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A Study on Mathematics Learning Strategies Among Pre-University Students

Kajian Berkaitan Strategi Pembelajaran Matematik Di Kalangan Pelajar Pra-Universiti

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ABSTRACT

Mathematics is a fundamental subject for everyday problem-solving until advanced scientific research. However, for many students, Mathematics can be a challenging subject. To effectively learn and master mathematical concepts, it is essential to apply effective learning strategies. Therefore, this research aims to analyze students' learning strategies in Mathematics. The study employed a quantitative research design with a structured questionnaire as the primary data collection instrument. The questionnaire is divided into two main parts: Part A (Demographic Profile) and Part B (Learning Strategies). Part B has three components: cognitive, metacognitive self-regulation, and resource management. A 5-point Likert scale: never, rarely, sometimes, very often, and always was used to investigate students' frequency in using specific learning strategies. About 198 respondents from the Science and Engineering Programme in the Centre of Foundation Studies, UiTM responded to the survey. The study used descriptive analysis to analyze the data gathered. The results show that the students utilized cognitive strategy in learning Mathematics, whereby students rehearse, organize, elaborate, and apply critical thinking. The respondents were aware of metacognitive strategies and could manage available resources in learning Mathematics. The study benefits students, educators, and the Ministry of Higher Education to improve the quality of learning and education in Mathematics, especially at the higher education level.

Keywords: Cognitive; metacognitive; resource management; mathematics learning strategies; learning style

ABSTRAK

Matematik adalah mata pelajaran asas bagi penyelesaian masalah harian sehingga kepada penyelidikan saintifik. Walau bagaimanapun, bagi kebanyakan pelajar, matematik boleh menjadi subjek yang mencabar. Untuk mempelajari dan menguasai konsep matematik dengan berkesan, adalah penting untuk menggunakan strategi pembelajaran yang berkesan. Oleh itu, kajian ini bertujuan untuk menganalisis strategi pembelajaran pelajar dalam matematik. Kajian ini menggunakan reka bentuk kajian kuantitatif dengan soal selidik berstruktur sebagai instrumen pengumpulan data primer. Soal selidik terbahagi kepada dua bahagian utama iaitu Bahagian A (Profil Demografi) dan Bahagian B (Strategi Pembelajaran). Bahagian B terdiri daripada tiga komponen: kognitif, pengawalan kendiri metakognitif, dan pengurusan sumber. Skala Likert: tidak pernah, jarang, kadang-kadang, sangat kerap, dan selalu telah digunakan bagi mengkaji kekerapan pelajar menggunakan strategi pembelajaran tertentu. Seramai 198 orang pelajar Program Sains dan Kejuruteraan di Pusat Asasi UiTM telah terlibat dalam soal selidik. Kajian menggunakan analisis deskriptif untuk analisis data. Hasil kajian mendapati bahawa pelajar menggunakan strategi kognitif seperti membuat latihan, menyusun, menghuraikan, dan mengaplikasikan pemikiran kritis. Pelajar juga sedar tentang strategi metakognitif dan boleh menguruskan sumber yang ada dalam pembelajaran Matematik. Dapatan kajian ini memberi manfaat kepada pelajar, pendidik, dan Kementerian Pengajian Tinggi untuk meningkatkan kualiti pembelajaran dan pendidikan dalam matematik khususnya di peringkat pengajian tinggi.

Kata kunci: Kognitif; metakognitif; pengurusan sumber; strategi pembelajaran matematik; teknik pembelajaran

INTRODUCTION

Mathematics is applied in numerous fields, including science, engineering, economics, and more. Success in this subject requires a solid understanding rather than memorization of formulas. Students must grasp its concepts to progress effectively. They need to understand the meaning of theory math lessons and how to apply them in real life. A variety of learning strategies is needed to achieve this level of understanding. Therefore, learning Mathematics requires a thoughtful and strategic approach. Wenden and Rubin (1987) defined learning strategies as "... any sets of operations, steps, plans, routines used by the learner to facilitate the obtaining, storage, retrieval, and use of information.". Richards and Platt (1992) considered learning strategies as "intentional behavior and thoughts used by learners during learning to better help them understand, learn, or remember new information”. Ungureanu and Georgescu (2012) suggested three language learning strategies: cognitive, metacognitive, and resource management.

Without appropriate strategic learning behaviors, students are ill-equipped to cope with the high cognitive demands of a constructivist learning environment (Anthony, 1996). Cognition refers to the mental processes and activities of acquiring, processing, storing, and using information. It involves various aspects of thinking, such as perception, attention, memory, language, problem-solving, and decision-making. Cognitive processes are how individuals mentally engage with and make sense of the world around them. Cognitive abilities are fundamental to learning and understanding new information. According to Messick (1984), cognitive is an individual’s consistent approach to organizing and processing information during learning. In learning and education, cognitive strategies involve the methods individuals use to comprehend and remember information. Those include techniques like summarization, visualization, making connections, and organization of information to enhance learning and problem-solving skills. Ungureanu and Georgescu (2012) state that the cognitive component itself has four sub-components: (1) Rehearsal, (2) Organization, (3) Elaboration, and (4) Critical thinking.

Metacognition is the ability to think about and regulate thinking processes. It involves being aware and understanding one cognitive processes, such as problem-solving, decision-making, and learning. In the learning context, metacognition plays a crucial role in enhancing the effectiveness of the learning process. According to Khan and Khan (2013), metacognition denotes individual knowledge and beliefs about their cognitive processes and resulting attempts to regulate cognitive processes to maximize learning and memory. Flavell (1971) defined metacognition as "cognition about cognition," emphasizing the idea that it involves thinking about one's thinking processes. Flavell (1971) identified three components of metacognition: knowledge, regulation, and experiences. Palincsar & Brown (1987) stated that metacognitive instruction can enhance memory skills, text comprehension, written expression, and math performance for students experiencing academic difficulty. Resource management in learning strategies involves allocating and utilizing various resources to enhance learning. The resources include time, materials, and social support. Efficient resource management improves learning outcomes and benefits students, professionals, and lifelong learners. According to Patricia Chen et al. (2021), strategic resource management behaviors, such as exploring, exploiting, and pruning, predict higher academic achievement in self-regulated learners.

Literature Review

Cognitive, metacognitive, and resource management strategies are essential for effective Mathematics learning. By employing these strategies synergistically, students can enhance their understanding and problem-solving skills. Wenden and Rubin (1987) categorized learning strategies as cognitive, metacognitive, and resource management. According to Wenden and Rubin (1987), the cognitive strategy refers to learners' mental processing activity when knowledge is retrieved and analyzed. Oxford (1990) emphasized that cognitive strategies are how learners use the new knowledge meaningfully.

In contrast, the metacognitive strategy refers to how learners organize their learning strategies, monitor their ongoing progress, and evaluate their knowledge. Metacognitive strategies are effective in helping learners progress in their learning process. Oxford (1990) categorized the metacognitive strategy into three sub-components, which are "centering learning, arranging and planning learning, and evaluating learning" (as cited in Micheal et al., 2022, p. 348).

The resource management strategy commonly has three sub-components: "environment management, effort management, and help-seeking" (McKeachie et al., 1986 as cited in Raffi et al., 2023, p. 515). Environment management is students' strategies to prepare a conducive space for studying; meanwhile, effort management is students' effort and motivation when studying. Additionally, help-seeking refers to students' willingness to find help when facing difficulties in their learning.

Cognitive learning theory explains how internal and external factors influence an individual's mental processes to supplement learning. Delays and difficulties in learning occur when cognitive processes are not working regularly. Several researchers have made significant contributions to the theory. Shi (2011) focused on the relationship between cognitive styles and learning strategies of English majors from the Foreign Language School of a university in Wuhan. The results show that cognitive styles influence learners' choices of learning strategies. Meanwhile, Stefanou and Salisbury-Glennon (2002) described the effects of cognitive learning strategies on enhanced learner motivation involving an undergraduate learner-centered community.

Metacognition is a crucial part of the learning process. A study by Sumadyo (2018) proposed the role of the metacognitive component as the basis for the smart-learning environment, Shannon (2008) discovered that applying metacognitive strategies to the daily learning process helps learners become self-directed. Ahmed (2014) proved the relationship between learning resources management strategies and academic achievement. The study showed that academic performance is related to time and study environment management, effort management, and seeking help from qualified others.

Raffi et al. (2023) studied cognitive, metacognitive, and resource management by adopting Wenden and Rubin’s (1987) instrument and discovered that most students preferred resource management strategies when learning Arabic. The findings also showed a positive inter-correlation between resource management, metacognitive self-regulation, and cognitive components. Hence, the study suggests that students should be more aware of and employ these strategies effectively to empower their learning process. Additionally, teachers should encourage the process by implementing those strategies in or outside classrooms to assist the students.

PROBLEM STATEMENT

Despite the central role of Mathematics in academic and professional success, students struggle with the subject, leading to poor performance and reduced confidence in their mathematical abilities. These learning challenges are not merely due to the complexity of mathematical concepts but also to the varied and often ineffective learning strategies. Cognitive and metacognitive learning strategies are essential to facilitate effective learning, resulting in improved academic outcomes. A study by Sercenia and Prudente (2023) found that metacognitive-based pedagogical intervention affects students' Mathematics achievement. Furthermore, Vosniadou’s (2021) study involving 366 pre-service teachers demonstrated that the adoption of cognitive and metacognitive learning approaches positively correlated with the academic success of the pre-service teachers.

Active learning strategies such as interactive presentations and group collaboration enhance interest in specific topics, involve students in mathematical explorations, foster continuous motivation, and improve average section results and student passing rates (Lugosi & Uribe, 2020). Simorangkir and Sembiring (2018) utilized the learning media tool Lectora Inspire to aid in Mathematics education, focusing on fractional materials. The study demonstrates an enhancement in student number sense abilities, consequently leading to improved learning outcomes. Tachie (2019) found that metacognitive skills and strategies helped students in Mathematics problem-solving. Selecting appropriate learning strategies enhances the quality of Mathematics learning. Therefore, understanding student perception of the use of learning strategies is crucial. Few studies have focused on learning strategies among pre-university students, especially in learning Mathematics. Thus, the study aims to analyze students’ perceptions of learning strategies in Mathematics among pre-university students.

Research Objective and Research Questions

The current study explores students' perceptions about their use of learning strategies. Specifically, it aims to answer the following research questions;

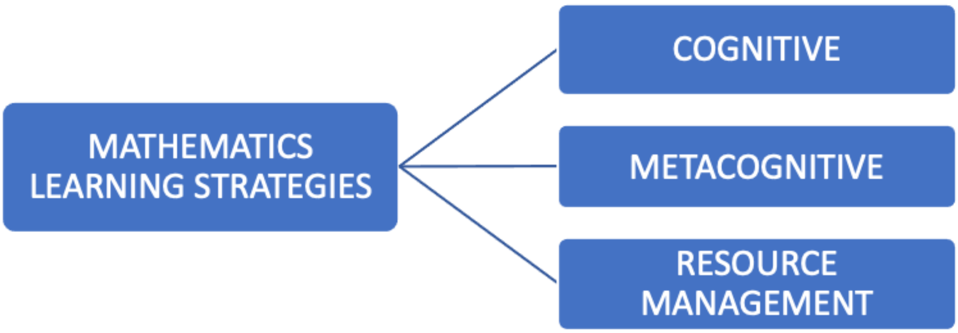
- How do students perceive the use of cognitive components in learning Mathematics?

- How do students perceive the use of metacognitive components in learning Mathematics?
- How do students perceive the use of resource management in learning Mathematics?

Theoretical Framework

Learners need to use a variety of strategies to make learning successful. According to Rahmat (2018), language learning strategies employed by the learners may facilitate or hinder learning. Figure 1 shows the theoretical framework of the study. It is rooted in Wenden and Rubin's (1987) language learning strategies: cognitive, metacognitive, and resource management.

Figure 1: Theoretical Framework of the Study - Wenden and Rubin's (1987) Mathematics Learning Strategies



METHODOLOGY

The study employed a quantitative method to explore motivation factors for learning among undergraduates. A purposive sampling was applied as 198 respondents completed the survey. The instrument used a 5 Likert-scale survey adapted from Wenden and Rubin (1987) to reveal the variables in Table 1 below. The survey has four sections: Section A for the demographic background, Section B for the cognitive components with 19 items, Section C for the metacognitive self-regulation with 11 items, and Section D for the resource management with 11 items.

Table 1: Distribution of Items in the Survey

Section	Strategy (Wenden And Rubin (1987))		Sub-Strategy	No. of Items	Total Items	Cronbach Alpha Values
B	Cognitive	(a)	Rehearsal	4	19	0.917

	Components	(b)	Organization	4		
		(c)	Elaboration	6		
		(d)	Critical Thinking	5		
C	Metacognitive Self-Regulation			11	11	0.827
D	Resource Management	(a)	Environment Management	5	11	0.789
		(b)	Effort Management	4		
		(c)	Help-Seeking	2		
Overall					**41**	**0.939**

Table 1 also reveals the results of the analysis performed using SPSS to determine the reliability of the survey. The results show Cronbach alpha values of 0.917 for Section B, 0.827 for Section C, and 0.789 for Section D. Hence, those results prove a good reliability of the survey.

FINDINGS AND DISCUSSIONS

Section A: Demographic Background
Tables 2 to 5 show the findings for Section A consisting of students' gender, program, types of previous schools, and learning medium.

Table 2: The Distribution of Respondents Based on Gender

Gender	Frequency	Percentage (%)
Male	89	44.9
Female	109	55.1
Total	198	100.0

Table 2 presents the distribution of respondents based on their gender in frequency and percentage. The majority of the respondents are 109 female students (55.1%); meanwhile, 89 respondents are males (44.9%).

Table 3: The Distribution of Respondents Based on Program

Program	Frequency	Percentage (%)
Foundation of Science	97	49
Foundation of Engineering	101	51
Total	198	100.0

Table 3 above tabulates the distribution of the respondents based on their program. The majority of the respondents are from the Foundation of Engineering program comprising 101 students (51%). In contrast, 97 respondents are from the Foundation of Science program (49%).

Table 4: The Distribution of the Respondents Based on Types of Previous School

Types of school	Frequency	Percentage (%)
Boarding school	114	57.6
Daily school	84	42.4
Total	198	100.0

Table 4 exhibits the distribution of the respondents based on the types of their previous schools. As can be observed in the table, 114 (57.6%) respondents used to study at boarding schools, while the rest 84 (42.4%) of the respondents studied at daily schools.

Table 5: The Distribution of the Respondents Based on Preferred Learning Medium

Learning medium	Frequency	Percentage (%)
Face-to-face	158	79.8
Online	0	0
Hybrid	40	20.2
Total	198	100.0

Table 5 displays the distribution of the respondents based on their preferred learning medium. As can be viewed in the table, 158 (79.8%) respondents preferred face-to-face as the learning medium in learning Mathematics. Meanwhile, 40 (20.2%) respondents preferred hybrid as a learning medium. No respondents preferred online learning in learning Mathematics, probably due to the lack of immediate clarification for their doubts during online learning.

Section B: Cognitive Components

This section presents the results from the analysis of items in Section B – Cognitive Components to answer research question 1- How do students perceive the use of cognitive components in learning Mathematics?

The section has four sub-components: (1) Rehearsal, (2) Organization, (3) Elaboration, (4) Critical thinking. The results for Section B include cognitive components, which are displayed in Table 6, Table 7, Table 8, and Table 9, respectively.

Table 6: The Results from Section B Part (a) Rehearsal

Items	Mean Values
LSCCRQ1 When I study Mathematics, I practice saying the material to myself over and over.	3.7
LSCCRQ2 When studying Mathematics, I read my class notes and the course readings over and over again.	4.0
LSCCRQ3 I memorize keywords to remind me of important concepts in Mathematics.	4.2
LSCCRQ4 I make lists of important concepts of Mathematics and memorize the lists.	4.1
Overall	4.0

From Table 6, the overall mean score for sub-strategy rehearsal is 4.0. Most students memorized keywords to remind them of the important concepts in Mathematics (M=4.2). They also made lists of important concepts of Mathematics and memorized the lists (M=4.1). They rehearsed Mathematics by reading class notes repeatedly (M=4.0). Besides, students practiced saying the material to themselves over and over (M=3.7).

Table 7: The Results from Section B Part (b) Organization

Items	Mean Values
LSCCOQ1 When I study Mathematics, I outline the concept to help me organize my thoughts.	4.1
LSCCOQ2 When I study Mathematics, I go through the class notes and try to find the most important ideas.	4.5
LSCCOQ3 I make simple charts, diagrams, or tables to help me organize lecture notes in Mathematics.	3.6
LSCCOQ4 When I study Mathematics, I go over my class notes and make an outline of important concepts.	4.2
Overall	4.1

The results from Table 7 disclose the sub-strategy organization's overall mean among the 198 respondents is 4.1. The majority of students went through the class notes and tried to find the most important ideas when studying Mathematics (M=4.5). They also outlined important concepts after going through the class notes (M=4.2). Outlining the concept helped them organize their thoughts (M=4.1). Subsequently, making simple charts, diagrams, or tables helped them organize lecture notes in Mathematics (M=3.6).

Table 8: The Results from Section B Part (c) Elaboration

Items	Mean Values
LSCCEQ1 When I study Mathematics, I pull together information from different sources, such as lectures, readings,	4.0

and discussions.	
LSCCEQ2 I try to relate ideas in Mathematics to other courses whenever possible.	3.9
LSCCEQ3 When I study Mathematics, I try to relate the material to what I already know.	4.3
LSCCEQ4 When I study Mathematics, I write summaries of the main ideas from the readings and my class notes.	3.7
LSCCEQ5 I try to understand the material in the classes by making connections between the readings and the concepts from the lectures.	4.2
LSCCEQ6 I try to apply ideas from Mathematics in other class activities such as lectures and discussions.	4.1
Overall	4.0

As shown in Table 8, the overall mean for sub-strategy elaboration is 4.0. When studying Mathematics, students tried to relate the material to what they already knew (M=4.3). They also tried to understand the material in the classes by making connections between the readings and the concepts from the lectures (M=4.2). Additionally, they tried to apply ideas from Mathematics in other class activities such as lectures and discussions (M=4.1). Pulling together information from different sources, such as lectures, readings, and discussions was also their strategy for learning Mathematics (M=4.0).

Table 9: The Results from Section B Part (d) Critical Thinking

Items	Mean Values
LSCCCTQ1 I often find myself questioning things I hear or read in Mathematics to decide if I find them convincing.	3.9
LSCCCTQ2 When a theory, interpretation, or conclusion is presented in classes or self-reading, I try to decide if there is good supporting evidence.	3.9
LSCCCTQ3 I treat Mathematics materials as a starting point and try to develop my ideas about it.	3.9
LSCCCTQ4 I try to play around with ideas of my own related to what I am learning in Mathematics.	3.9
LSCCCTQ5 Whenever I read or hear an assertion or conclusion in the classes, I think about possible alternatives.	3.9
Overall	3.9

Based on Table 9, the overall mean score for sub-strategy critical thinking is 3.9. The mean for all items in sub-strategy critical thinking is 3.9. Students often found themself questioning things they heard or read in Mathematics to decide if they found them convincing. They tried to decide if there was good supporting evidence when a theory, interpretation, or conclusion was presented in classes or self-reading. They also treated Mathematics materials as a starting point and tried to develop their ideas. They took the initiative to try to play around with their ideas related to what they learned, and whenever they read or heard an assertion or conclusion in the classes, they thought about possible alternatives.

Section C: Metacognitive Components

This section unveils the results from the analysis of items in Section C-Metacognitive Components to answer research question 2- How do students perceive the use of metacognitive components in learning Mathematics?

Three key components of metacognition are knowledge, regulation, and experiences. The results for Section C are shown in Table 10.

Table 10: The Results from Section C Metacognitive Self-Regulation

Items	Mean Values
MSSRQ1 During class time, I often miss important points because I am thinking of other things.	2.7
MSSRQ2 When learning Mathematics, I make up questions to help focus my learning.	3.4
MSSRQ3 When I become confused about something I am learning for the classes, I go back and try to figure it out.	4.3
MSSRQ4 If course learning is difficult to understand, I change the way I learn the material.	3.7
MSSRQ5 Before I study new topic material thoroughly, I often read it over to see how it is organized.	3.6
MSSRQ6 I ask myself questions to make sure I understand the material I have been studying in Mathematics.	4.0
MSSRQ7 I try to change the way I study to fit any course requirements and the instructors' teaching style.	3.8
MSSRQ8 I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for Mathematics.	3.9
MSSRQ9 When studying Mathematics, I try to determine which concepts I do not understand well.	4.3
MSSRQ10 When I study Mathematics, I set goals for myself to direct my activities in each study period.	4.0
MSSRQ 11 If I get confused taking notes in classes, I make sure I sort it out afterward.	3.9
Overall	3.8

Table 10 depicts the overall mean score for metacognitive components is 3.8. Most participants who encountered confusion while learning in class tended to revisit the material to understand it better. The tendency is shown by the highest average score recorded at 4.3. Other than that, students identified the concepts in Mathematics that they struggled to understand, contributing to the same average score of 4.3. Students sometimes made up questions to help them focus on learning Mathematics with an average mean of 3.4. However, students rarely missed important points in class due to distractions, as indicated by the lowest average mean score of only 2.7.

Section D: Resource Management.

This section presents the results from the analysis of items in Section D – Resource Management to answer research question 3- How do students perceive the use of resource management in learning Mathematics?

Resource management is divided into three components which are environment management, effort management, and help-seeking. The average mean scores for these parts are shown in Table 11, Table 12, and Table 13 respectively.

Table 11: The Results from Section D Part (a) Environment Management

Items	Mean Values
RMCEMQ I usually study in a place where I can concentrate on my studies.	4.5
RMCEMQ2 I make good use of my study time for Mathematics.	4.2
RMCEMQ3 I have a regular place for studying Mathematics.	3.8
RMCEMQ4 I make sure that I keep up with the weekly lecture notes and tutorials for Mathematics.	4.4
RMCEMQ5 I attend the classes regularly for Mathematics	4.8
Overall	4.3

Table 11 illustrates the overall mean score for environment management is 4.3. Most students consistently attended Mathematics classes, as evidenced by a mean score of 4.8. Additionally, they frequently chose study environments conducive to concentration, reflected in a mean score of 4.5. The lowest mean score is students having regular a place for studying Mathematics at 3.8.

Table 12: The Results from Section D Part (b) Effort Management

Items	Mean Values
RMCEMQ1 I have a regular place for studying Mathematics.	3.9
RMCEMQ2 I work hard to do well in mathematics classes even if I do not like what I am doing.	4.2
RMCEMQ3 When a certain Mathematics topic is difficult, I either give up or only study the easy parts.	2.4
RMCEMQ4 Even when topics in Mathematics are dull and uninteresting, I manage to keep studying until I finish.	4.2
Overall	3.7

Table 12 tabulates the average mean score for effort management, and the overall average is 3.7. The highest mean score is 4.2 for students working hard to succeed in Mathematics, persisting in their studies despite disliking certain aspects and finding some topics dull. Conversely, the lowest mean score is 2.4, suggesting that students did not tend to give up when faced with challenging Mathematics topics.

Table 13: The Results from Section D Part (c) Help-Seeking

Items	Mean Values
RMCHSQ1 When I cannot understand the topics in Mathematics, I ask another student in the class for help.	4.5
RMCHSQ 2 I try to identify students in the classes whom I can ask for help if necessary.	4.4
Overall	4.5

Meanwhile, Table 13 displays the mean scores for help-seeking. The overall mean score is 4.5. Most students tended to seek assistance from their peers when they could not understand the topics in Mathematics at a higher mean value of 4.5. They also demonstrated a readiness to identify classmates from whom they could seek help at 4.4.

CONCLUSION

Summary of Findings and Discussions

The results show that the mean score for the overall cognitive component is 4.0. It implies that students utilize cognitive components in learning Mathematics. The cognitive sub-components can be combined and modified to accommodate different learning preferences and styles. Students can improve their mathematical ability and have a profound comprehension of mathematical subjects by implementing strategies to the study routines. The result is similar to Daud et al. (2020), who conducted a study among school students and reported a positive perception of learning Mathematics. By considering the mathematics study strategies subdimensions of secondary school students, Tezer et al. (2020) discovered that the students perceived higher of their execution of cognitive strategies than the others.

Additionally, the findings indicate that the metacognitive component has an average mean score of 3.8. It implies that students perceive the use of metacognitive components in learning Mathematics. Integrating metacognitive skills into Mathematics instruction helps students become more engaged and self-directed with enhanced comprehension and problem-solving abilities. The methods assist in developing a lifelong enjoyment of Mathematics learning, enhanced knowledge, and improved problem-solving abilities. Khanal et al. (2021) discovered that the majority of Nepalese high school students preferred peer learning strategies to metacognition and critical thinking in learning Mathematics.

The results reveal that the overall mean score for resource management is 4.1. Hence, students understand that resource management is utilized when studying Mathematics. Efficient resource management in Mathematics education assists students in enhancing the learning process, establishing a solid foundation in mathematical ideas, and succeeding in their studies. It also shows that students highly apply all the components as a strategy to learn Mathematics. The components need to be applied parallelly.

Pedagogical Implications and Suggestions for Future Research

The findings from this study highlight the various students' approaches toward learning strategies in Mathematics. Effective learning techniques can improve Mathematics studies in a variety of ways. Understanding it eliminates the perception that Mathematics is a killer subject. Moreover, it can foster more passion and interest in the subject. As a result, teaching and learning in Mathematics classrooms can be improved. Understanding how students perceive learning strategies assists educators and policymakers in designing more effective teaching methods and curriculum frameworks. The instructions can be tailored to meet students' needs and preferences, eventually enhancing engagement and learning outcomes in Mathematics. Additionally, comprehending learning strategies can effectively address the underlying causes of failure and success in Mathematics among pre-university students.

Further research can explore and compare the relationship between cognitive, metacognitive, and resource management components to determine their impact on mathematical learning. Comparative studies assist in identifying the most influential component in Mathematics learning. Since the current study focuses on pre-university students, future studies should expand its scope to involve public university, secondary, and elementary school students.

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