ABSTRACT

Mathematical concepts are useful to the extent that it can be applied to various practical situations. Specifically, non-routine problems were given emphasis in this study to understand education students’ dispositions, appreciations, and experiences in applying mathematics in practical life situations and, consequently, will employ a more personalized teaching technique which suits their mathematical learning styles especially in doing problem solving. Using the interpretive case study technique and phenomenological analysis, 62 education students of SLSU-Tomas Oppus shared their experiences in solving non-routine problems in mathematics through FGD, direct, and indirect interview. Positively, solving non-routine problems in mathematics intensifies their study habit, actualizes their creative skill, improves their strategic thinking skill, and develops their focus and mental discipline. Conversely, it discourages them because it is highly difficult, mentally and physically exhausting, and, lastly, their experience with the teacher is frustrating. These experiences intensify their desire to study individually, consult for experts/tutors, and conduct group study. Individually or in a group, when doing intense study, education students forget and release negative experiences in the solving non-routine problem and gain confidence of their outputs and products. Thus, whether the experience is positive or negative, it encouraged education students to strengthen their learning desire to solve the non-routine problem in mathematics.

Keywords: mathematics education, non-routine problems in mathematics, interpretive case study

1.0 Introduction

The term ‘problem’ may which a solution is needed, and have different meanings for which a direct way of depending on one’s perspective. solution is not known (Polya, In daily life, problem is 1983). From a mathematical explained as any situation for perspective, problem is defined
as something to be found or heuristics such as describing shown and the way to find or the problem situation, making show it is not quickly obvious the problem simpler, finding by the current knowledge or irrelevant information, working information available (Grouws, backwards, and classifying 1996). To a Math teacher, information are also empha-
problem is an engaging sized (Gilfeather & Regato, question for which students 1999).

have no readily available set of non-routine problem mathematical steps to solve, solving also serves a different but have the necessary factual purpose than routine problem and procedural knowledge solving. While routine problem (Schoenfeld, 1989).

A mathematics problem problems that are useful for can be a routine or a daily living, non-routine non-routine one. Routine problem solving concerns that problem is the one which is only indirectly. Non-routine practical in nature, containing problem solving is mostly at least one of the four concerned with developing the arithmetic operations or ratio students’ mathematical (Altun, 2001). Non-routine reasoning power and fostering problems focus on developing understanding that students’ mathematical mathematics is a creative reasoning, and fostering the endeavor.

understanding that See, from the students’ mathematics is a creative perspective, non-routine subject matter (Polya, 1966). problem solving can be

Non-routine problem challenging and interesting. solving stresses the use of From the point of view of heuristics and often requires planning classroom instruc-
little to no use of algorithms. tion, teachers can use non-
Heuristics are procedures or routine problem solving to strategies that do not promise introduce ideas; to deepen and a solution to a problem but extend understandings of provide a more highly probable algorithms, skills, concepts; method for discovering the and to motivate and challenge solution to a problem. Building students (Kayan, 2007).

a model and drawing a picture In a position paper on of the problem are two basic basic skills, the National problem-solving heuristics. Council of Supervisors of Other problem-solving Mathematics (1977) stated that
learning to solve problems is the principal reason for studying mathematics. Cockcroft (1982) even attempted to characterize problem solving as follows:

“The ability to solve problems is at the heart of mathematics. Mathematics is only useful to the extent to which it can be applied to a particular situation and, it is the ability to apply mathematics to a variety of situations to which we give the name ‘problem solving.”

Though considered the heart of studying mathematics, students continue to feel disappointed in their experiences and performances in solving mathematical problems. Fear, hatred, and anxiety, govern student’s experience towards problem solving. This study, therefore, is formulated to better describe students’ experiences in dealing with the non-routine problem in mathematics. This allows researchers to better understand student dispositions in solving non-routine word problems and, consequently, employ a more personalized teaching technique which will suit the mathematical learning styles of students especially when doing problem solving.

2.0 Conceptual Framework of the Study

This study is anchored on the theoretical perspective of Lenore Borzak. For Borzak (1981), experiential learning involves a direct experiential encounter with the learning event rather than simply a thought process associated with learning. This direct experiential encounter with the learning event requires active engagement of the student as opposed to passive engagement commonly associated with teacher directed instruction generally resulting in minimal student interaction in the learning process. Poor performance of event rather than simply a students on mathematical thought process associated problem solving tasks has led with learning. This direct researchers and instructors to experiential encounter with a adopt various methods and learning event requires active techniques to help students engagement of the student as appreciate mathematical opposed to passive engagement problem solving. In fact, a lot of commonly associated with quantitative studies seek to teacher directed instruction determine the factors affecting generally resulting in minimal performance in problem solving student interaction in the in general. However, there were learning process (Clark,
Threeton, & Ewing, 2010). It merely thinking about the thus involves a direct encounter, or only considering encounter with the phenomena the possibility of doing being studied rather than something about it” (Borzak,

![Figure 1. Experiential learning via a direct educational encounter (Borzak, 1981)](image)

3.0 Methodology

This interpretive case study identified 62 elementary education students of Southern Leyte State University – Tomas Oppus enrolled in a problem solving subject during the academic years 2011-12 and 2012-13 as subjects of the study. The researcher also used solving subject during the the triangulation method of academic years 2011-12 and Campbell and Fiskel (1959) in 2012-13 as subjects of the data gathering to ensure study. The study utilized the dependability and accuracy of triangulation method (Rubin & the recorded responses. By Rubin, 2005) to obtain a combining multiple methods,
researchers can hope to overcome weaknesses or intrinsic biases and problems that come from single-method and single-observer studies. Often the purpose of triangulation in specific contexts is to obtain confirmation of findings through convergence of different perspectives (Jakob, 2001).

4.0 Results and Discussion

Education Students’ Experience in Solving Non-routine Problems in Mathematics

Focus Group Discussion and interview responses (FGD), and direct and indirect interviews were further employed to solicit information asked to narrate their experiences in working and/or solving non-routine problems in mathematics. Multiple responses revealed how students both appreciate and hate working with non-routine problems. Majority, however, expressed the view that despite the difficulty of the subject, they were able to accomplish and find solutions to problems posted.

Participants’ narrative and interview responses revealed complex reactions, feedback, and comments when asked to narrate their experiences in working and/or solving non-routine problems in mathematics. Multiple responses revealed how students both appreciate and hate working with non-routine problems. Majority, however, expressed the view that despite the difficulty of the subject, they were able to accomplish and find solutions to problems posted.

Qualitative data gathered from the subjects was analyzed using the constant comparative technique (Strauss & Corbin, 1990) and narrative analysis (Soanes & Stevenson, 2004). The final analysis was twice presented to subjects to validate and re-validate the researchers’ interpretation of the narratives and responses (Myers, 2009).
Table 1. Students’ encouraging experiences in solving non-routine problems in mathematics.

<table>
<thead>
<tr>
<th>Experiential Category</th>
<th>Frequency/Regularity of Experience</th>
<th>Sample Verbatim Response</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensifies study habit</td>
<td>62 (100%)/Always</td>
<td>R26: I really hate math but it forced me to study almost every night.</td>
<td>Working with non-routine problems in mathematics is always a challenging experience. Such experience encourages students to intensify study habits. It inspires students to find time in a day to review notes by comparing it to available books for better understanding of the process in problem solving.</td>
</tr>
<tr>
<td>Actualizes creative skill</td>
<td>54 (87%)/Always</td>
<td>R30: I really love solving math problems because it enhances my creative ability in manipulating number in the equation.</td>
<td>Doing non-routine problems in mathematics creates a challenge to students’ mental capacity because of its creative dimension. It allows the students to operate independently from any given formulae, thereby, challenging them to construct mathematical model creatively.</td>
</tr>
<tr>
<td>Improves Strategic Thinking Skill</td>
<td>53 (85%)/Always</td>
<td>R19: My experience in working with problems in mathematics is that it develops my strategy to solve.</td>
<td>Despite the difficulty of working non-routine problems, students were interested in patiently working and looking for a positive strategy for solutions. The problem does not only excite them but it also interests them because of the strategic aspect necessary for the solution of problems. Success in solving problems results to a deep satisfaction for achieving the objective of solving them.</td>
</tr>
<tr>
<td>Develops mental focus and discipline</td>
<td>53 (85%)/Always</td>
<td>R60: My own description of problem solving is that there is a need for focus to solve the problem.</td>
<td>Students found working with non-routine problems a tool that disciplines their mind. The necessity to find for correct solution increases students’ ability to focus on the important aspect in the problem that will facilitate in reaching its solution. The mental focus and discipline enable the student to remove problem distractors and concentrate more on the significant value/s necessary for the solution of the problem.</td>
</tr>
</tbody>
</table>
Students’ engagement in solving non-routine mathematical challenges in an unfamiliar context (CPDD, 2000). Should this happen in the Philippines, we are certain that this will increase student awareness of problem solving as a skill to be learned and used in mathematics which has applications in everyday problems, thus serving them throughout life (Posamentier, Smith & Stepelman, 2010).

Psychologists refer to this as positive reinforcers – or stimuli which strengthen the desired behavior (Limpingco, Tria, & Jao, 2008). Students considered problem solving a positive reinforcer because it intensifies a study habit, actualizes a creative skill, improves strategic thinking, and develops focus and mental discipline. This positive contribution of problem solving to a students’ learning reflects how problem solving helps a student learn complex skills (Heller, Keith, & Anderson, 1999). The very nature of problem solving is leading and guiding students from a simple to a more complicated process, in order to discover the unknown and the desired answer in mathematics and in the practical tasks of real life. The ability to apply mathematics to a variety of situations is said to be problem solving itself. Regardless of what others
may mean when they attempt to define the term, the key issue is still how to go about observation of mathematical finding a solution when faced with a problem that may involve the use of mathematical skills, concepts, and processes (Yee & Hoe, 2009).

In this study, education students' revealed that their experience in working with non-routine problems consist not only of solving the problems by solving. This study revealed the same strategy but also the application of different strategies to the same problem. It is further discovered that students' increasing exposure and encounter with different types of non-routine problems increases their strategic thinking skills and develops their creativity in inventing their own strategies. The last narrated contribution of non-routine problems is the realizations that the encounters taught them mental focus and discipline. One of the objectives of Philippine mathematics education is to introduce mathematics as a tool to develop mental discipline. Students narrated how disciplined focus on the definitions, principles, axioms, theorems and postulates, enabled them to construct models out of the mathematical problems posted.

This admission reveals the importance of focus and observation of mathematical principles. Moving away from these principles means failure to achieve the goal of attaining solutions to problems. On the contrary, despite this, the positive contribution of students’ problem solving to student learning, it is fact students at the same time fail in problem solving. This study revealed the consistency with previous application of different studies (Lee, 2006; Coxeter, 2008; Papanastasiou, 2002).

It is further discovered whose findings considered that students' increasing problem solving as highly exposure and encounter with difficult, mentally and different types of non-routine physically exhausting, and problems increases their frustrating. Skinner labeled strategic thinking skills and this a negative reinforcer to develops their creativity in learning (Bigge & Hunt, 1980). The negative experiences of students in solving non-routine problems explains problems is the realizations why many still continue to fear that the encounters taught or hate the activity. However, them mental focus and interviews revealed that such discouraging experiences of Philippine mathematics somehow motivates students to learn more the basics of solving mathematics as a tool to problems. This displays the mental maturity of students.

Students narrated how towards solving non-routine problems the disciplined focus on the problems in mathematics. definitions, principles, axioms, theorems and postulates, non-routine problems solving is enabled them to construct more difficult that routine models out of the mathematical problems. In the narrative of education students’ experi-
ences, the situation do not fully discourage them; instead, it motivates and somehow challenged them to continue to study.

Another prevailing narration in working non-routine problems is the feeling of frustration, described by students as the feeling of sensing the lack or absence of support from their teachers in solving mathematical problems. Students quoted Vygotsky and considered the faculty scaffolds of learning (Limpingco et al., 2008), making them frustrated whenever teachers are not helping and motivating them to learn.

The above narration shows not a students’ direct negative experience with problem solving. It is, however, an indirect effect of teachers teaching style and classroom practices. Being a more skilled

Table 2. Students’ discouraging experiences in solving non-routine problems in mathematics.

<table>
<thead>
<tr>
<th>Experiential Category</th>
<th>Frequency/Regularity of Experience</th>
<th>Sample Verbatim Response</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Difficult</td>
<td>62 (100%)/Always</td>
<td>R40: Problem solving is so very difficult for me work. R5: I am afraid with problem solving because it is difficult.</td>
<td>Problem solving is considered as a difficult task by education students because it requires a deep understanding and analysis on the given conditions in order to accurately arrive at a correct answer.</td>
</tr>
<tr>
<td>Mentally and Physically Exhauling</td>
<td>62 (100%)/Always</td>
<td>R3: I am so tired after solving the problem, I’m so exhausted.</td>
<td>Working with non-routine problems in mathematics caused fatigue to students mentally and physically. Such experience do not only discouraged and frustrate them, it likewise is the root of hating the subject.</td>
</tr>
<tr>
<td>Frustrating</td>
<td>40 (84%)/Sometimes</td>
<td>R10: I am sad. Am frustrated with my performance in problem solving.</td>
<td>Working alone with no support from teachers caused students’ frustration in solving non-routine problems in mathematics. Students considered the faculty as scaffolds of learning making them frustrated whenever teachers are not helping and motivating them to learn.</td>
</tr>
</tbody>
</table>
professional and trained to teach students (Limpingco, Tria, & Jao, 2008), teachers working non-routine problems are considered as a direct factor who could affect students’ encounter and experience in solving non-routine problems in mathematics. When these encounters and experiences while working with non-routine problems in mathematics continue to subsist in the mind of the students, then teaching problem solving defies its educational purpose. Failure to curb and eliminate such problems deprives a student of the opportunity to appreciate the creative value of problem solving in mathematics.

Coping Strategies which Affect Education Students’ Success in Solving Non-routine Problems in Mathematics

A portion of education students’ encounter in working non-routine problems in mathematics is their effort to find coping strategies to find solutions of the problems. Data from narratives and interviews revealed that students’ coping strategies ranged from individual review, tutorial, to group study in boarding houses, classrooms, and in the library (Figure 1). Individualized study is believed by education students in SLSU-Tomas Oppus as the tool that helped them in their success in solving non-routine problems in mathematics. With individual study, students revealed that they can review notes, scan books, and practice individually in solving problems at their pace. They agreed on the concept of individual differences in which every individual has his own

![Fig. 1. Flow of coping strategies employed by education students in solving non-routine problems](image-url)
uniqueness in almost all he does (Aquino, 2009). Galotti (2004) said that people do have different cognitive styles with regards to some task assigned. Students, therefore, can work alone whenever they think working independently can help them become more successful.

Individuals who prefer a field-independent learning style tend to view concepts more analytically, therefore finding it easier to solve problems. Those preferring a field-independent learning style were more likely to involve inquiry and discovery, favor learning activities that required individual effort and study. In addition, they prefer to develop their own structure and organization for learning, and are intrinsically motivated and are less receptive to social reinforcement (Witkin et. al., 1977; Garton, Dyer, & King, 2000).

The desire of education students to be more confident in doing problem solving encouraged them to consult friends, teachers, and online tutorial just to increase their confidence. It is undeniable that the role of scaffolds is very important in increasing learning to students (Bee & Boyd, 2007). For Bruner, 110). Working in groups, scaffolding describes the therefore, provides every
learner the opportunity to solving non-routine problems share ideas, hear other in mathematics. Non-routine perspectives, benefit from the problem solving positively experience and expertise of affect elementary education others, and to receive help and students because it intensified support (De Janasz, 2002).

Narratives and responses of education students revealed that group study makes them comfortable because they allow them to share, compare, and learn solutions of some non-routine problems. Working in a group provides them comfort and, frustrating out of frustrating experiences with a teacher. searching for solutions to the problem. A group is seen as an assurance that result of a certain solution to a problem is a collaborative effort, whose success or failure will be shared by many. Group study also provides them confidence especially if they work with the top students in the class. Group study provides education assurance that result of a students in their desire for learning non-routine problems in mathematics. It instead intensified their desire to study individually, consult for experts/tutors, and conduct group study. These coping strategies provide education students the chance to share ideas, hear other perspectives, study removes anxiety, fear, and stress in solving non-routine problems. Working in a group created a happy mood in an effort to decrease tensions in working with mathematical problems.

5.0 Conclusion

Elementary education students of SLSU–Tomas Oppus shared encouraging and discouraging experiences in trying to pursue their learning desire to
solve non-routine problem in mathematics.

It is, however, necessary to remember that the effort to divert negative impact of the non-routine problem solving in mathematics to elementary education students is not a single struggle. It is a conglomeration of the students’ desire and the learning they get from their scaffolds and/or group. Still, greater influence was considered in the individual and groups’ desire to learn together in working non-routine problems in mathematics.

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