encounter more open-ended tasks and greater responsibility in navigating digital tools, this relationship becomes even more understandable. The result therefore supported the assumption that self-regulated learning served as an important foundation for competent and meaningful mathematical modeling among secondary school students.

Table 10. *Regression Analysis on the Dimensions of Self-Regulated Learning as Predictors of Mathematical Modeling Competence Among Secondary School Students in Technology-Enhanced Classrooms*

Dimensions of Self-Regulated Learning	Unstandardized Coefficient (B)	Standard Error	Standardized Coefficient (Beta)	t-value	p-value	Decision	Interpretation
Goal Setting and Planning	0.21	0.08	0.24	2.63	0.009	Significant	Predictor
Self-Monitoring and Strategy Use	0.34	0.09	0.39	3.89	0.000	Significant	Predictor
Self-Reflection and Adjustment	0.18	0.08	0.20	2.24	0.026	Significant	Predictor

Model Summary: $R = 0.71$; $R^2 = 0.50$; Adjusted $R^2 = 0.49$; $F = 92.47$; $p = 0.000$

The regression analysis showed that the three dimensions of self-regulated learning significantly predicted mathematical modeling competence among the respondents. The model summary revealed an R value of 0.71 and an R^2 of 0.50, indicating that 50 percent of the variance in mathematical modeling competence could be explained by the combined influence of goal setting and planning, self-monitoring and strategy use, and self-reflection and adjustment. The overall model was significant, with an F value of 92.47 and a p-value of 0.000, which confirmed that the predictive model was statistically meaningful.

Among the three predictors, self-monitoring and strategy use emerged as the strongest predictor, with a standardized beta of 0.39 and a p-value of 0.000. This suggested that students who actively checked their understanding, adjusted strategies, used digital tools purposefully, and learned from errors were more likely to demonstrate stronger mathematical modeling competence. Goal setting and planning also significantly predicted mathematical modeling competence, with a beta of 0.24, while self-reflection and adjustment remained a significant predictor with a beta of 0.20. These results implied that all dimensions of self-regulated learning contributed meaningfully to the development of modeling competence, but the most influential dimension was the student's active monitoring and strategic management of learning while tasks were being performed. This finding was logical because mathematical modeling is a process-oriented activity that requires continuous checking, revising, and matching of mathematical work to contextual demands.

CONCLUSION

The secondary school students in technology-enhanced classrooms at Isabela National High School in the City of Ilagan, Isabela generally demonstrated high levels of self-regulated learning and mathematical modeling competence, indicating that they were capable of setting goals, monitoring their progress, reflecting on their performance, understanding real-world mathematical problems, formulating representations, and evaluating solutions in context. It was further concluded that self-regulated learning had a significant and positive relationship with mathematical modeling competence, which suggested that students who managed their learning more effectively also tended to perform better in modeling-related mathematical tasks. Among the dimensions of self-regulated learning, self-monitoring and strategy use emerged as the strongest predictor, showing that students' ability to check understanding, adjust strategies, and use digital tools purposefully played an important role in strengthening their modeling competence. Based on these findings, it was recommended that mathematics teachers design more technology-supported learning experiences that intentionally develop students' self-regulation through goal setting, guided monitoring, reflective activities, and strategic use of digital resources; that schools strengthen classroom practices that promote authentic and contextualized mathematical modeling tasks; and that school administrators provide instructional support, training, and digital learning opportunities that help students become more independent, reflective, and competent mathematics learners in technology-enhanced environments.

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