Problem Solving Processes of Mathematically Skilled Filipino Students

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Abstract: ***This phenomenological study aimed to develop better understanding of problem solving processes of first year mathematically skilled teacher education students at the Laguna State Polytechnic University, Los Baños Campus, LosBaños Laguna. Eight (8) First Year Teacher Education students were chosen as the participants of this study. They were selected based on their academic standing in the preliminary and midterm grading period in Mathematics I (Fundamentals of Mathematics).The researcher conducted interviews, discussions and participant observation, and representing it from the perspective of the research participants. Qualitative analysis of the study resulted in two groups of students: Group A included four students who were successful in discovering the solutions of the given problem while Group B is composed of another four students who were not able to solve the problem correctly.Group A students conform with the expected problem solving processes which include understanding the problem, devising a plan through representation, carrying out the plan using appropriate algorithms and looking back or checking if the solution works. On the other hand, Group B is also considered as skilled math students but failed to use any illustration that will guide them as they go along with the problem. It can be concluded that being skilled in mathematics does not guarantee that one is a good problem solver too. Students need explicit instruction on how to use visualization to represent problems. They should be reminded that in using both verbal translation and visual representation, they are not only guided toward understanding the problem, but they are also guided toward developing a plan to solve the problem and thus, become a better problem solver. The Mathematics instructor needs to assess the problem solving processes of non-skilled mathematics students so that their strengths and weaknesses will be determined. In doing so, more appropriate teaching strategy can be applied.***

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1. Introduction

The National Council of Teachers of Mathematics has identified problem solving as one of the five fundamental mathematical process standards along with reasoning and proof, communication, connections, and representations (National Council of Teachers of Mathematics [NCTM], 2000). “Problem solving is the foundation of all mathematical activity” (Reys, Lindquist, Lambdin, Smith, & Suydam, 2001). “In order to function in our complex and changing society, people need to be able to solve a wide variety of problems. The elementary math curriculum must prepare children to become effective problem solvers” (Burns, 2000). Problem solving shouldn’t be a separate process, but rather the context within which students learn math skills and concepts (Zemelman, Daniels, & Hyde, 1998). Although problem solving is an integral part of all mathematics, many students struggle with solving problems. In fact, students’ “ability to solve word problems falls far below their ability to compute” (Burns, 2000). Research shows that this discrepancy is not because children have poor computation or reading skills, but because children “do not know how to choose the correct operation to apply to the problem” (Burns, 2000).

Greenes (1981) claimed that mathematically gifted students differed from the general group in their abilities to formulate problems spontaneously, their flexibility in data management, and their ability to abstract and generalize. There is also empirical evidence of differences in generalization in gifted and non-gifted learners at the primary and secondary levels (Kanevsky, 1990; Sriraman, 2003; Heinze, 2005). However, quite a few studies at the tertiary level focus on the problem solving processes of math skilled students in Mathematics.

Analyzing and describing the problem solving experiences of the students will support learning by making the mathematics curriculum in tertiary education more specific and meaningful.

This study sought to assess the problem solving processes in which the first year teacher education students are engaged.

2. Materials and Methods

Phenomenological research design was used in the study. Phenomenological approach gathered deep information through inductive, qualitative methods such as interviews, discussions and participant observation, and representing it from the perspective of the research participants (Lester, 1999).

This study made use of a purposive sampling technique. Eight first year respondents came from the College of Teacher Education of the Laguna State Polytechnic University – Los Baños Campus. They comprised the upper 5% of the total population of freshmen students enrolled in the Fundamentals of Mathematics subject during the first semester Academic Year 2011-2012.

One non-routine mathematics word problem was used.The problem was chosen with great care and represented situations that would facilitate representation, reasoning, abstraction, and eventually the formulation of their own strategy.

The time they started and ended solving the problem was recorded to compare skilled students’ speed in finding solutions to the given problem. Erasures, if any, in their written solutions were observed. The researcher asked the students to record everything they tried, including scratch work for analysis.

Respondents were given three cues to initiate the four processes of problem solving:
1) Restate the problem in your own words. In other words, what is the problem asked?
2) How would you begin solving the problem?
3) Solve the problem.

Full credit was given to all students for completing the three cues and including all their work. The respondents were told to work on the problems independently. Data were collected through researcher's observations, students' written solutions, and interviews. The researcher collected the output and read the solutions developed by the students.

Respondents were interviewed using the following questions:
1) How did you start the problem?
2) How long did you spend on this problem?
3) How can you be sure that your solution is correct?
4) Did you use a known procedure to solve the problem?

The interviews were open-ended with the purpose of getting them to verbalize their thought processes while solving the given problem and elaborate their reasoning.

3. Results and Discussion

Qualitative analysis of the study resulted in two groups of students based on the problem-solving processes and strategies developed by the first year teacher education students who are good in Mathematics. Their names were coded for confidentiality purposes. GroupA included CArla, LArry, BARbie, and ZONny who were successful in discovering the solutions of the given problem. On the other hand, Group B is composed of MIke, MAry, ROse, and PAtrick, who were not able to solve the problem correctly. See table 1.

It can be seen in Table 1 that Groups A and B read and reread the problem for understanding. However only Larry and Zonny of Group A and Mary and Patrick of Group B were able to translate clearly what is asked in the problem.

All students in Group A drew rectangle and illustrated its length and width with appropriate label and none among the four students in Group B did such. In contrary with what the Group A performed, the non-representation of the problems of students in Group B didn't help them to find the correct answer of the given problem.

When Mike and Mary were asked why they failed to represent the problem using any diagram or illustration, the former said *"I focused on the translation using variables; I forgot to illustrate using diagrams"* while the latter stressed *"I just pictured it out in my mind Sir…"*

Mike and Mary from Group B were the only two students who did not try to check their answer. Mike revealed that *"I am not sure about my answer. I need to consult you first, Sir…"* Mary declared that *"I'm really not that sure with my answer Sir…"*

Table 1: Researcher's Observation on the Students' Problem Solving Processes

Problem Solving Processes	Problem Set	
	Indication of Group A	Indication of Group B
1. READ the problem for understanding. • *Have read the problem more than once and reread parts of the problem as they progress and think through the problem.*	All 4 students	All 4 students
2. PARAPHRASE the problem by putting it into their own words. • *Used self-regulation strategies by translating the given problem into their own words.*	Larry and Zonny	Mary and Patrick
3. VISUALIZING or drawing a picture or diagram. • *Developed a schematic representation of the problem.*	All 4 students	None
4. HYPOTHESIZE, by thinking about logical solutions and the types of operations and number of steps needed to solve the problem. • *Written the operation symbols as they decided on the most appropriate solution path and the needed algorithms they need to carry out the plan. Predicted the answer using written calculations.* ESTIMATE, COMPUTE • *Did the arithmetic and compared their answer with their estimate.*	All 4 students	All 4 students
5. CHECK • *Asked themselves if the answer makes sense and if they have used all the necessary symbols and labels* • *Checked if they used appropriate procedures and their answers were correct.*	All 4 students	Rose and Patrcik

The time consumed in solving the non-routine problem, the erasures and strategies are presented on the next table.

Table 2: Researcher's Observation on the Students' Problem Solving Processes

Respondents	Time Consumed (in minutes)	Erasures	Strategy	Output
Group A				
Carla	20	Not Observed	Guess and Check	It works
Larry	4	Observed	Algebraic	It works
Barbie	20	Not Observed	Guess and Check	It works
Zonny	6	Observed	Arithmetic	It works
Average: 12.5				
GROUP B				
Mike	8	Observed	Algebraic	It does not work

Mary	27	Not Observed	Arithmetic	It does not work
Rose	20	Not Observed	Guess and Check	It does not work
Patrick	16	Observed	Algebraic	It does not work
Average: 17.75				

The results show that GroupA students consumed an average time of 12.5 in solving the problem while the students from Subset B took 17.5 minutes in solving the same problem. It seems that since Subset A was able to understand, represent, solve and check the problem they finish their assigned task at a very considerable time compared to those students of Subset B.

Male respondents (Lary, Zonny, Mike, and Patrick) solved the problems faster than their female counterparts (Carla, Barbie, Rose, and Mary). Apparently, male are faster problem solvers than female in this particular study. Corollary to this, erasures were observed from male written solutions but not from females'. Hence, it can be assumed that carelessness in writing the solutions are dominated by male students.

Three students used Guess and Check but only two works, two students utilized Algebraic method but only one succeeded, and one of the two students who engaged in Arithmetic approach was able to find the solution of the problem. Regardless of the number of times they are used, all of the three strategies existed to both Subsets. This may imply that the adopted does not discriminate the good problem solver from poor problem solver.

4. Summary of Findings

Figure 1 below illustrates the salient findings of this study.

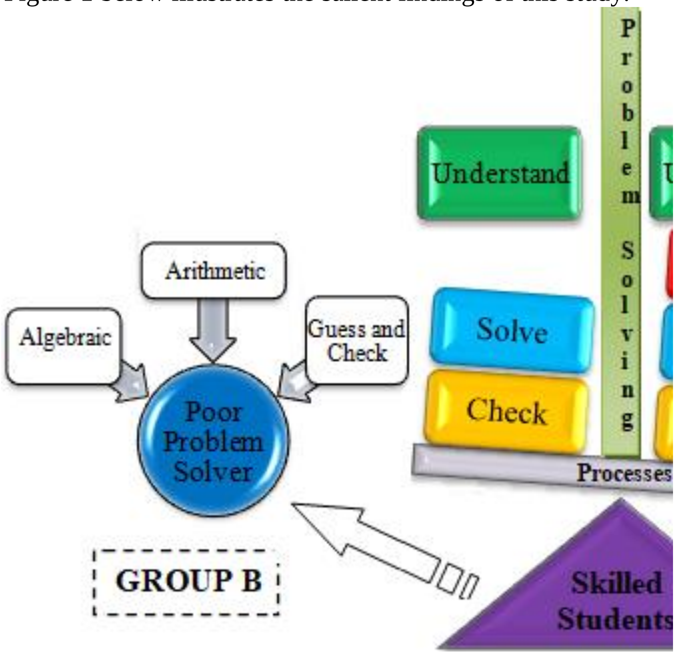

Figure 1: Skilled Students' Problem Solving Processes

It can be gleaned from Figure 2 that mathematically proficient students under study were subdivided into two, namely: Group A and Group B. Group t A are those proficient students who conform with the expected problem solving processes which include understanding the problem, devising a plan through representation, carrying out the plan using appropriate algorithms and looking back or checking if the solution works. On the other hand, Group B are those students who are also considered as proficient math students but failed to use any illustration that will guide them as they go along with the problem.

The figure symbolically suggests that complying with the four problem solving processes consume more weight and result to being a good problem solver just like what Group A students did. The way student consider their problem solving processes will justify whether they are good or poor problem solvers.

5. Conclusion

Fifty percent (50%) of the students under study do not develop the ability to use visual representation automatically during math problem solving which lead them to answer the second problem incorrectly. **It can be concluded therefore that being proficient in mathematics does not guarantee that one is a good problem solver too.**

6. Recommendations

These Group B students need explicit instruction on how to use visualization to represent problems. All of the students should be reminded that in using both verbal translation and visual representation, they are not only guided toward understanding the problem, but they are also guided toward developing a plan to solve the problem and thus, become a better problem solver. The Mathematics instructor should also assess the problem solving processes of non-proficient mathematics students so that their strengths and weaknesses will be determine. In doing so, more appropriate teaching strategy will be applied.

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