▪ Global Social Sciences Review (GSSR) ▪ Vol. VII, No. IV (Fall 2022) ▪ Pages: 82 – 88
▪ DOI: 10.31703/gssr.2022(VII-IV).09 ▪ URL: http://dx.doi.org/10.31703/gssr.2022(VII-IV).09
▪ L- ISSN: 2520-0348 ▪ p- ISSN: 2520-0348 ▪ e-ISSN: 2616-793X
▪ Citation: Noor, B. (2022). Students' Meta-cognition Skills and Problem-solving Strategies in Math: A Preliminary Literature Review. *Global Social Sciences Review*, *VII*(IV), 82–88. https://doi.org/10.31703/gssr.2022(VII-IV).09

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Students' Meta-cognition Skills and Problem-solving Strategies in Math: A Preliminary Literature Review

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Contents:

Abstract: *Math problem-solving is difficult for students and instructors. Metacognition abilities may help tackle these problems. Math problem-solving success depends on metacognitive abilities and methods. These abilities and tactics benefit students and instructors. Metacognitive abilities and methods are examined in mathematics problem-solving for instructors and students. A qualitative case-study design was utilised. to describe things deeply and broadly. Metacognitive abilities and methods such as task analysis, planning, monitoring, checking, and reflection, as well as self- and group-monitoring, reading and writing, self-regulation (SR), and self-assessment (SA), helped students solve arithmetic problems. Group talks and self-reflection help pupils tackle challenges, too. Meta-cognition for problem-solving is recommended for students and instructors.*

Key Words: Mathematics, Meta-cognitive Skills, Self-regulation, Self-assessment, Teaching and Learning, Problem-solving

Introduction

Despite the fact that research on metacognition has only rarely been published in the past, our findings showed that students do use monitoring and self-assessment procedures to monitor their knowledge of a topic by going over all of their original mistakes. This was the case even though metacognition research has only rarely been published in the past. After that, they spoke about several alterations to that effect, as was described orally in the part on the results that came before this one. Students who are skilled in metacognitive regulation may be able to assist their classmates by analysing the tactics that they use for self-regulation, such as pausing for reflection before proceeding to plan and solve an issue (Muis, 2008). This gives students the ability to use the action-procedure lists to their maximum extent in order to solve any mathematical problem that may crop up in the course of their day-to-day lives. Some of the students who participated in this research prepared their strategy for problem-solving from the very beginning, either in groups or on their own, by drawing, labelling, recognizing, and filling out information. This was done to assist them (the learners) in re-channelling any worrying or anxious thoughts that they had in their minds (Bormotova, 2010). In a similar vein, students stated that they would continue to use the trial-and-error strategy

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until they had successfully solved the issue after attempting a few other approaches that initially did not assist them. At this stage, the learners were able to witness their group leader resolve issues in a group discussion, and as a consequence, they were able to apply their own knowledge by recalling how to tackle problems that were either linked to or unrelated to the group discussion. The majority of the time, students rely on their own individual capabilities to develop their metacognitive skills. These skills include self-regulation, self-assessment, monitoring, planning, and the capacity to judge for themselves whether the learning strategies they are employing are successful in assisting them in solving the problem at hand. Students use their metacognitive skills by doing life evaluations on a variety of topics in order to make changes. They may, for example, use it to assess the amount of learning accomplishment they have attained, locate a variety of potential solutions to a problem at hand, choose the best option, and then appraise the level of achievement they have attained in their lives. However, studies have shown that teachers only carry out knowledge, comprehension, and application in the first three phases of the cognitive domain by employing conventional approaches in analysis, synthesis, and assessment, all of which call for high-level thinking skills. This is the case even though these activities require higher levels of cognitive ability. Techniques for problem-solving are often taught in schools and are expected to follow a certain format. The students' understanding of the topic will be advanced if they are able to recognise problems in the material and make an effort to find solutions to those problems. According to the findings of cognitive research experts such as Piaget (1973), Vygotsky (1978), and Bruner (1966), learners attempt to make sense of their surroundings by drawing upon the schemas they have already developed. As a consequence of this, the development of social connections with both professors and students via participation in practical activities is beneficial to educational attainment. The teachers of mathematics should constantly encourage their pupils to participate in activities that include tangible things since these activities reflect a natural comprehension of the topics being studied. Because physical things transmit a greater level of knowledge than abstract ones, it is crucial to encourage children to utilise any elements in their surroundings that may help them think creatively while solving mathematical problems (Bruner, 1966). The development of metacognitive skills and strategies is aided in various ways by these theories' intellectual, social, and psychological subfields, which are the three fundamental domains (Jagals, 2013; Strawderman, 2010).

Methodology and Identification of Relevant Literature

Because this study is simply the first step of a much more extensive one, this report is based on a review of the previous research that has been conducted. Finding papers and databases like Web of Science (WOS) and Scopus that contain pertinent information is the first step in doing a literature review. We didn't confine the search to a single field or index because we wanted to make sure that we didn't miss any helpful results that may have been found in other fields. As potential sources for literature reviews, we offered journal articles and conference papers throughout the Metacognitions process. Because we were interested in learning what other studies had discovered in the past about the metacognition abilities and problem-solving methods used by math students, we decided to use a mix of keywords and articles that were published within the previous 10 years.

A search of the available literature in August 2022 turned up a total of fifty entries, with 25 coming from WOS and 25 from Scopus. Following the integration of the results and the removal of duplicate articles, there were 45 articles left for analysis. Then came the results of a more refined search. We went through and carefully got rid of any unnecessary abstractions. It would be noteworthy if the research directly addressed metacognitive talents and procedures in both teachers and students while they were completing arithmetic problems. For instance, if it were shown that students used metacognition skills and approaches in all subject areas, not just mathematics, then papers on arithmetic problem solving would

focus on metacognition. Following an assessment of the articles' levels of relevance, twenty were selected. After that came the coding and the data extraction. Three further papers were disregarded: one because it was written in French, and the other two because they assessed their claims using simulation software rather than a case study. One of the publications was disregarded because it was written in French. Both students' metacognitive skills and their mathematical problem-solving strategies are investigated in this study, as well as the impact of those investigations on the students.

Research Results

For the purpose of this paper, which aims to investigate the topic of metacognition skills and strategies among students during problem solving in mathematics in practise cases and explore how teachers and students use such skills and strategies for problem solving in mathematics, a number of attributes have been selected for analysis. These attributes include: This is due to the fact that the objective of this research is to explore the issue of metacognition abilities and tactics among students when they are engaged in the process of problem solving in mathematics using real-world examples. The following are a few examples of some of the instances: Aspects relating to time (the year), geography, the metacognition process, expertise, strategy, the discipline of mathematics, as well as students of varied grade levels The students had a lively discussion about a variety of metacognitive strategies and skills, which included things they did independently as well as things they did with the assistance of their teachers. All of these things were beneficial to the students in terms of their ability to comprehend the mathematical ideas that were being presented to them. They also said that the use of metacognition in the context of an educational institution is highly beneficial. The students participated in exercises in which they were forced to articulate their thoughts aloud while working on difficulties either in groups or by themselves. The students' level of understanding is determined by how effectively they are able to answer challenges that are presented in the context of group talks. As a result of overcoming adversity, they develop habits of introspection as a result of their experience. They use the internet to find information relevant to the tasks at hand. They were always given the solutions to the issues first, and then the results were provided to other people so that they could examine the steps or method as well as the answers to see whether they were accurate or erroneous. This was done so that everyone could learn from the experience. If the students' responses were erroneous, they were always given an explanation and shown where they had made the error or blunders. If the answers were accurate, the students received praise. Students said that they needed to engage in in-depth thinking in order to get the answers they were looking for. They reported that taking part in group discussions had a positive impact on their level of understanding of the material. They were able to comprehend a variety of mathematical ideas that they had previously been unable to do, but with the support of meta-cognitive techniques, they were able to do so. Their knowledge of the topic improved as a result. They were able to comprehend a variety of mathematical ideas that they had not been able to grasp in the past thanks to the use of meta-cognitive strategies. Some educators felt that teaching children independence and how to handle difficulties through the use of metacognitive methods was beneficial to their practise. Some individuals were of the opinion that adults needed to teach youngsters to think critically about their own perspectives. Their awareness of the learning process was raised, which resulted in an increase in their capacity to take control of their own education. It helped me develop a more analytical way of thinking, and I'm grateful for that. They went on to say that metacognition allows students to take responsibility for their own learning by supporting them in discovering various tactics to achieve their educational objectives. As a consequence of participating in this activity, students develop more self-reliance and trust in their own capacities as individuals capable of learning. According to a number of educators, metacognition gave pupils the ability to evaluate the quality of their own education and better organise themselves for the future. Students have the ability to negotiate evaluation techniques and criteria that are adapted

to their own educational objectives in order to get a more personalised experience. The analysis of the paper and the discussion Despite the lack of metacognition research, students nevertheless used monitoring and self-assessment as a means of determining how well they understood a subject by analyzing the errors they made. As was discussed before, this motivated them to investigate the possibility of impacts that might be modified. Students who have a great ability for metacognitive control, such as those who put thinking before action when tackling difficulties, may be able to assist their classmates by reflecting on the tactics that they themselves use (Muis, 2008). Students are able to make full use of the action-procedure lists thanks to this, which enables them to work on typical arithmetic assignments. Some of the kids who participated in this research were instructed to draw pictures, give them names, identify things, and fill out forms so that they might learn how to refocus their anxious and concerned thoughts (Bormotova, 2010). A significant number of the students said that they intended to proceed by way of trial and error procedures until they discovered a solution. The students then put their newly acquired knowledge to use to solve problems that were either very similar to the ones they were initially presented with or very different from them. They did this by following the lead of their group leader, who had demonstrated how to handle a contentious conversation. Students often acquire metacognitive skills such as self-control, self-awareness, self-evaluation, monitoring, planning, and measuring the efficiency of their own learning practices. These abilities are typically referred to as "self-control" and "self-awareness." Students who have developed high levels of metacognition are able to assess and enhance both their educational and social surroundings continually. Students make use of it to assess their current academic standing, consider a variety of alternative solutions to a problem, and decide upon the most effective way to proceed. Research has revealed that instructors only use tried-and-true approaches when instructing students in the first three cognitive domains (knowledge, comprehension, and application), despite the fact that these methods require higher-level thinking abilities from their students (analysis, synthesis, and assessment). In school, students gain abilities that are essential and organised for problem-solving. The learning of kids is improved when they have the capacity to recognise and correct their own errors. According to the research of Piaget (1973), Vygotsky (1978), and Bruner (1973), students use their schemas to help them make sense of the world (1978). (1966). As a consequence of this, academic performance is improved through interactions between professors and students that take place in the real world. Mathematical educators should constantly urge their pupils to show their theories by using real-world examples wherever possible. Because concrete things contain more information than abstract ones, students should be encouraged to use any component in their settings to drive creative problem-solving in mathematics (Bruner, 1966). Cognition, socialisation, and psychology are the three pillars that support these ideas, and they all contribute to the development of metacognitive skills and approaches (Jagals, 2013; Strawderman, 2010).

Conclusion

According to the preliminary findings of a number of publications, students were able to apply metacognitive methods and skills to the process of solving mathematical problems, which assisted them in their efforts to acquire a more in-depth understanding of mathematics. It was stated in these documents that the pupils have this capacity. Students, for instance, could utilise metacognitive regulation strategies such as reflection in order to plan and monitor their procedures and assessments, come up with solutions to difficulties they face on a daily basis or that are assigned to them by their teachers, and address challenges associated with groupwork. Another example would be for students to come up with solutions to difficulties they face on a daily basis or that are assigned to them by their teachers. Through the process of figuring out solutions to problems, the students were given the chance to express the emotions that they were experiencing. The ease with which students can access a variety of instructional approaches, skills, and strategies and put them to use in an appropriate

manner is directly proportional to the degree to which they are successful in locating solutions to problems. This is the case regardless of the subject matter being studied. In the literature review for this study, it is outlined how contemplation, planning, and evaluation can be used to help students develop and apply metacognitive skills and methods in naturally occuring ways when solving mathematical problems. These are all aspects of the mathematical problem-solving process that are considered to be metacognitive. This is significant since the goal of this research is to discover how students may acquire and use these abilities; therefore, this information is vital. In order for pupils to grow organically and to the best degree possible in their problem-solving skills, teachers should consistently expose students to increasingly effective mathematical demonstrations, debates, arguments, and challenges, as well as meta-cognitive control. Students will be able to develop their metacognitive talents in a manner that is compatible with the greatest degree of problem-solving as a result of this (such as reflection and hands-on teaching and learning techniques).

Recommendations

This preliminary study uncovered multiple themes, and these suggestions address a number of those topics, ranging from administrative problems to teaching and learning issues to the basic layout of the school environment. The researcher anticipates that the curriculum designers at the Department of Education, in particular, will be able to use the results of this empirical investigation to construct future mathematics education based on the findings of this study. In fact, in order to improve students' capacity for problem-solving, there is a need for more research on the lesson study model as well as other approaches that are analogous to it that are highlighted in the literature review for the teaching and learning of mathematics. Learners also need to make good use of meta-cognitive abilities and techniques (planning, monitoring, self-regulation, and self-assessment) in nearly all learning domains in order to be competent and have a grasp of teaching and learning. These abilities and techniques include planning, monitoring, and self-assessment. The findings of this research should enable individuals who are working to provide math educators with cutting-edge paedagogies and skills to familiarise themselves with the use of meta-cognitive abilities and strategies in the process of problem-solving.

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