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Research Article

Students Metacognitive Strategies in Solving Mathematics Problems in Distance Learning: A Phenomenological Study

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ABSTRACT

The COVID-19 pandemic has transformed the educational terrain from face-to-face to distance learning. In the Philippines, the Department of Education implemented different distance learning modalities such as modular distance learning, online distance learning, TV/radio-based instruction, and blended distance learning to continue education delivery. Consequently, this study explored senior high school students' experiences using metacognitive strategies to solve pre-calculus problems in distance learning through a phenomenological approach to qualitative research. Using purposive sampling, the researchers selected ten senior high school students from Marinduque and Palawan. They conducted two sets of online interviews via Google Meet to elicit students' experiences, views, and opinions regarding their metacognitive strategies in solving problems in pre-calculus. During the first set, all participants were involved, while they chose only three to proceed to the second set of interviews. They crafted the open-ended questions they utilized in the online interviews according to the research questions. The recorded interviews were transcribed and analyzed through thematic analysis. The results revealed that (1) students' metacognitive strategies for solving problems in pre-calculus include planning, monitoring, and evaluating the solution and final answer. Also, (2) students perceived their metacognitive strategies as practical tools to overcome difficulties in solving pre-calculus problems in distance learning. Further, (3) students recognized their metacognitive strategies in solving problems in pre-calculus as applicable in making decisions in real-life and pursuing lifelong learning.

Keywords*: Distance learning, Metacognitive strategies, Phenomenological study, Problem-solving*

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Introduction

The spread of COVID-19 has affected almost all aspects of life in just a wink of an eye. It came as a surprise not only to the financial industry but most especially to the educational sectors worldwide (Cahapay, 2020; Crawford et al., 2020). While the world has been finding ways to mitigate the impact of the pandemic on different sectors, educators have been considering flexible learning modes. This sudden shift brought about abrupt educational decisions employing different distance learning setups. Distance education models were implemented where students work on learning at home, on their own, and self-paced (Bol & Garner, 2011). In the Philippines, the Department of Education (DepEd) has implemented the Learning Continuity Plan (LCP), which identified distance learning as the primary learning modality for School Year 2020-2021 (DepEd, 2020). Distance Learning is a learning delivery modality where learners are given materials or access to resources in which they undertake self-directed study at home or in another venue (Inan, 2020; Savara, 2020). Distance Learning has different varieties, such as modular distance learning, online distance learning, TV-based instruction/ radio-based instruction, and blended distance learning. Blended distance learning combines one or more types of distance learning.

Distance learning allows students to continue their education, but it has both advantages and disadvantages regarding how students conceptualize learning amidst the pandemic. Learning at home demands more on students' skills, such as self-regulation. Students need self-discipline and time management to complete the required tasks in distance learning with limited supervision from the teacher (Almarashdi & Jarrah, 2021). The distance learning setup leads to an increase in students' learning anxiety and a decrease in students' motivation to learn (Goodenow, 1993). These consequences of distance learning may be induced by decreased social interaction among students and teachers. According to Almarashdi and Jarrah (2021), students identified the lack of interaction between their teachers and classmates as one of their negative perceptions of distance learning. Also, students are not secure that they can ask their teachers for further explanations and clarifications once they do not understand the content of what they are learning, especially in asynchronous discussions (Hassan, 2021).

Accordingly, 78.3% of the participants in the study conducted by Almarashdi and Jarrah (2021) opted to study mathematics in person and inside the classroom over distance learning if they were given a choice. In addition, students' mathematics anxiety increases when combined with the feeling of isolation in distance learning and the difficulty in communicating mathematical ideas in symbols, formulas, and graphs (Mayes et al., 2011). Because of the unique nature of mathematics, students may experience difficulties in doing their mathematical learning tasks in distance learning, like solving word problems in pre-calculus.

Metacognition and Problem-Solving Skills

Problem-solving is a skill we need in our daily lives (Casaig, 2019). It is one of mathematics education's goals and essential components since it has practical use in our society (Casaig, 2019; Izzati & Mahmud, 2018). Consequently, the National Council of Teachers of Mathematics (2000) posits that students must be able to acquire the skill to make sense of a myriad of applications outside the mathematics classroom. However, students tend to have difficulties acquiring problem-solving skills due to their inability to monitor and regulate their process of cognition (Casaig, 2019). This situation may be due to the lack of exposure of the learners to problem-solving scenarios. Hence, giving opportunities for the learners to examine situations, providing guided strategies and activities, and training learners to be self-regulated through self-control and self-thinking (Izzati & Mahmudi, 2018) can help overcome this predicament. All these point to metacognition as an effective problem-solving agent (Lee et al., 2009).

Several studies have been conducted on students’ metacognition and mathematical problem-solving (Aurah et al., 2011; Guner & Erbay, 2021; Izzati & Mahmud, 2018; Kuzle, 2019; Lee et al., 2009; Purnomo et al., 2017; Vula et al., 2017). Lee et al. (2009) examined the relationship between elementary students' metacognition and everyday problem-solving. Kuzle (2019) investigated the metacognitive behaviors of primary grades students during mathematics problem-solving. Meanwhile, Purnomo et al. (2017) focused their study on the patterns and characteristics of Indonesian college students' metacognitive processes in solving calculus problems. Metacognitive skills were found to positively affect students' problem-solving skills (Izzati & Mahmud, 2018; Vula et al., 2017; Aurah et al., 2011) and success (Guner & Erbay, 2021). A learner with high metacognitive skills has high-level problem-solving skills. This statement is supported by the study of Izzati and Mahmud (2018), which avers that learners with optimal metacognitive skills will have commendable problem-solving skills. Moreover, students with high metacognitive skills can solve problems accurately, employing appropriate strategies, mathematical notations, and logical reasons. On the other hand, students with low metacognitive skills encounter difficulties understanding the problem, choosing appropriate strategies, and getting the correct answer (Guner & Erbay, 2021).

Metacognitive Strategies and Life-long Learning

Lifelong learning is a crucial educational objective to adapt to unexpected adversities (Dunlap & Grabinger, 2008). This is evident, especially during the pandemic when people seek to uncover ways of overcoming this challenging situation. It involves understanding how one adjusts to change, identifying his/her strengths and weaknesses for self-development, and monitoring and assessing opportunities (Richards, 2016). Furthermore, it involves retooling oneself amidst different situations using various metacognitive strategies (Dunlap & Grabinger, 2008).

Metacognitive strategies are prerequisites to lifelong learning skills. It involves planning a procedure and evaluating and monitoring progress (Hattie, 2009; Vallin, 2019) to solve problems effectively and efficiently. Dunlap and Grabinger (2008) asserted that metacognitive and self-directed learning skills contribute to lifelong learning, which is imperative in an ever-changing professional sphere. Self-directed learners possess metacognitive skills that enable them to manage and control the process of sound decision-making and problem-solving. They can monitor and assess themselves by self-questioning, allowing them to identify the necessary skills for accomplishing specific tasks. Self-questioning provides a channel for learners to contemplate the essence of the task and lay out a plan of action and process of check and balance for decision-making, which activates self-regulation (Iftikhar, 2015). Self-regulation is a process of self-direction which transforms the learner's mental capacity into lifelong learning skills (Zimmerman, 2002). In addition, self-regulation is a process that comprises behaviors, feelings, and thoughts under the cognitive aspects of learning (Bandura, 1991; Iftikhar, 2015; Zimmerman, 2002). Self-regulation (Narciss et al., 2007; Pintrich, 2004; Schunk & Zimmerman, 2003) and self-direction (Dunlap & Grabinger, 2008; Iftikhar, 2015) are the resultants of metacognitive strategies. Metacognitive strategies enable students to pursue life-long learning successfully and cope with 21st-century challenges.

Due to a lack of interaction between teachers and students, even among students, and mathematics anxiety brought by distance learning, students may experience more difficulties solving mathematical problems. Metacognition is a significant variable in students' problem-solving (Aurah et al., 2011; Davidson & Sternberg, 1998; Izzati & Mahmud, 2018; Vula et al., 2017). These studies investigating the relationship between metacognitive strategies and students' problem-solving did not specifically address distance learning and lifelong learning. Nevertheless, these studies provide a foundation for understanding the importance of metacognitive strategies in mathematics education and point out that there is still a need to conduct a study that explores students' metacognitive strategies for solving problems in distance learning and its association with lifelong learning. The current study aims to fill this gap by exploring the metacognitive strategies of senior high school students in solving precalculus problems in distance learning, their experiences, and how they could relate their experiences to lifelong learning.

Methods

Research Design

This study employed a phenomenological approach to qualitative research. Phenomenological research is a design of inquiry that describes individuals' lived experiences about a phenomenon as described by the participants (Creswell, 2014). This inquiry design is most appropriate for this study since the researchers aimed to capture senior high school students' lived experiences as they used metacognitive strategies to solve pre-calculus problems in distance learning.

Participants

The participants in this study were ten senior high school students who had experienced solving pre-calculus problems in distance learning. They were selected through purposive sampling, as recommended for qualitative research (Creswell, 2014). The number of participants also meets the suggested sample size for phenomenological studies, which should range from five to 25 participants (Polkinghorne, 1989, as mentioned by Creswell, 2007). The researchers considered two criteria in choosing the participants. They should: (1) be a Grade 11 student taking pre-calculus classes via blended distance learning and (2) have stable internet connectivity at home. Among the participants, four are males, and six are females. Five are from Marinduque, while the other five are from Palawan. Their ages are 16 and 17.

Data Collection

The researchers collected data through online interviews with the participants via Google Meet. The interviews were scheduled depending on the availability of the participants. There were two sessions of interviews. During the first interview, the researchers used a set of open-ended questions crafted according to the research questions to capture the experiences and views of the participants on solving pre-calculus problems using metacognitive strategies. For the second interview session, the researchers selected three students based on their responses during the first interview. These students were further asked about their experiences using metacognitive strategies to solve pre-calculus problems and their views on how these strategies can be applied in lifelong learning. All the interviews were recorded in Google Meet with the participants' permission.

Data Analysis

Data analysis was done according to the suggested steps of Creswell (2014) in qualitative data analysis. First, the researchers transcribed the recorded interviews; they organized and prepared the data for analysis. Second, they read the data to grasp the general sense of the information and reflect on its overall meaning. Third, they proceeded with coding all the data. Coding is gathering data into categories and labelling each category with a term commonly derived from the participant's actual language (called an in vivo term). Fourth, they used the coding process to generate a description of the phenomenon and formulate themes for analysis. Fifth, they determined how the description and themes will be represented in the qualitative narrative to convey the analysis findings effectively. Lastly, they interpreted the findings and results. The researchers utilized Microsoft Word and Microsoft Excel in carrying out these processes.

Ethical Considerations

The researchers contacted the prospective participants through Messenger with the letter of request and parental consent form as attached files. The letter of request and parental consent form stated the objectives of this study, explained the data collection procedure, and assured the participants that their privacy would be protected. The online interviews were conducted after the researchers secured consent from the participants' parents. At the start of each online interview, the researchers verbally explained the purpose of the study and the participants' rights regarding data collection and reporting. The researchers made sure the participants were aware of and in favor of recording the online interviews before doing so. In reporting the results of the online interviews, the researchers assigned a pseudonym to each participant to maintain their anonymity and protect their privacy.

Results and Discussion

Students Metacognitive Strategies for Solving Problems in Pre-Calculus

The senior high school students' metacognitive strategies for solving problems in pre-calculus were displayed through the following: (1) planning the solution, (2) monitoring the solution, and (3) evaluating the solution and final answer.

Planning the solution. Whenever students are given a problem to solve in pre-calculus, the first thing that they usually do is assess the difficulty level of the problem and their ability to solve it. After which, they recall the definitions of terms, mathematical concepts, and formulas that can be applied to solve the problem.

Student 5: *"I think about the problem and whether it will be difficult for me to solve it or not."*

Student 10: *"Usually, after reading the problem, I analyze if it is easy or difficult. Then, I go back to the concepts involved in the problem."*

Student 7: *"Just like Student 6, I also recall our previous lessons...I think about the formulas in our previous lessons that can be applied to the problem. Also concepts and the likes..."*

In planning for the problem's solution, they begin with identifying the given and other elements of the problem, like keywords for the arithmetic operations. They also look into the relationships among the given and how they can be used in solving the problem.

Student 4: *"I look for keywords to know the appropriate operations to be used."*

Student 9: *"Usually, in solving the problem, I identify first the given and how they are related...and how they can be utilized in solving the problem."*

As shared by the students, there were times when a problem in pre-calculus could be solved in different ways. In such cases, they consider the allotted time to decide which solution is most efficient and suitable for the problem.

Student 10: *"One of the things that I consider in solving problems is time [...] how long it will take me to solve the problem."*

Student 9: *"So when I am solving a problem, I consider the time, then I will think of the best way...I will think of the optimal way to solve the problem."*

As part of planning for the solution to a problem, students think about the difficulty of the problem, concepts related to the problem, given values in the problem, and the solution that will allow them to solve the problem within the time given to them.

Monitoring the solution. Two responses emerged when students were asked if they usually paused while solving a problem in pre-calculus to check what they had already written as part of the solution. Some students said they were doing it, while others claimed they did not practice it. For the students who constantly monitor their solution, it is a way of ensuring that their solution is correct. In the middle of solving, they pause to scan what they already did in the solution. They check if they were able to substitute the correct values of the given in the equation and if the equation is still aligned with the problem.

Student 4: *"Once I have completed some steps, I stop first to check if the process I did is correct. I go back to the previous steps to check if something is wrong. If some steps are wrong, then it will be wrong until the end. The answer will also be wrong. That is why each step should be checked from time to time. It really helps (referring to checking each step) if you are careful with the answer."*

Student 9: *"For me, as a careless person, I usually pause in my solutions, but for a brief time only, like after I did this part of the solution, I would pause for 10 seconds to scan if I did something incorrectly. I usually remember that I should not have any mistakes in what I did and what I wrote as input in the equations."*

However, other students prefer to skip this process and check the complete solution after identifying the final answer. According to them, if they stop in the middle of solving, they tend to forget the solution they have in mind. It breaks their momentum. So, they usually check their answer and solution at the end of solving. As Student 6 shared: *"I don't pause. I solve the problem continuously. After being done with the solution and getting an answer, that's when I check if they are correct [...] If I stop in my solution for a while, I usually forget the part in which I stopped, so I just solve continuously."*

The above statements showed that students have different perspectives when it comes to monitoring their solutions while solving. Despite this, they all agreed that evaluating the solution and the final answer at the end of solving is a vital part of the whole process of solving problems.

Evaluating the solution and final answer. After solving the problem and having the final answer, the students evaluate their final answer by checking if it is realistic and aligned with the question in the problem.

Student 7: *"Normally, I use the question as a basis if my answer is realistic."*

Student 10: *"When I already have an answer, I usually check if it is a possible answer to the problem."*

If the final answer is an equation of the given graph, the students verify if the equation they answered will form the given graph. According to Student 9, *"Let's say for an equation of the ellipse, I usually look at how the lengths of its parts and coordinates match."* He added, *"Usually, evaluating the final answer entails checking the whole solution."* This statement points out how important for students to evaluate their final answer in solving problems.

These results showed that the three components of students' metacognitive strategies in solving problems in pre-calculus are planning, monitoring, and evaluating the final answer and solution. During planning, students manifest their metacognitive strategies by assessing the problem's difficulty level, recalling mathematical concepts related to the problem, identifying the given and keywords in the problem, and looking into the relationship among them. Through these, they can think about possible solutions for solving the problem. Since mathematical problems can be solved in different ways, it is also important for the students to choose the solution that will help them solve the problem accurately within the shortest period. For the monitoring part, some preferred to check their solution and answer once they finished solving the problem. It is also helpful for students to track their solutions as they progress in solving especially mathematical problems that involve notations that should always be in the right places. Otherwise, the entire meaning of the equation will change. Finally, after finishing the solution and getting an answer, students should always go back to the problem and evaluate if their answer satisfies what is being asked.

Students Experiences in Using Metacognitive Strategies for Solving Pre-Calculus Problems

The students have difficulties solving some pre-calculus problems. They identified that this difficulty stems from the lack of knowledge about some concepts involved in the problem and limited examples in the module. In addition, the limited interaction with their teacher, who knows more about pre-calculus topics, also contributes to this difficulty.

Whenever students encounter a complex problem to solve or when they get stuck in solving a problem, the first thing that they do is think about the concepts and possible formulas that can help them in solving the problem. After that, they look for other resources online and even watch instructional videos on YouTube. Then, they also ask their classmates about the problem through online messaging platforms. In the middle of the student's difficulties in solving problems in pre-calculus, they consider using the strategies that they mentioned as a great help for them. When they were asked about an object that would represent their strategies, some of their answers were Bible, stepping stones, and compass.

Using metacognitive strategies as a Bible in solving problems. Student 5 considers the Bible to represent her metacognitive strategies in solving problems. Just like how the Bible teaches us what to do in different situations, she uses her metacognitive strategies in deciding on how to solve mathematics problems.

Student 5: *"Bible, because my strategies are like the Bible that serves as a guide in making the right decision."*

This is perceptible in the experience that she shared when she solved a problem in pre-calculus about finding the height of a tree, given that from a point on the ground, the top of the three can be seen at an angle of 35° and from 12 meters closer, the top can be seen at an angle 63°.

Student 5: *"Before I solved the problem, I looked for what is being asked and the given in the problem. Then, I think about a topic that is related to the problem. I realized that it is about the trigonometric ratio. Then I thought of illustrating the problem because it is more difficult to solve if you cannot visualize the situation. I also think about what trigonometric ratios I can use based on the given and unknown. I considered this problem challenging, and although I already learned it when I was in Grade 9, somehow, I forgot it already. The first thing that I did was identify the given. It can be seen in the illustration of the problem that the values of a and c are already given. The formula for b was also given. [...] Since the center of this hyperbola is not on the origin, I already have some choices on what equation to use. And then, its major is on the x-axis. From there, I already know the form of the equation. And so, from there, I substituted the values of a and c in the equation, and then I used a and c to find for b and substituted it also in the equation to find the equation of the hyperbola."*

Using metacognitive strategies as stepping stones in solving problems. When Student 8 was asked what could represent her metacognitive strategies in solving problems, she answered, *"Imagine that there is a river, and its current is very strong. In that river, there are stepping stones that create a path to get from one side to the other. So, my strategies with each step represents one stepping stone. So, you can't skip one; you need to take one stepping stone at a time before you can proceed to the next. While proceeding to the next, you need to do it slowly, or else you might be put in an uncertain situation. So, you really need to be careful until you reach the other side."*

Metacognitive strategies are not only applicable to complicated problems in pre-calculus. As shared by Student 8 these can also be applied in simple problems like finding the equation of a hyperbola given the coordinates for the vertex and foci.

Student 8: *"The first thing that I did was identify the given. It can be seen in the illustration of the problem that the values of a and c are already given. The formula for b was also given. [...] Since the center of this hyperbola is not on the origin, I already have some choices on what equation to use. And then, its major is on the x-axis. From there, I already know the form of the equation. And so, from there, I substituted the values of a and c in the equation, and then I used a and c to find for b and substituted it also in the equation to find the equation of the hyperbola."*

According to Student 8, although this problem has a very short solution, she used her metacognitive strategies as stepping stones in finding the hyperbola equation.

Using metacognitive strategies as a compass in solving problems. Student 9 chose a compass to represent his metacognitive strategies in solving problems in pre-calculus. He said, *"It can be represented by a compass because it has flow. I mean, it has direction usually compass because it gives direction."*

Then, he shared his experience of using his metacognitive strategies in solving a problem about two identical ellipses with foci on the x-axis, and each ellipse passes through the center of the other. Given the equation of the first ellipse, he solved for the equation of the second ellipse, the points of intersection of the two ellipses, and the length of the points of intersection.

Student 9: *"After reading the problem, I already know what to do. I included an illustration to see the problem clearly. [...] I identified the center of the first ellipse. The two ellipses have the same major axis since it was stated in the problem that they touch each other's center. So based on this, the equation of the second ellipse can be determined. With the second sub-question, the first thing that came into my mind is I had to do a system of equations since I needed to identify the points of intersection. I usually use that in other graphs if they have points of intersection. For the third sub-question, at first, I considered the distance formula with an absolute value because the two points have the same x-coordinate. However, I told myself that I would just use the other distance formula because it is more formal. [...] I answered the first sub-question, paused, then scanned if I did something wrong in my solution, then the next sub-question, then once again paused. Then, the third sub-question pauses again to ensure that I have no error. I checked my computations like simple arithmetic operations. And I also analyzed if I was able to apply the correct concept in answering the* *problem. [...] Repeatedly checking my solution assures me that my answer is correct."*

Although it takes some time to monitor and check their solution from time to time, it assures them that by doing so, they can get the correct answer at the end of solving.

Students perceived their metacognitive strategies as effective tools in planning how to solve a problem, monitoring their solution, and evaluating their final answer, making their problem-solving process more efficient.

Students Metacognitive Strategies for Solving Problems in Pre-Calculus and Lifelong Learning

The senior high school students recognized that their metacognitive strategies in solving problems in pre-calculus are also applicable in making simple decisions and even important ones in their everyday lives.

Making sound and practical decisions. The first one that they identified is on making a decision regarding finances. One of the students shared that she encountered a problem with how to budget her money at school. Student 5 claimed that she was able to overcome this problem by analyzing her situation and thinking about what she could do before deciding.

Student 5: *"I only have 50 pesos; when I got to school, I learned that there were fees that I needed to pay. Twenty-five pesos for our group project and 5 pesos for the materials needed in TLE then, 20 pesos for my lunch, and 30 pesos for another group project. So, I need to pay a total of 80 pesos. I asked my classmates about the deadline for our group projects, so I'll know what to pay first. I knew I couldn't skip lunch, and we needed the materials for TLE that day. I learned I needed to pay 25 pesos for our group project that day. Then for the other project, the payment deadline is still in February. So, I asked my groupmates to let me pay for the project the next day. With that, I spent exactly 50 pesos on that day."*

In addition to this, Student 9 shared that metacognitive strategies in solving problems in pre-calculus can also be applied in deciding whether to purchase something or not.

Student 9: *"For example, in buying shoes with your own money. You have to think if you will buy the shoes or just keep them for future use. [...] If you choose to keep your money, you can check if you made the right choice. Then, later on, when something happens that you need some money, and you have the fund because you kept your money. Then, you will realize that you made the right choice."*

Aside from applying metacognitive strategies in making decisions regarding money matters, Student 9 also added that he was able to use these strategies when he decided where he would study for high school.

Student 9: *"There was one time that I had to choose if PNS or PhiSci. Before deciding what to choose, I considered many things, like my readiness. I am the youngest among my siblings, and I also know that I am like the baby in our family. I told myself that I needed to make sure that I would make the right decision because high school is a very important phase. [...]My decision was right because, at that stage, it would be difficult for me to live far from my mother and father."*

Pursuing personal growth and development. Student 8 shared that her metacognitive strategies in solving problems in pre-calculus can also be applied in pursuing personal growth and development and even in life in general.

Student 8: *"As a child, we have dreams that we want to achieve in life. You can consider this as planning in which we try to identify our personality, what would be the circumstances in our lives, and then the middle part is monitoring. While growing up, the fast pace of the world, especially because of social media and the internet, lets us know many things; we can learn a lot of information. And so there are times that our decisions for our lives can be influenced, even our attitude towards other people and society as a whole. So, it is important to step back and look at our progress...and see if we were able to do things that contributed to reaching our goal. Once we reach our goal, we can also look into whether it is what we want and what fits us. And so, the process is like a cycle, even though you can say that you already reached your goal, there will always be another goal, and so the cycle continues."*

These results imply that the students are aware that the metacognitive strategies they use to solve problems in pre-calculus can be applied to real-life situations and lifelong learning. In the same way, a solution can be planned by considering many things; planning goals in life (e.g., choosing a profession) requires analyzing one's strengths, weaknesses, and resources. Just like how checking the solution in the middle of solving the problems helps students in ensuring that they will end with the correct answer; monitoring and reflecting on one's actions in real-life allows an individual to check the alignment of his/her words and actions to what he/she aims to achieve. Also, evaluating one's success is the same as checking if the final answer and solution are both correct and considering the parts of the solution that can be further improved on the subsequent problems to be solved. Hence, using metacognitive strategies outside of solving mathematical problems and the four corners of the classroom will enable students to adapt to different situations and pursue lifelong learning.

Conclusion

This study explored the senior high school students' experiences using metacognitive strategies to solve pre-calculus problems in distance learning. It provided insights into the senior high school students' metacognitive strategies and how they perceive their experiences using them to solve problems in pre-calculus.

Findings revealed that senior high school students have metacognitive strategies for planning, monitoring, and evaluating their solutions and answers to pre-calculus problems. The experiences of senior high school students in using metacognitive strategies to solve pre-calculus problems showed that these strategies served as tools for them to overcome their difficulties in solving problems in distance learning, wherein there is limited interaction between the teacher and students and learning is self-regulated. Further, senior high school students recognized how metacognitive strategies could be applied to real-life situations and in pursuing lifelong learning.

This implies that students need to recognize and understand their metacognitive strategies in solving mathematics problems to know what to do when they are given complicated mathematics problems instead of just giving up without trying. Moreover, awareness of the applications of their metacognitive strategies outside the context of solving mathematics problems can empower them to make sound decisions, adapt to unexpected adversities, and pursue lifelong learning.

This study suggests that modules in pre-calculus should be contextualized to learners' experiences to foster metacognitive strategies. Activities (i.e., metacognitive frames, thinking/learning logs, and reflection prompts) that can address students' metacognition in blended distance learning can be included in the learning modules. Moreover, training on metacognitive teaching strategies should be conducted among mathematics teachers to capacitate them in helping students develop metacognitive strategies for learning and problem-solving.

Lastly, further studies can be conducted to investigate students' metacognitive strategies in solving problems across grade levels in different learning modalities.

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