

Problem-Solving Heuristic in Mathematics Subject of Senior High School Learners

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Abstract - *This study involved mixed methodology wherein quantitative and qualitative data were analyzed. Set of basic mathematical problems test with different levels of difficulty was developed to be solved by the respondents to determine their problem-solving ability. Another set of a mathematical problem composed of different types of routine and nonroutine problems was developed to be solved by selected students to determine the metacognitive behavior while solving the problems. A set of self-monitoring questionnaires was also developed to gather data regarding their behaviour on problem-solving. The set of self-monitoring instruments was adopted from Schoenfeld's (1987) on mathematical thinking during problem-solving. Some of the items in the questionnaire were deleted and revised to make it appropriate for the present study. There were items added that the researcher thought was important to better understand the behavior of the students during problem-solving. Another checklist was developed to determine the different problem-solving heuristics employed by the students in solving problems.*

Key Words: *Problem Solving, Mathematics, Learners, Senior Highschool, Heuristic*

INTRODUCTION

Mathematics is one of the most interesting and challenging subjects. It is considered as the key in developing students to become critical thinkers,

good problem solvers and wise-decision makers. However, it is depressing to note that in a class of 50 students, only 10 percent of the students find Mathematics as interesting one, instead, they considered it dry, abstract and very hard. Many of the students hate the subject especially if the topic is application of concepts or if the topic is mathematical problem solving.

Institute Education Sciences (IES) National Center for Education Statistics pointed out on their report that the Philippines ranked third in Mathematics but from the bottom in the Trends in International Mathematics and Science Study conducted in 2003. This decline in the standard of education and the deterioration of achievements in Mathematics is becoming a major problem of all the educators especially the mathematics teachers because the teachers are often affected for the dismal feature of education. The low performance of the students in the TIMMS according to mathematics experts was due to the poor performance of the students in Mathematical problem solving.

In this present situation of the mathematics educational system, mathematics teachers, whose main goal is to provide students with opportunities to become active, critical thinkers and great problem solvers and whose responsibility is to mold, encourage, guide and develop our students to perform their utmost capability, must keep abreast with all the changes in the field of education to

provide our students a learning activities that make them successful in their chosen field and to become globally competitive. Teachers have to give them a high quality education through effective teaching methods and techniques. Although, there are many factors that affect the Mathematics teaching-learning process many researches today suggest that the teachers must focus their instruction on number sense and in the process of learning Mathematics.

For the last few years of teaching in Nueva Ecija High School, the researcher witnessed that most of the Mathematics classes were dull for they were more on teacher's activities. The teachers were focusing their instruction in teaching the basic mathematical skills and concepts. Mathematical problem solving which is the heart of mathematics education is being neglected and skipped by majority of the Mathematics teachers especially those teachers handling middle and lower sections. Thus, the students must not even aware of different problem solving heuristics which are necessary in order to solve different kinds of routine and nonroutine Mathematical problems. In addition to that, mathematical problems presented to the students were focus only on applying basic concepts in Mathematics rather than problems that require critical and higher order thinking skills that requires making them good problem solvers and being globally competitive.

LITERATURE REVIEW

Chan Chun & Mansoor (2007) in their study "Metacognitive behaviours of Primary 6 Studnets in Mathematical problem Solving in a Problem-Based Learning Setting" stated that metacognitive thinking has been very much related to the application of mathematical reasoning and academic skills as well. They added that Problem-based Learning setting can be an appropriate platform for problem solving. Its key features of task complexity, group collaboration and teacher-scaffolding can be powerful means to enhance social interaction, mathematical reasoning and metacognitive thinking.

In the study "Evaluating and Improving the Mathematics Teaching-Learning Process through Metacognition", Desoete (2007) emphasized that metacognitive skills were found to be trainable. Students could learn to adopt a more orienting and self judging learning approach, even through a very short metacognitive training. He also stated that metacognitive training improved pupil performance in mathematical problem solving and was found to have a sustained effect on mathematical problem solving. He also added that, although teachers still pay too little attention to the explicit teaching of metacognitive skills several studies point to the fact that metacognition needs to be taught explicitly in order to develop and to enhance mathematical problem solving skills.

Patricia Goldberg (2003) in her study entitled "Using Metacognitive Skills to Improve 3rd Graders' Math Problem Solving" emphasized that teaching centered on metacognitive strategies helps the learners to become good problem solvers. He also revealed that instruction in metacognition may have a positive impact on students' performance in problem solving. The students learned to monitor their thinking more often during problem solving process. Students receiving instruction in metacognitive skills increased their planning and evaluation skills and the problem solving performance improved throughout the process and most importantly the students improved in the area of understanding.

Polina Biryukov of Israel in her research entitled "Metacognitive Aspects of Solving Combinatorics Problems" confirmed that metacognition is important mathematical problem solving. His study revealed that metacognitive behavior, expressed in constructing a schematic model of the given condition of the problem and building a solution strategy is crucial for successful problem solving. He added that metacognition provides a more promising platform to set goals, and to perform actions to achieve those goals to achieve goals, during problem solving. He also emphasized that the development of reflection and metacognition must be in the focus of instruction for it helps students to become effective problem solvers.

Denis Abao Tan in his paper “Senior High School Students’ Use of Metacognitive Skills in the Mathematical Problem Solving Heuristics revealed that the multi-distinct yet related processes could serve as a grounded frame of reference in which students do mathematical problem solving. These multi-distinct related processes are: 1) understanding the problem through sense-making, organizing and constructing useful information from the problem, 2) planning solution strategies by identifying conjecture and selecting strategies, 3) executing the plan, 4) checking the process and strategies undertaken, and 5) reflecting and extending the problem.

METHODOLOGY

This study involved mixed methodology wherein quantitative and qualitative data were analyzed. Set of basic mathematical problems test with different levels of difficulty was developed to be solved by the respondents to determine their problem solving ability. Another set of mathematical problem which is composed of different type of routine and nonroutine problems was developed to be solved by selected students to determine the metacognitive behavior while solving the problems. The respondents in this study will come from the bracket A Sections of Fourth Year students in Nueva Ecija National High School, school year 2010-2011. A sample of 120 students selected randomly from 480 bracket A sections participated in this study.

RESULTS AND DISCUSSION

Problem solving topic in mathematics is the most hated topic of the students. Math scores of the students were affected if there are mathematical problem solving that are included in the test. Factors affecting this dismal feature of mathematical problem solving are the main concern of this study. Thus, the researcher gathered data and information for analysis to remedy this dilemma in Mathematics education.

Before further testing and analysis, the problem solving ability of the students were tested.

Table 1: Problem Solving Ability of the Senior High School Students

Level of Achievement	Number of Respondents	Percentage
Low Below 80	74	61.67
Moderate 80 - 90	39	32.50
High Above 90	7	5.83
Total	120	100

The table 1 on page indicated that 61.67 percent or 74 of the respondents did not perform well in the mathematics problem ability test. It also indicated the 39 of the respondents belongs to moderate level and only 5.83 percent or 9 of the respondents performed well in the test.

Based on the result of the test, majority of the students were able to solve the problems of the 1st and 2nd level of difficulty only. Only few of the respondents were able to solve problems in the 3rd and 4th level of difficulty.

Based on the results of the students’ performance in the test, the researcher selected purposively 15 respondents among 120 respondents. Fifteen samples were selected from each of the level, 5 from low performer, 5 from moderate performer and 5 from high performer students.

Set of 10 items routine and nonroutine problem test were given to the 15 purposive samples to observe the process they made as well as their behavior while solving the problems. After that, set of checklist to determine the problem solving heuristics they employed while solving the nonroutine mathematical problems and it was followed by giving them a self-monitoring questionnaire indicating their metacognitive behavior before, during and after solving the problems.

One of the factors that help the students to improve their problem solving performance is the

familiarity with different problem solving strategies or heuristics.

Table 2: Problem Solving Heuristics Employed by the Respondents

Problem Solving Heuristics	yes	Maybe	No
Trial & Error	8	2	2
Draw a Diagram	24	0	1
Make a Table/List	13	1	1
Look for Pattern	10	5	1
Test & Simulate	8	0	10
Working Backward	0	0	15
Act it Out	0	3	12
Use common sense/Logic	17	10	1
Look for a clue	9	5	5
Skip counting	9	2	3

Table 2 above presented the problem solving strategies employed by the respondents in solving the given nonroutine problem to them. Multiple responses were indicated for the respondents can use one strategy for one or more problems in the test. Based on the table, the most common strategies used by the respondents were: draw a diagram in item number 6, 7, 8, and 10 and the use of common sense/logic in item number 2, 3 and 5. All of the respondents did not use the working backward strategy and 12 respondents revealed that they did not use act it out strategies. Some of the respondents as shown on the table that they are not aware that they employed some strategies given in the checklist. It showed that they do not know well the strategies as well as how to use appropriately those strategies in particular problems. Lastly, the table indicated that some of the respondents were aware of the listed strategies and they applied them on some items in the given routine problems.

The data gathered from the self-monitoring questionnaire that corresponds to the 5 steps-procedure of problem solving by Krulik and Rudnic (1996) were analyzed using factor analysis.

CONCLUSION

Based on the results and discussion, the following conclusions were drawn.

First, problem solving is one of the areas in mathematics that teachers and students have difficulty. It really affects the performance of the students in mathematics. It is shown in the study for the majority of the senior students in the Nueva Ecija High School were in the low level of performance in Mathematics. Second, achievement in problem solving were affected by some of the factors such as basic mathematical skills, problem solving skills which includes problem solving strategies and metacognitive skills which focus on the behavioural process of solving the problem. Third, senior students were aware of many problem solving heuristics, however, the most common strategies used by the students are draw a diagram/tables or model and use of common sense/logic. Working backward is the only strategy that the students are not familiar with.

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