THE RELATIONSHIP BETWEEN PROBLEM SOLVING ABILITY AND LOGICAL MATHEMATICAL INTELLIGENCE OF MIDDLE SCHOOL STUDENTS

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Abstract

The main purpose of this study is to investigate the relationship between problem solving ability and logical mathematical intelligence of middle school students. The research design for this study was descriptive (survey) research design and it was conducted in Nattalin District, Bago Region (West). The participants of this study were (450) Grade Eight students and the questionnaire for problem solving ability including (25) items, the questionnaire for logical mathematical intelligence including (25) items and eight open-ended questions were used as an instrument. In order to address the research questions, the descriptive statistics (mean, standard deviation, frequency, percentage) and the inferential statistics (Pearson product-moment correlation) were used. The comparison of mean values of problem solving abilities indicated that the mean score of confident problem solving ability was the highest and that of avoidant problem solving ability was the lowest among six dimensions of problem solving ability. The result of the finding of logical mathematical intelligence indicated that most students possess the moderate level of logical mathematical intelligence. Moreover, the result also showed that problem solving ability was moderately correlated with logical mathematical intelligence of middle school students (r = .464). The results of eight open-ended questions indicated that some students skip the steps and get wrong answers while they are solving problems, they have to use previously learned concepts and they can manage challenging problems by calming down their mind and by using self-monitoring activities but sometimes they face difficulties according to misunderstanding and nearly all students use their logical mathematical intelligence for making various activities.

Keywords: Problem, Problem Solving, Ability, Problem Solving Ability, Mathematical Problem Solving, Intelligence, Logical Mathematical Intelligence

Introduction

The main purpose of education is to make children to become autonomous and independent person. To implement such purpose, there is no subject in the world as important as mathematics. Mathematics is the gateway to numerous career path and profession and can develop critical thinking skill and problem solving ability. It teaches students to analyze problem, to break them down into smaller components and to apply logical reasoning to find solutions. These skills are essential in various fields, including science, technology, engineering and even everyday life situations (Algani, 2022).

All the exercises in mathematics are rooted on problem solving ability. Unless the students have this ability, they cannot be able to perform well in mathematics. Furthermore, students have to use problem solving ability acquired from mathematics throughout their lives. As a consequence of this, problem solving ability has played a fundamental role in human history.

In problem solving process, students have to use their efforts to find solutions by using analytical thinking, critical thinking, reasoning and past experiences. All forms of thinking and cognitive processes are rooted in human intelligence. Logical mathematical intelligence provides

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a strong foundation for mathematics. Based on the above facts, problem solving ability and logical mathematical intelligence of middle school students are needed to study for the development of mathematics education.

Purposes of the Study

The main purpose of this study is to investigate the relationship between problem solving ability and logical mathematical intelligence of middle school students. The specific objectives of the study are as follows.

1. To find out the impulsive, reflective, confident, avoidant, monitoring and planful problem solving abilities of middle school students
2. To investigate logical mathematical intelligence of middle school students
3. To examine the relationship between problem solving ability and logical mathematical intelligence of the middle school students
4. To investigate middle school students' ideas and opinions about problem solving ability and logical mathematical intelligence
5. To make suggestions for improving mathematics teaching and learning at middle school level

Research Questions

Research questions for this study are as follows.

1. What is the impulsive, reflective, confident, avoidant, monitoring and planful problem solving abilities of middle school students?
2. What is the logical mathematical intelligence of middle school students?
3. Is there a relationship between problem solving ability and logical mathematical intelligence of middle school students?
4. What are the middle school students' ideas and perspectives about problem solving ability and logical mathematical intelligence?

Scope of the Study

This study was geographically restricted to Nattalin District, Bago Region (West). The participants of this study are (450) Grade Eight students of 2023-2024 Academic Year from the selected schools. This study was intended to investigate problem solving ability in mathematics and logical mathematical intelligence of middle school students. This study was limited to investigate six types of problem solving abilities namely impulsive problem solving ability, reflective problem solving ability, confident problem solving ability, avoidant problem solving ability, monitoring problem solving ability and planful problem solving ability.

Definition of Key Terms

Seven key terms are defined as follows.

Problem

Problem is mathematical object representing a collection of questions that might be able to solve (Alubady, 2013).

Problem Solving

Problem solving is a process of developing, testing and evaluating a method for overcoming an obstacle by identifying a problem and finding the best alternative to solve it (Miller & Stoeckel, 2011).

Ability

Ability is the quality of being able to do something; physical, mental, financial or legal power to perform (Carroll, 1987).

Problem Solving Ability

Problem solving ability is a person's ability to obtain a solution or way out of a goal that is not easy to achieve (Polya, 1957).

Mathematical Problem Solving

Mathematical problem solving is the process of applying previously acquired mathematical knowledge to new, unknown situations (Rahmat, 2020).

Intelligence

Intelligence may be defined as the ability to do something with facility, speed and adequacy (Colendrino-Bucu, Guerrero, Pascual & Mateo, 1997).

Logical Mathematical Intelligence

Logical mathematical intelligence is the ability to effectively use numbers and solve problems (Breaux & Magee, 2010).

Significance of the Research

In Myanmar, the new curriculum for basic education is well designed with greater focus on learning concepts, problem solving process and understanding of basic principles and reasons behind the knowledge (Ministry of Education [MoE], 2016). This means that it is important for the students to develop problem solving ability in order to face the challenges of a changing world. This study can contribute for the curriculum developers, mathematics teachers, students and teaching and learning process. Firstly, curriculum developers take into account the aspect of problem solving ability and logical mathematical intelligence of students and design to include various types of mathematics problems that can be solved by the students having different types of problem solving abilities and different levels of logical mathematical intelligence. Secondly, this study can provide mathematics teachers for their effective teaching. Therefore, the teachers need to advocate students with different types of problem solving abilities and different levels of logical mathematical intelligence to become genius and the teachers need to prepare a wide variety of learning activities for the students. Consequently, the students have to learn by using five senses to accommodate to the teachers' teaching. As a result, there will be productive teaching learning process and the students can acquire soft skills needed for 21st century. Hence, this study is very significant and can give profound effects for education.

Review of Related Literature

Philosophical Foundations of Problem Solving Ability and Logical Mathematical Intelligence of Middle School Students

This study was based on philosophical foundations of constructivism and cognitivism.

Constructivism. Ozmon and Craver (2003) say that constructivist learning is based on students' active participation in problem solving and critical thinking regarding a learning activity. Students construct their own knowledge by testing ideas and approaches based on their knowledge and experiences, applying them to new situation and integrating new knowledge gained with preexisting intellectual constructs. Piaget's cognitive constructivism also implies that

the teachers must look at the students' ability to solve problems in order to understand how children think. Vygotsky sees teachers and peers as living representations. Teachers are considered as means of transition of knowledge of a particular culture. During this process, students are encouraged to develop meta cognitive skills such as reflective thinking and problem solving techniques in constructive approach unlike the traditional method of learning (Brooks & Brooks, 1993).

Cognitivism. Cognitivism is a theory of learning that began in cognitive psychology. It argues that learning requires the use of memory, reflection, thinking, abstraction, metacognition and motivation. Montague, Warger and Morgan (2000) believe that cognitive processes incorporate the activities of reading, paraphrasing, visualizing, hypothesizing, estimating, computing and checking out of the process. Moreover, they also offer another cognitive process. It incorporates some stages: comprehending linguistic and numerical information problems, translating that information into mathematical notations, algorithm and equation, observing relationship among the elements of the problems, formulating a plan to solve the problems, predicting outcome, regulating the solution path as it is executed and detecting and correcting errors during the problem solution. Cognitivism is important for problem solving ability and logical mathematical intelligence because it emphasizes information processing, problem representation, cognitive strategies, metacognition and the transfer of learning. By understanding and applying cognitive process effectively, learners can enhance their problem solving ability, logical mathematical intelligence and become adept at solving complex problems in a wide range of domains.

Theoretical Foundations of Problem Solving Ability of Middle School Students

This study was based on Polya's problem solving theory, Schoenfeld's mathematical problem solving theory and Gardner's theory of multiple intelligence.

Polya's problem solving theory. Problem solving ability is a very important ability. Students must be able to understand the problem and might be able to face real life. Problem solving requires understanding the problems situation and need to make decision which direct individual understanding (Daulay & Ruhaimah, 2019). One way to improve problem solving ability is to teach learning theory that can be used to solve problem, namely Polya's theory. The four principles introduced by Polya (1957) are: understanding the problem, devising the plan, carrying out the plan and looking back. Polya's prescription for solving problems consist of four steps that use the 3R's (Request, Response, Result) of problem solving and the verification of the result.

Schoenfeld's mathematical problem solving theory. In most classes of secondary education, mathematics teachers teach students to solve mathematics problems by having them copy standard solutions methods provided by the textbooks. Schoenfeld (1992) states that students need to learn to define goals and to self-regulated their problem solving behavior in order to improve solving of non-standard mathematics problems. Schoenfeld (1985) observes that during problem solving, students display distinct categories of behaviors. These are called episodes. Crucial episodes are analyzing the problem, selecting appropriate mathematical knowledge, making plan, carrying it out, checking the answer against the question asked. According to Schoenfeld (1985), four categories of knowledge or skills are needed to be

successful in mathematics namely (1) resources: proposition and procedural knowledge of mathematics, (2) heuristics: strategies and techniques for problem solving such as working backwards or drawing figures, (3) control: decision about when and what resources and strategies to use and (4) beliefs: a mathematical "world view" that determines how someone approaches a problem.

Gardners' theory of multiple intelligence. The theory of multiple intelligence (MI), developed by psychologist Howard Gardner in the late 1970s and early 1980s, posits that individuals possess eight or more relatively autonomous intelligences. These intelligences include linguistic intelligence, logical mathematical intelligence, spatial intelligence, musical intelligence, bodily kinesthetic intelligence, naturalist intelligence, interpersonal intelligence and intrapersonal intelligence (Gardner, 2006). Logical mathematical intelligence is the capacity to use number effectively and to reason well (Armstrong, 2009). This intelligence includes sensitivity to logical patterns and relationships, statements and propositions, functions and other related abstractions. It is important for problem solving and mathematics education. By recognizing and nurturing this intelligence, educators and individuals can promote inclusive education, enhance problem solving skill and encourage a broader understanding of intelligence beyond traditional measure.

Problem Solving Ability

Polya (1957) states that problem solving ability is a person's ability to obtain a solution or way out of a goal that is not easy to achieve. According to National Council of Teachers of Mathematics (NCTM, 2000), problem solving is the basic foundation of school mathematics. Unless the students possess the ability to solve problems, the usefulness and power of mathematical ideas, knowledge and skills are severely limited.

Impulsive problem solving ability. According to D'Zurilla and Nezu (2010), impulsive or careless problem solving ability is a dysfunctional problem solving ability characterized by active attempts to apply problem solving procedures and techniques, but these attempts are narrow, impulsive, careless hurried and incomplete. A person with this problem solving ability generally consider only a few alternatives.

Reflective problem solving ability. Students with reflective problem solving ability anticipate the consequences of each alternatives and compare each other when making a decision for solving problems. In the problem solving process, students with reflective problem solving ability try to consider the problem situation, collect the necessary information to solve, make decision and reflect on the whole process (Richards, 2015).

Confident problem solving ability. Confidence is necessary for the process of problem solving. It is a firm belief in personal abilities. Critical thinkers and good problem solvers are confident in their abilities and believe that they can do the best in whatever situation. When they encounter problem situation, confident people often expect that they can handle the problem well (Wandberg, 2010).

Avoidant problem solving ability. Avoidant problem solving ability is a dysfunctional one. People with this type of problem solving ability do nothing when they confront the problem situations. They act as if a problem does not exist or they are not concerned with the problems. Such people act passive, inactive, dependent and procrastinating behaviors.

Monitoring problem solving ability. Monitoring serves a foundation for problem solving ability and it is important for successful problem solving. This is why complex problem solving includes a high level of uncertainty, temporally unfolding events and evaluating the effectiveness of the strategies (Phang ,2009).

Planful problem solving ability. Planful problem solving ability is the conductive approach involving the systematic and planful application of the following set of skills (Nezu, Nezu, Ricelli & Stern, 2015).

Logical Mathematical Intelligence

Logical mathematical intelligence is the capacity to use numbers effectively and to reason well. This intelligence involves the sensitivity to logical patterns and relationships, statements and propositions, functions and other related abstractions. People with this intelligence can perform the process like categorization, classification, inference, generalization, calculation and hypothesis testing (Armstrong, 2009).

Research Method

Research Design

The research design adopted in this study was the descriptive (survey) design.

Procedure

Firstly, the problem was formulated. Then, related literature for this study was collected from various resources. Secondly, instrument for this study was constructed, conducted expert review and validated through pilot test. The internal consistency (Cronbach's Alpha) was 0.779. Then, modified instrument was distributed to all participants on 1st October, 2023. After collecting the data, the data were analyzed by using the Statistical Package for Social Science (SPSS 22).

Instrument

The instrument for problem solving ability was constructed in accordance with six dimensions such as impulsive, reflective, confident, avoidant, monitoring and planful problem solving ability. Confident problem solving ability consists of five items while each of the remaining five dimensions has four items. Therefore, 25 items were included in the six dimensions of instrument for problem solving ability. The questionnaire for logical mathematical intelligence includes 25 items. The items were constructed on five-point Likert scales ranging from strongly disagreed to strongly agreed. Finally, eight open-ended questions were used to investigate the ideas and opinions about problem solving ability and logical mathematical intelligence of middle school students.

Population and Sample Size

This study was conducted in Nattalin District, Bago Region (West). All participants in this study were Grade Eight students of 2023-2024 Academic Year. There were 4136 Grade Eight students in Nattalin District and 450 students were selected by using simple random sampling method. Therefore, the population and sample size are presented in Table 1.

Table 1 Population and Sample Size

No.	District	No. of Population	No. of Participant
1	Nattalin	4136	450

The number of participants from the four townships are presented in Table 2.

Table 2 Number of Participants from the Four Townships

No.	District	Township	No. of Participant
1	Nattalin	Thae Gone	153
		Paungde	72
		Nattalin	133
		Ze Gone	92
Total			**450**

Data Analysis

The data was analyzed by using descriptive statistics (mean, standard deviation, frequency and percentage,) and inferential statistics (Pearson product-moment correlation).

Findings

Findings of Problem Solving Ability of Middle School Students

According to the participants' responses, the mean scores of impulsive, reflective, confident, avoidant, monitoring and planful problem solving ability of middle school students are presented in Table 3.

Table 3 Mean Scores of Problem Solving Ability of Middle School Students

Dimension of Problem Solving Ability	Mean Score	Standard Deviation	Minimum	Maximum	Percentage (%)
Impulsive	10.60	3.12	5	18	35.4
Reflective	15.33	2.27	7	20	62.9
Confident	18.83	2.79	10	24	77.4
Avoidant	8.44	3.53	4	19	17.9
Monitoring	15.77	2.49	5	20	64.8
Planful	15.04	2.54	7	20	61.8

According to the data presented in Table 3, it can be interpreted that the mean score of avoidant problem solving ability (8.44) is the lowest and that of confident problem solving ability (18.83) is the highest among the problem solving abilities. And the remaining problem solving abilities also have their respective proper mean scores.

Findings of Logical Mathematical Intelligence of Middle School Students

To investigate the logical mathematical intelligence of the middle school students, descriptive statistics (mean, standard deviation and percentage) was used to analyze the responses in this questionnaire. Table 4 presents the mean score of logical mathematical intelligence of the middle school students.

Table 4 Mean Score of Logical Mathematical Intelligence of Middle School Students

Dimension	Mean Score	Standard Deviation	Minimum	Maximum
Logical Mathematical Intelligence	91.44	11.43	52	120

According to the data presented in Table 4, the mean score and standard deviation were (91.44) and (11.43) respectively. And then (+1) standard deviation to the mean and (-1) standard deviation from the mean were carried out. Therefore, the scores less than (80.01) are grouped as low level, the scores between (80.01) and (102.87) are grouped as moderate level and the scores higher than (102.87) are grouped as high level of logical mathematical intelligence. Therefore, the level of logical mathematical intelligence of middle school students are described in Table 5.

Table 5 Levels of Logical Mathematical Intelligence of Middle School Students

Level	Score	No. of Students	Percentage (%)
Low	$x < 80.01$	76	16.8
Moderate	$80.01 \leq x \leq 102.87$	295	65.6
High	$x > 102.87$	79	17.6
Total		**450**	**100**

According to the results from Table 5, (16.8%) of the students possess low level of logical mathematical intelligence, (65.6%) of the students possess moderate level of logical mathematical intelligence and (17.6%) of the students possess high level of logical mathematical intelligence. Therefore, it can be interpreted that more than half of the students possess moderate level of logical mathematical intelligence and the number of students who possess high level of logical mathematical intelligence is a little bit more than the number of students who possess low level of logical mathematical intelligence.

Relationship between Problem Solving Ability and Logical Mathematical Intelligence of Middle School Students

Pearson's product-moment correlation coefficient was used to determine the relationship between problem solving ability and logical mathematical intelligence of middle school students. The result is presented in Table 6.

Table 6 Correlation between Problem Solving Ability and Logical Mathematical Intelligence of Middle School Students

Variable		Problem Solving Ability	Logical Mathematical Intelligence
Problem Solving Ability	Pearson Correlation	1	.464**
	Sig (2-tailed)		.000
	N	450	450
Logical Mathematical Intelligence	Pearson Correlation	.464**	1
	Sig (2-tailed)	.000	
	N	450	450

Note. **Correlation is significant at the 0.01level (2-tailed).

Table 6 indicated that there was a correlation (r = .464). Therefore, it can be interpreted that there was a moderate positive correlation between problem solving ability and logical mathematical intelligence of middle school students.

Findings of Students' Ideas and Opinions of Problem Solving Ability and Logical Mathematical Intelligence

The questions for getting the ideas and opinions of problem solving ability and logical mathematical intelligence were composed of eight open-ended questions. The first six open-ended were intended for receiving extra information about impulsive, reflective, confident, avoidant, monitoring and planful problem solving ability of the middle school students. The last two questions were intended for receiving extra information about their logical mathematical intelligence. The most answered responses of the eight questions are presented in Table 7.

Table 7 Percentage of Students' Ideas and Opinions of Problem Solving Ability and Logical Mathematical Intelligence

Category	*N*	Frequency	Percentage (%)
Never do impulsive activity	450	213	47.33
Using theorems, corollaries and properties	450	200	44.44
Calming down and computing quickly	450	118	26.22
Understanding the problems thoroughly	450	187	41.56
Brainstorming	450	314	69.78
No difficulties	450	244	54.22
Solving problem quickly and easily	450	275	61.11
Studying	450	128	28.44

Table 7 showed that 47.33%of the students do not perform impulsive manner in solving mathematical problems, 44.44% of the students have to use previously learned theorems, corollaries, properties and concepts in solving new problems and 26.22% of the students make themselves to calm down and solve quickly by skipping unnecessary steps. Moreover, 41.56% of the students want to solve the problem by themselves because they understand the problems thoroughly. Surprisingly, 69.78% of the students can solve the problems by brainstorming their ideas. Besides, 54.22% of the students never encounter difficulties and challenges in solving the problem. Furthermore, 61.11% of the students like computers or calculators because they can solve the problems quickly and easily. Finally, 28.44% of the students apply their logical mathematical intelligence for planning different activities. According to the data presented in Table 7, the percentage of ideas and opinions of problem solving ability and logical mathematical intelligence is illustrated in Figure 1.

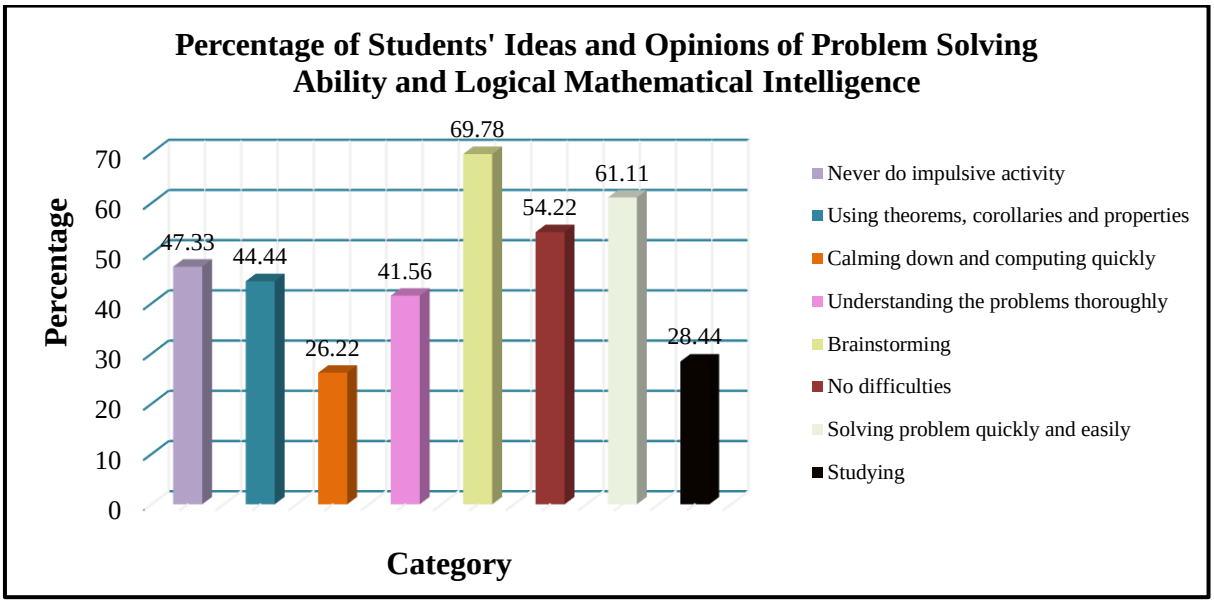

Figure 1 Percentage of Students' Ideas and Opinions of Problem Solving Ability and Logical Mathematical Intelligence

Summary of Research Findings

The findings of this study are summarized as follows.

1. The study found that the mean score of confident problem solving was the highest and that of avoidant problem solving ability was the lowest among impulsive, reflective, confident, avoidant, monitoring and planful problem solving ability.
2. Finding of the extent of logical mathematical intelligence showed that most of the students possess moderate level of logical mathematical intelligence and the number of students who possess high level of logical mathematical intelligence was a little bit more than those who possess low level of logical mathematical intelligence.
3. Problem solving ability was moderately correlated with logical mathematical intelligence of middle school students (r = .464).
4. The results of eight open-ended questions indicated that some students skip the steps and get wrong answers while solving problems, they have to use previously learned concepts, they can manage challenging problems by calming down their mind and by using self-monitoring activities but sometimes face difficulties according to misunderstanding and nearly all students use their logical mathematical intelligence for making various activities.

Discussion

According to the research finding of problem solving ability of middle school students, the mean score of impulsive problem solving was (10.60), that of reflective problem solving ability was (15.33), that of confident problem solving ability was (18.83), that of avoidant problem solving ability was (8.44), that of monitoring problem solving ability was (15.77) and that of planful problem solving ability was (15.04). The result showed that the mean score of confident problem solving ability is the highest and that of avoidant problem solving ability is the lowest among impulsive, reflective, confident, avoidant, monitoring and planful problem solving ability of middle school students.

The second research question is to investigate logical mathematical intelligence of middle school students. According to the result, most of the students possess moderate level of logical mathematical intelligence and the number of students who possess high level of logical mathematical intelligence was a little bit more than those of students who possess low level of logical mathematical intelligence. Therefore, it can be interpreted that more than half of the students possess moderate level of logical mathematical intelligence and they can think abstractly, logically and conceptually. Moreover, they can discern logic and reason while carrying out mathematical operations or solving complex problems. Likewise, they understand mathematical concepts, identify patterns create logical pathways and apply systematic approaches for solving problems. Besides, they can break down complex problems into manageable steps, facilitating a more structured and efficient problem solving process. In addition, students who possess moderate and high level of logical mathematical intelligence perform well in the subjects like mathematics and science. Moreover, they can solve complex problems by using their abilities and systematic approaches to various challenges.

The third research question is to investigate the relationship between problem solving ability and logical mathematical intelligence of middle school students. The result showed that there was a significant correlation (r = .464) between problem solving ability and logical mathematical intelligence, and the direction of correlation was positive. Therefore, it can be interpreted that problem solving ability has moderately correlated with logical mathematical intelligence of middle school students.

The fourth research question is to investigate students' ideas and perspective about problem solving ability and logical mathematical intelligence. The result showed that 47.33% of the students did not perform impulsive manner in solving mathematical problems, 44.44% of the students answered that they had to use previously learned theorems, corollaries, properties and concepts in solving new problems and 26.22% of the students answered that they made themselves to calm down and solve quickly by skipping unnecessary steps and they were confident their ability when they encountered to solve problems in a small amount of time. Furthermore, 41.56% of the students can solve the problems by themselves as a consequence of understanding the problems thoroughly. Moreover, 69.78% of the students can solve the problems by brainstorming. Besides, 54.22% of the students encountered difficulties and challenges in solving the problem but they can reflect previously learned concepts and solved till the correct solution was received. Furthermore, 61.11% of the students like to use computers and calculators in order to solve the problems quickly and 28.44% of the students applied their logical mathematical intelligence for planning different activities.

Suggestions

From the findings of problem solving ability of middle school students, 35.4% of the students possess impulsive problem solving ability. Therefore, curriculum developers should design the curriculum that includes interactive workshops and encourage students to think critically. Moreover, the school administrators should invest in professional development for teachers. In addition, mathematics teachers should use real-life scenarios and problems that students can relate their mathematics problems to their real-life situations.

Moreover, 62.9% of the students possess reflective problem solving ability. Therefore, the curriculum developers should design the curriculum that can help the students to visually map out problems, relationships and solutions by reflecting on information. Likewise, the school administers should support differentiated learning. Furthermore, mathematics teachers provide constructive feedback on students' problem solving approaches. In addition, parents should encourage their children to think critically and ask questions about the world around them.

In addition, 77.4% of the students possess confident problem solving ability. Therefore, the curriculum developers should plan the mathematics curriculum starting with a solid understanding of fundamental concepts ensuring a strong foundation for problem solving. Additionally, mathematics teachers should ask open-ended questions that require students to think critically and explore different solutions.

According to the result of problem solving ability of middle school students, 17.9% of the students possess avoidant problem solving ability. In order to help students with avoidant problem solving ability, the curriculum developers should integrate real-life problem solving scenario relevant to students' experience by making the content more engaging and applicable.

According to the results from the finding of problem solving ability of the middle school students, 64.8% of the students possess monitoring problem solving ability. Therefore, curriculum developers should integrate formative assessments throughout the curriculum to continuously monitor students' progress. In addition, the school administrators should celebrate achievements of students.

In addition, 61.8% of the students possess planful problem solving ability. Therefore, curriculum developers should develop curriculum content including real-world problems. This help students apply planful problem solving skill to situations they may encounter in their future careers. Moreover, mathematics teachers should use variety of resources including textbooks, online tools, diagrams and charts to cater to different learning styles. Additionally, parents should introduce age-appropriate mathematics books and resources that make mathematics to be more interesting. Furthermore, parents should consider to enroll in mathematics competitions or clubs like mathematics Olympic if their children show an interest in mathematics.

According to the research findings of the extent of logical mathematical intelligence of middle school students, most students (65.6%) possess moderate level of logical mathematical intelligence and the number of students who possess high level of logical mathematical intelligence (17.6%) is a little bit more than the number of students who possess low level of logical mathematical intelligence (16.8%). Therefore, the mathematics teachers should assign projects that require students to apply their mathematics and problem solving skill to research and create something meaningful. And then, the teachers should ensure consistent practice with a mix of easy, moderate and challenging problems to strengthen problem solving ability over time.

The result of the findings of students' ideas and opinions of problem solving ability and logical mathematical intelligence of middle school students also revealed that students solved mathematical problems on their own in order to improve their abilities and to memorize the previously earned materials. Therefore, mathematics teachers should provide constructive feedback on students' problem solving approaches and the teachers should highlight both correct and incorrect methods. In order to make the students to be interested in mathematics, the teachers

should show how mathematics is used in real world professions and encourage students to explore mathematics related careers. Additionally, mathematics teachers should ask open-ended questions that require students to think critically and explore different solutions. This fosters logical thinking. Besides, mathematics teachers should encourage group work that can encourage students to collaborate, discuss ideas and learn from each other's problem solving strategies. Furthermore, mathematics teachers should use variety of resources including textbooks, online tools, diagrams and charts to cater to different learning styles and enhance their understanding and employ questioning techniques to guide students in thinking step by step and solving problems on their own.

Recommendations

This study was carried out in basic education high schools, high schools (branch) and middle schools in Nattalin District, Bago Region (West). This cannot completely cover the overall areas of Bago Region and of Myanmar. Similar studies should be carried out in other districts, states and regions of Myanmar within rural and urban settings. The sample size in this study was limited to (450) students. Similar study with different sample size should be conducted. The selected students in this study were middle school students. The replication of study should be conducted with other school level. Problem solving ability and logical mathematical intelligence of middle school students were studied by using questionnaires. Further study should be conducted by using problem solving ability tests, logical mathematical intelligence tests, interviews and observations. More than six dimensions should be used for studying problem solving ability and more than one dimension should be used for studying logical mathematical intelligence of middle school students.

Therefore, it can be hoped that this study will support not only for the further researchers but also for the curriculum developers, mathematics teachers, students and teaching learning process.

Conclusion

To sum up, this study will help curriculum developers to design various types of mathematics problems that can be solved by the students who possess different types of problem solving ability and varying levels of logical mathematical intelligence. Furthermore, this study can provide mathematics teachers for their effective teaching. Thus, the teachers need to advocate those students to become genius and the teachers need to prepare a wide variety of learning activities. Consequently, the students have to learn by using five senses to accommodate to the teachers' teaching. Then, there will be productive teaching learning process and the students can acquire soft skills needed for 21st century. Moreover, a new curriculum for basic education in Myanmar is well designed with greater focus on learning concepts, problem solving process and understanding basic principles and reasons behind the knowledge (Ministry of Education [MoE], 2016). According to this statement, problem solving ability, logical reasoning and reflective thinking are essential for the teaching and learning process and education system in Myanmar is looking for the best practices for the students to cope well with the problems in their everyday lives. Therefore, this study will contribute to some extent for effective mathematics teaching and learning process at the basic education level.

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