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Pre-Service Class Teacher' Ability in Solving Mathematical Problems and Skills in Solving Daily Problems

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Abstract

This study aims to investigate the ability of pre-service class teacher at University of Petrain solving mathematical problems using Polya's Techniques, their level of problem solving skills in daily-life issues. The study also investigates the correlation between their ability to solve mathematical problems and their level of problem solving skills in daily-life issues. The study sample consisted of 65 female students majoring in class teacher. Data were collected using two questionnaires: the mathematical problem solving test which was developed by the researchers and daily life problem solving scale which was developed by (Hamdi, 1998). The findings indicate that students had high level skills in solving daily problems; there are no statistically significant differences in daily problem solving in relation to their academic year or high-school stream. Conversely, the findings also indicate weaknesses in students' skills in solving mathematical problems, with no statistically significant differences among students in solving mathematical problems according to Polya's problem solving steps. However, there were statistically significant differences in students' performance in solving mathematical problems in relation to the mathematical topic, and in favor of measurements and algebra; in addition to statistically significant differences in students' ability to solve mathematical problems in relation to academic year and high-school stream, but no correlation between students' abilities in solving mathematical problems and those in solving daily problems.

Keywords: problem solving, daily problems, mathematical problems, class teacher

1. Introduction

1.1 Introduce the Problem

Problem Solving is one of the most crucial cognitive activities an individual may put into use in a variety of lifestyle-related contexts, particularly in respect to the rapid lifestyle, informational technology revolution and accelerated changes in all aspects of life. Mathematical problem solving, on the other hand, is the most important aspect of teaching mathematics. Despite the high significance of problem solving, teaching for problem solving is rarely present in formal teaching environments. This could possibly be due to our limited understanding of problem solving, and that fact that instruction design gives minimal attention to the problem solving process (Jonassen, 2000).

Great attention has been drawn to solving mathematical problems on behalf of experts in the field of teaching mathematics in specialized institutions and centers, such as the Mathematical Association of America, as well as a number of educators; as this could help raise thinking levels in learners and develop their problem-solving abilities (NCTM, 1989). The significance of problem solving in mathematics lies in that it is the goal and final outcome of the learning and teaching process, as problem solving is perceived as the right way toward practicing thinking in general—in other words, there is no math without thinking, and there is no thinking without problems.

Taplin (2004) asserted that solving a problem extends beyond simply learning and reinforcing the mathematical knowledge needed to face daily problems that an individual may encounter, but it also is a skill that helps individuals in developing logical thinking and improving their decision-making skills by the use of logical processes such as induction and deduction, as well as using Algorithms when needed to work out daily situations.

The standards of teaching mathematics consider problem solving an inseparable part of the process of teaching and learning mathematics. These standards have emphasized the need to provide students with opportunities to build mathematical knowledge through the problem solving approach; and so, mathematics curriculums should include mathematical problems that appear in mathematical contexts or others (NCTM, 2000).

A problem is that gap which separates a person from accomplishing his or her goal and solving the current existing issue—which could appear to be in different shapes or ways—starting at games and extending to include different daily-life problems. Furthermore, it is evident that students who have a strong desire to understand and solve problems often provide unique and accurate answers (Coutinho, 2006).

Schoenfeld (2013) defines problem solving in mathematics, and all other fields, as attempting to reach certain outcomes with an unclear method one may follow to do so; thus, one must exert a large amount of efforts and attempts to reach these desired outcomes. Additionally, Heppner and Krauskopf (1987) define a problem as cognitive and behavioral processes performed in order for an individual to adapt to his/her external or internal needs.

Alternatively, VanGundy (2008) affirms that problems are new situations that an individual may face, and that act as an obstacle between him/her and reaching the desired goal, which require him/her to investigate and inquiry. He adds that the type of problem an individual may face determines the way in which he/she solves it. Thus, if one defines a problem as the gap between the current situation and the desirable state, one may also define problem solving as the process that turn things into what one may desire and demand.

Students are provided with the chance to solve a wide array of problems, whether those in their textbooks and syllables (which can be described as clearly-defined problems with specified goals and outcomes), or daily problems, which rather allow students to use a variety of methods to solve them, and presents them with a variety of different outcomes to the extent that some may not even have a solution (Lee, Teo, & Bergin, 2009). Mayer (1998) asserts that it is possible to teach students problem solving strategies on how to properly solve the first type of problems that are involved in school curricula and textbooks, and this is done through incorporating these problems in suitable contexts and identifying the necessary steps for explaining and solving this type of problems.

Researchers categorize problems by how strongly structured they are. If a problem has a strong structure, an individual will have a clear idea of how it must be solved. However, if a problem is unclear with a weak structure, it will not hold any indications that lead to a solution. Therefore, the type of the problem determines the most suitable approach for solving it (VanGundy, 2008).

Straus (2009) believes that there is no particular method for problem solving, and that one may employ several strategies in the solving process. Moreover, he defines problem solving as the status that an individual seeks to change, which includes what an individual does in his/her daily life, such as communication, learning, planning, working, and decision making. He further adds that that there is a correlation between problem solving strategies an individual may acquire and his/her ability in being an expert in problem solving. Polya (1980) asserted that intelligence in developing the ability to solve daily and personal problems, and others intersect with all of these skills.

Individuals differ in how they solve daily problems, in contrast to their methods of choice in solving mathematical ones. This is consistent with the views of Newell and Simon (1972) in clarifying the difference between daily problem solving and Algorithms and mathematical problems solving. To put it briefly, solving problems a person may face in his/her daily life allows easy and flexible strategies, but does not guarantee success in finding a solution; whereas problem solving in Algorithms demand a systematic approach that may require time, but guarantees a success in finding a solution. Carpenter (1989) asserts that one of the most important objectives of learning through solving problems is to support students and encourage them to take part in unique thinking processes for creating ideas and proposing solutions; so to nurture their interest in future possibilities and knowledge development.

The processes of solving daily problems are dependent on trial and error, and demand that an explorative strategy is used and tested. If this strategy is to fail, a different one is chosen as an alternative, and so on (Newell & Simon, 1972).

One's success in solving a problem or choosing appropriate strategies and procedures for solving one differs in relation to the circumstances or contexts in which this problem exists (Lave, 1988). Furthermore, Newell and Simon (1972) assert that learning and teaching problem solving skills begins with an individual's confidence in his or her ability to solve problems, and his or her flexibility in choosing and discovering suitable strategies from a variety of previously learned ones; as well as being initially aware of possessing such strategies, and being capable of revealing, implementing, and employing them in newly emerging situations. However, Schwartz (2005) assert that learning the essential strategies for problem solving is not sufficient for making the individual good at solving problems; students will need to learn how to break out from the old outdated and restrictive problem-solving system, and seek to explore new and creative ideas in solving problems they may encounter (Schwartz et al., 2005).

Herald (1991) suggests that one may solve daily problems using a method he called I.D.E.A.L, where each letter of the acronym represents a step in the problem-solving process, presented below:

1) Identify the Problem

2) Describe the Possibilities

3) Evaluate the Ideas

4) Act Out a Plan

5) Learn for the Future

The method illustrated above views problem-solving as the act of organizing the process of thinking of data and what should be done with it. Coming to determine or identify the problem is an individual's recognition of the existing of it, without underestimating the situation at hand, nor putting the blame on others. Describing the possibilities, however, is to take several methods of solving a problem into consideration; in this step, the individual needs to be open to all ideas he or she may think of. Next comes evaluating the ideas, which requires the individual to be positively critical of the situation in which a problem occurs, and to be capable of adopting the problem. Later, one must act out a plan by filtering one's ideas to come to choose the most suitable method of solving a problem, to then implement a suggested plan; this is done by putting one's self in the necessary position where implementing the suggested solution is made possible, while being aware of one's way of thinking, one's emotions, and opinions toward the outcomes. Finally, in learning for the future, one must employ what one has learned from the reaching of a solution, and use it as an accumulative gained experience to be employed later in the future as needed (Herald, 1991). Figure 1 illustrates the aforementioned steps:

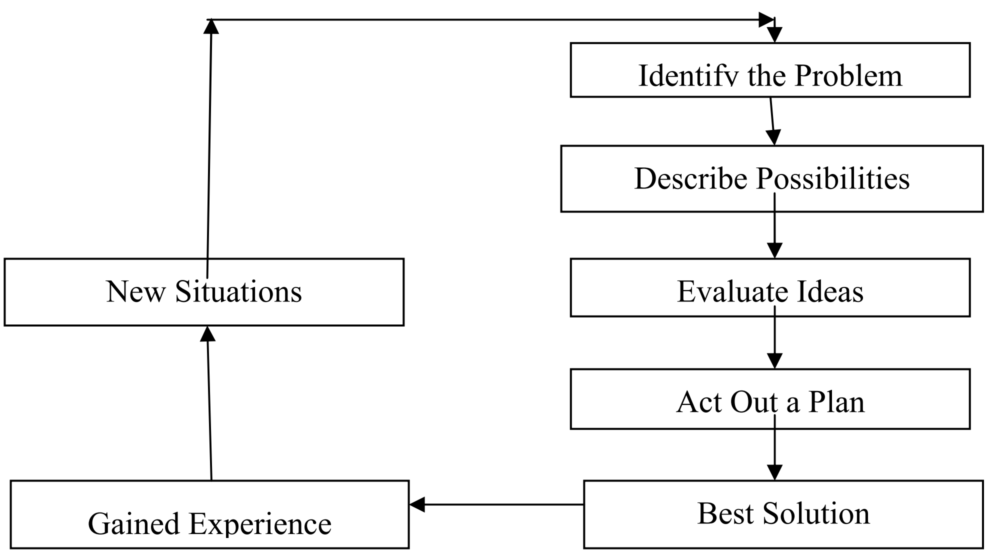

Figure 1. Steps toward daily problem solving and linking them to an individual's experiences

Problem-solving requires a large amount of training, since learners face numerous setbacks in solving problems in general and mathematical problems in particular. Students' weakness in understanding mathematical problems may be attributed to their lack of assisting mathematical strategies and necessary skills, and their low motivational drive to learn. Moreover, many students and teachers view the process of teaching problem-solving as extremely tricky (Sonacatl et al., 2010).

There are a variety of learning strategies that could be used in problem-solving; the best strategies to learning problem-solving skills are through a meaningful context. For this purpose, the learner will need guidance in explaining success or failure through the problem-solving process (Mayer, 1998). One of the most significant aspects of learning problem-solving is when individuals understand what they are doing in the process of comprehending and solving the problem; students who possess learning, thinking, and problem-solving strategies are more capable of using and employing these in various situations, in comparison to those who do not possess this amount of knowledge (Cai, 2003). Furthermore, Pintrich (2002) asserts that one of the most important signs of learning problem-solving is understanding what strategies and methods an individual may employ in understanding and resolving a problem. Therefore, students who possess a number of different learning and thinking strategies, and use these in problem-solving, are more capable of using and employing these strategies in different learning situations; where they accumulate their gained knowledge so to invest it in the future in facing new problems.

The process of teaching problem-solving is not an easy task, since there are a variety of types of problems, which require massive amounts of effort, time, and appropriate teaching methods—in order to attain an appropriate problem-solving training approach (Soancatl et al., 2010). Moreover, low problem-solving skills in any subject are one of the crucial factors that lead to students' failure and despair (Carmo et al., 2006). In addition, students need to learn how to think when solving a problem, and need to analyze the steps when seeking to resolve an issue.

Ghafour (2012) explored the difficulties faced by students during pre-service teacher preparation in solving mathematical problems, which he attributed to students' lack of suitable teaching styles and methods, in addition to a general weakness in mathematics. To make it clearer, problem-solving is dependent on three main components: mathematical and arithmetical skills, meta-cognitive skills, and determination and resolution. These components are affected by the steps and instructions which reinforce non-routine problem solving, or problem-solving in non-mathematic contexts.

Gholami and Bagheri (2013) have asserted that the difficulties faced by individuals in problem-solving go back to their lack in abilities in choosing appropriate strategies and behaviors in facing the problem; the behaviors an individual adopts when facing a problem is of great importance to devising a plan for a solution. Through their research, they have attributed this to individuals' poor preparation in the elementary educational levels.

Problem solving goes a long history back in teaching mathematics. Numerous studies have tackled the subject with great attention; in fact, 1945 was a turning point how mathematical problems are taught, when George Polya published his book "*How to Solve it*", listing steps one must take to solve mathematical problems, and encouraging students to solve them (Louange, 2007). Polya asserted that solving simple problems an individual may face helps raise a learners' curiosity and give him or her sense of enjoyment; this could have a positive impact on the learner in different stages of life. Furthermore, Polya affirmed that problem-solving is a practical skill, like swimming, and thus requires large amounts of training and experimentation (Polya, 1945). Polya's strategy was widely accepted and soon became the basic cornerstone of any other strategy. The researchers' have chosen this strategy as all recommendations and strategies in former literature, which tackled the subject of problem-solving in mathematics, can be edited and molded into this particular strategy in one way or another. Additionally, Awwad (1999) asserts that teaching students how to solve mathematical problems using Polya's strategy—being the cornerstone of teaching mathematics. Polya's steps toward solving a problem are as follows:

1) "Understanding the Problem"; in this step, one must determine the data and information and their adequacy, as well as identifying the assumptions and the desired outcome.

2) "Devising a Plan"; in this step, the learner attempts to link data and information to the desired outcome. In this step, if things still seem unclear, the learner must develop a plan that shows how to link the data with the desired outcome.

3) "Carrying out the Plan"; in this step, the learner carries out the plan to resolve the issue, and verifies the series of steps taking to reach the solution.

4) "Look back"; this is done to examine the solution and whether its results are valid.

Figure 2 shows the relationships between the different stages of problem-solving, and the processes necessary to each step.

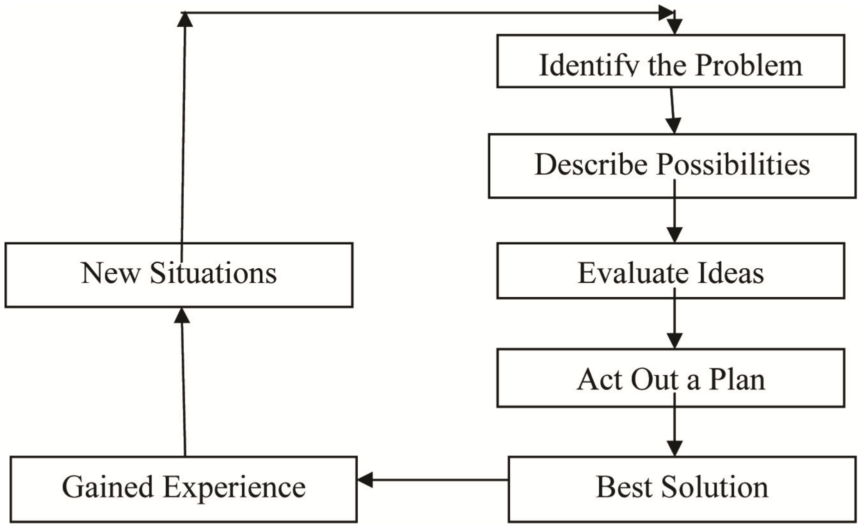

Figure 2. Steps of solving a mathematical problem according to Polya's strategy

According to Polya, solving a problem means finding a way to exit the difficult situation and to overcome an obstacle in hopes of fulfilling the desired goals, when no solutions for the problem are known. Furthermore, he also believes that problem-solving strategies are separate from the nature of the question; in other words, these steps can be employed in a variety of different situations (Polya, 1945).

1.2 Study Purpose

Since the Researchers had previously taught science and mathematics courses to class teacher majors at university, they have observed a number of difficulties faced by students in these courses, in addition to a clear weakness in solving mathematical problems; this has prompted the researchers to explore the levels of students' abilities in solving mathematical problems, in hopes of designing more comprehensive training and strategy development programs for their students. Specifically, this study aims to identify the level of skills of class teacher majors at the University of Petra in solving daily problems as well as mathematical problems using George Polya's strategy; in addition, the current study aimed to identify the extent to which students' level of skills in daily problem solving correlate with each step of solving mathematical problems using Polya's strategy; as well as pinpointing the effect of students' secondary education stream and academic level on their ability to solve mathematical and daily problems.

1.3 Importance of the Problem

Problem-solving skills are avitaltopic, whether in the field of teaching mathematics or in the daily life of any individual. Thus, the significance of the current study lies in that it attempts to reveal pre-service class teachers' abilities to solve mathematical and daily problems, and to what extent they possess such abilities and skills; moreover, the current study aims to explore the correlation between students' abilities to solve mathematical problems and the skills they possess. This may considerably help curriculum planner and designers, as well as teachers, in establishing strategies and training programs that could boost students' abilities to solve problems and to extend the impact of learning to include other issues and topics.

1.4 Study Questions

1) What is the level of daily problem solving skills in pre-service class teachers at the University of Petra?

2) Do students' daily problem solving skills differ in relation to their academic year and high school education stream?

3) What is the level of pre-service class teachers' abilities in solving mathematical problems in general, and their ability to use Polya's four steps of problem solving?

4) Do pre-service class teachers differ in their abilities in solving mathematical problems in general, and their ability to use Polya's four basic steps, in relation to academic year and high school education stream?

5) Do pre-service class teachers differ in their ability to solve mathematical problems in accordance with the five topics of mathematics (numbers and their operations, algebra and patterns, measurements, geometry, and data and probabilities) in relation to academic year and high school education stream?

6) Are pre-service class teachers' skills in daily problem solving correlated with their ability to solve mathematical problems?

1.5 Literature Review

Numerous studies have tackled the strategies of mathematical problem-solving in students and teachers alike, and its relationship to many variables. Akgun (2014) has conducted a study that aimed to identify problem-solving strategies in pre-service mathematics teachers, and how often they put these strategies into use in the classroom; the study concluded that teachers did not employ the strategies they reported during their interviews. Furthermore, Sabbagh (2006) conducted a study aimed to reveal the mathematical problem-solving strategies used by talented students in higher elementary levels; of which the findings showed that variations of mathematical problem-solving strategies used by these talented students were not high; as well as that students completely eliminated the step of checking their answers from their mathematical problem-solving process, whether during the document analysis, or during the interviews.

Other studies dealt with the correlation between problem-solving skills and a number of variables. For instance, Kaya, Izgiol, and Kesan (2014) attempted to explore the correlation between problem-solving skills in relation to a number of variables which included sex, family income, activities, residence area, and academic scores; the study has found that sex is an inactive variable in differentiating teachers' perceptions of problem-solving skills, as well as statistically significant differences in the problem-solving skills in relation to academic scores; furthermore, the researchers in the aforementioned study recommended that more attention should be given to thinking and daily problem-solving skills in order to develop individuals' abilities in building more realistic thinking models.

Additionally, Shubair (2011) conducted a study to explore the impact of the problem-solving strategy in treating mathematics learning difficulties in 8th grade students; his study concluded that there were statistically significant differences in the mean scores of the experimental group who studied mathematics using the problem-solving strategy in relation to the control group who were taught using the traditional method, in favor of the control group. This reinforces the importance of learning problem-solving strategies in overcoming learning difficulties. Furthermore, Alzoubi (2014) aimed to explore the impact of using a problem-solving based teaching strategy in developing mathematical creative thinking skills in class teacher students at Al-Yarmouk University; the findings revealed an improvement in students' mathematical creative thinking skills (fluency, flexibility, and novelty) in the experimental group. In the same field, Al-Khateeb and Ababneh (2011) attempted to investigate the impact of using problem-solving based teaching strategies on mathematical thinking and attitudes toward mathematics among 7th grade students' in Jordan; their findings indicated that the experimental group did better in comparison with the control group, and that the experimental group's attitudes toward mathematics were more positive than those of their peers in the control group.

In relation to solving everyday problems, Al-Khayat (2008) explored the impact of training programs in developing analytical thinking skills in solving everyday problems in students registered at Princess Rahma College in Jordan. The researcher suggested a number of analytical thinking skills, as well as launching a training program and constructing a scale to measure everyday problem solving. In Al-Khayyat's study, the sample was divided into two groups, one that underwent the training program. Study findings indicated statistically significant differences among both groups (experimental and control groups) in the efficiency of the training program in enhancing problem solving among students, in favor of the experimental group. The findings further indicated significant differences on the sex variable in favor of females, as well as on the academic achievement variable, in favor of high-scoring students.

In addition, Gallo and Johnson (2007) conducted a study aiming to understand the factors which impact university students' abilities to use basic mathematical skills in solving simple real-world problems. Their study sample consisted of 600 students registered in various college economics courses, and has shown that students with strong basic mathematical skills were better at putting their mathematical backgrounds into use when solving everyday problems. The researchers argued for the necessity of increasing the number of courses taken by students at university, in hopes of enhancing their abilities in applying mathematics to real-life situations.

A number of other studies tackled teachers' beliefs and attitudes toward mathematical problems, as well as their ability to solve them. Mason (2003), for instance, conducted a study that aimed to explore the beliefs of Italian graduate students on mathematics and solving mathematical problems, in addition to detecting the impact of their level in mathematics, sex and academic scores on these beliefs. Mason's findings indicated statistically significant differences in the sample's abilities in solving problems that require a large amount of time, solving problems that cannot be solved using typical standard procedures, and in the importance of mathematics.

1.6 Operational Definitions

1.6.1 Daily Problem-Solving Skills

The methods normally used by individuals in dealing with daily problems. These are measured through a scale of this study consisting of five dimensions which include steps of solving daily problems.

1.6.2 Mathematical Problem-Solving

The necessary level of ability required for an individual to find the solution of a certain problem. The ability to solve problems in this study is measured through a scale specifically designed for that purpose, consisting of problems that are similar and related to those found in the course of basic concepts in mathematics, which class teacher students attend at the university.

1.7 Study Limitations

1) This study is limited to class teacher major students at University of Petra.

2) The results of the study are limited by the characteristics of the scales used, and how capable these scales were in differentiating between students' skills and levels in solving daily problems.

3) The Mathematical Problem-Solving Scale is limited to topics included in the syllable of the mathematic course taken by class teacher major students at the university.

2. Method

2.1 Study Sample

The study sample consisted of 65 female students majoring in class teacher at University of Petra, who have all completed the "Basic Concepts in Mathematics" course. The sample was distributed into different levels, including 4 freshmen (6.2%), 18 sophomores (27.7%), 25 juniors (38.5%), and 18 seniors (27.7%). Furthermore, 4 students have graduated from secondary education in the scientific stream (6.2%), 24 in the literary stream (36.9%), 29 in the information technology stream (44.6%), and 8 in other streams (Religious, Economic, Domestic, etc.) with a percentage of (12.3%).

2.2 Measures and Covariates

2.2.1 Daily Problem-Solving Scale

This scale consisted of 40 items on 5 dimensions which represent the levels of solving daily problems, which include (1) Embarking upon the problem; (2) Identifying the problem; (3) Identifying alternatives and solutions; (4) Decision-making; (5) Checking and evaluation. Each dimension has 8 items assigned to it; where each item describes a method typically used by individuals in dealing with daily problems. Participants answered on a three-point scale which are as follows: (a) applies to a large extent, (b) applies to a moderate extent, and (c) applies to a small extent. This scale was used by Hamdi (1998). In the current study, the scale was applied to 30 female students; the reliability coefficient of the scale was then calculated on Cronbach's Alpha to be (0.93), which is acceptable for research purposes.

2.2.2 Mathematical Problem Solving Scale (Polya's Strategy)

The Researchers have designed a scale consisting of 12 multiple-choice questions in the following mathematical topics: (a) numbers and their operations, (b) algebra and patterns, (c) measurements, (d) geometry, and (e) data and probabilities. The scale was designed so that each question had a group of sub-questions to measure students' abilities in solving problems using George Polya's strategy. These questions measure students' abilities to identify given data, identify what is required of the problem, set hypothesis, identify a solving strategy, employing a strategy and finding a solution, and finally to check the answer. Students receive one point if the answer is correct, and zero points if the answer is incorrect for each sub-question of the different parts of the test scale, and this applies to all problems found therein. The scale was presented to a group of specialists in the field of mathematics and mathematical curriculum development to ensure that it is appropriate for the students. The scale was then applied on 30 female students, and its reliability coefficient was calculated on Cronbach's Alpha to be 0.88, which is acceptable for research purposes.

2.3 Experimental Manipulations or Interventions

The Researchers categorize students' in accordance with their abilities in solving mathematical problems using the following grouping system: students who had scored 70-100% of the problems correctly were considered "excellent", who scored 55-69% were "good", who scored 40-55% correctly were "fair", and those who scored 40% or less were deemed "weak".

3. Study Findings and Results

Firstly, to answer the first question: "What is the level of daily problem-solving skills in pre-service class teachers at the University of Petra?" Means and standard deviation values of students' scores on the daily problem solving scale as a whole and on each of its five dimensions (embarking on the problem, identifying the problem, setting alternatives, decision making, and checking) were calculated. These results are shown below in Table 1.

Table 1. Means and standard deviation of pre-service class teacher's scores on daily problem solving scale

Dimension	embarking on the problem	identifying the problem	setting alternatives	decision making	checking	overall scale	F-value	Sig.
Mean	**15.7**	**16.3**	**15.6**	**16.5**	**15.0**	**15.8**	**1.69**	**0.15**
S.D	**3.7**	**3.7**	**3.7**	**3.9**	**3.6**	**3.7**		

The data in Table 1 indicate that the mean values of students' scores on the overall test is 15.8; students' mean score on the "decision making" dimension marked the highest of all at 16.5, while it marked the lowest at 15.0 in "checking". To see whether there were any statistically significant differences in relation to these five dimensions, the F-value was calculated to be 1.69, showing that it is not statistically significant at $\alpha=0.05$.

To explore students' level of daily problem-solving skills, the frequency counts and percentages of their scores were calculated, as shown in Table 2.

Table 2. Frequency counts and percentages of pre-service class teachers' scores on daily problem solving scale

Rating	85-100	70- 84	50-69	Less than 50
Description	**Excellent**	**Good**	**Fair**	**Weak**
Frequency Count	**3**	**56**	**2**	**4**
Percentage %	**4.6%**	**86.2%**	**3.1%**	**6.2%**

Table 2 indicates that the percentage of students with mean scores of 85-100 on the daily problem-solving scale was 4.6%, while students with mean scores of 70-84 were 86.2%, marking the highest percentage of all. This shows that the majority of students possess a good level of daily problem-solving skills; moreover, students with a weak level of daily problem-solving skills were no more than 6.3%.

Secondly, to answer the second question: "Do students' daily problem solving skills differ in relation to their academic year and high school education stream?" Means and standard deviations of the students' scores on daily problem-solving scale were calculated on all four academic years (freshman, sophomore, junior and senior). Table 3 shows these findings.

Table 3. Means and standard deviations of pre-service class teacher' scores on daily problem-solving scale according to the academic year variable

Academic Year	(n)	embarking on the problem		identifying the problem		setting alternatives		decision making		checking		overall scale	
		Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	S.D
Freshman	**4**	**13.8**	**9.7**	**14.3**	**9.6**	**13.3**	**8.8**	**13.8**	**9.7**	**12.3**	**8.5**	**67.3**	45.6
Sophomore	**18**	**14.4**	**3.7**	**15.4**	**4.1**	**14.4**	**3.7**	**15.5**	**4.4**	**14**	**3.8**	**73.7**	17.8
Junior	**25**	**16.3**	**3.0**	**16.4**	**2.9**	**16.4**	**3**	**17**	**2.9**	**15.8**	**3.1**	**82**	12.3
Senior	**18**	**16.4**	**1.9**	**17.4**	**1.9**	**16.3**	**2.5**	**17.2**	**2.3**	**15.3**	**2.1**	**82.7**	6.4
Overall	**65**	**15.7**	**3.7**	**16.3**	**3.7**	**16.6**	**3.7**	**16.5**	**3.9**	**15**	**3.6**	**79**	16.5
f-value		**1.55**		**1.39**		**1.93**		**1.40**		**1.74**		1.93	
Sig.		**0.20**		**0.25**		**0.13**		**0.25**		**0.17**		0.14	

Table 3 indicates that mean scores of senior students on the overall daily problem solving scale were 82.7, marking the highest among all other academic years, followed by junior students with a mean score of 82.0, then sophomore students with a mean of 73.7, and finally freshmen who had a mean score of 67.3. To determine whether there were any statistically significant differences on these mean values, the F-value was calculated. These findings are shown in Table 6, and indicate that these differences were not statistically significant, meaning that mean scores of students in different academic years had no significance.

To determine whether students' level of skills in solving daily problems differ in relation to their secondary education stream, means and standard deviations were calculated for each stream as shown in Table 4.

Table 4. Means and standard deviations of the class teacher' scores on daily problem-solving scale according to their secondary education stream

Secondary education stream	(n)	embarking upon the problem		identifying the problem		setting alternatives		decision making		checking		overall scale	
		Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	S.D
Scientific	**4**	**12.8**	**5.1**	**15.0**	**4.7**	**13.5**	**3.7**	**14.0**	**5.8**	**13.3**	**6.5**	**68.5**	23.8
Literary	**24**	**15.9**	**2.8**	**16.2**	**3.4**	**15.8**	**2.8**	**16.2**	**3.5**	**14.9**	**3.0**	**79.1**	13.8
Information technology	**29**	**15.6**	**4.2**	**16.3**	**4.1**	**15.6**	**4.5**	**16.7**	**4.2**	**14.7**	**4.0**	**78.1**	19.1
Other	**8**	**16.4**	**2.9**	**17.2**	**2.7**	**16.5**	**2.6**	**17.0**	**2.7**	**16.9**	**1.1**	**84.4**	8.5
Overall	**65**	**15.7**	**3.7**	**16.3**	**3.7**	**15.6**	**3.7**	**16.5**	**3.9**	**15.0**	**3.6**	**79.0**	16.5
F-value		**1.0**		**0.3**		**0.6**		**0.8**		**1.1**		0.8	
Sig.		**0.4**		**0.83**		**0.6**		**0.5**		**0.35**		0.5	

Table 4 above shows that students' mean values on "other" secondary education streams was 84.4, marking the highest among all; this is followed by the literary and information technology streams with the same mean of 79.1, and finally the scientific stream with a mean of 68.5. Table 4 also shows the calculated F-value, which denotes that all these values are statistically insignificant, and that students do not differ in their daily problem-solving skills in relation to their secondary education stream.

Thirdly, to answer the third question: "What is the level of pre-service class teachers' abilities in solving mathematical problems according to Polya's four step problem solving process?" Frequency counts and percentages of students' score were calculated as shown in Table 5.

Table 5. Frequency counts and percentages of pre-service class teachers' scores on mathematical problems solving scale

Rating	70-100	55-69	40-54	Less than 40
Description	**Excellent**	**Good**	**Fair**	**Weak**
Frequency Count	**5**	**3**	**27**	**30**
Percentage %	**7.7%**	**4.6%**	**41.5%**	**46.2%**

As noticed in Table 5, students who were "Excellent" in solving Mathematical problem were 7.7% of the overall sample; those who were "Good" were 4.6%. On the other hand, students who were "Fair" were 41.5%, and those who were "Weak" were 46.2%. If grouped together, it could be said that 12.3% of all students were "Excellent and Good", whereas up to 46.2% were "Weak". It is clear that there is a great lacking in students' skills in solving mathematical problems in general.

To determine pre-service class teachers' level in solving mathematical problems according to Polya's four step problem solving process, means and standard deviations of their scores were calculated as shown in Table 6.

Table 6. Means and standard deviations of pre-service class teacher' scores on mathematical problems solving scale according to Polya's strategy

steps	Understanding the problem	Designing a solving strategy	Acting out a solution	Checking	Overall scale	F-value	Sig.
Mean	**1.97**	**1.51**	**1.65**	**1.74**	**1.72**	**2.15**	**0.095**
S.D	**1.15**	**1.02**	**1.07**	**0.95**	**1.06**		

Findings in Table 6 indicate that students' mean score on the overall scale was 1.72, with a mean of 1.97 on "understanding the problem", marking the highest of all, and followed by 1.74 in "checking the answer", then 1.65 in "acting out a plan", and finally 1.51 in "designing a solving strategy". To know whether these differences were statistically significant, the F-value was calculated to be 2.15, which denotes that they are in fact not.

Fourthly, to answer the fourth question Do pre-service class teachers differ in their abilities in solving mathematical problems in general, and their ability to use Polya's four basic steps, in relation to academic year and high school education stream? The means and standard deviations of their scores were calculated in relation to all four academic years, and high school education stream as shown in Tables (7 & 8).

Table 7. Means and standard deviations of pre-service class teacher' scores on mathematical problems solving scaleusing Polya's strategy according to the academic year variable

Academic Year	(n)	Understanding the Problem		Solving Strategy		Acting out a Plan		Checking		Overall Scale	
		Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	S.D
Freshman	**4**	**0.79**	**0.79**	**0.83**	**1.03**	**0.63**	**0.44**	**0.92**	**0.79**	**3.2**	2.69
Sophomore	**18**	**2.40**	**1.10**	**1.43**	**1.13**	**1.67**	**1.17**	**1.89**	**0.95**	**7.4**	3.7
Junior	**25**	**2.27**	**1.20**	**1.60**	**1.09**	**1.98**	**1.11**	**1.99**	**1.00**	**7.8**	3.78
Senior	**18**	**1.37**	**0.89**	**1.60**	**0.79**	**1.44**	**0.87**	**1.44**	**0.77**	**5.9**	2.3
Overall	**65**	**1.97**	**1.15**	**1.50**	**1.02**	**1.66**	**1.07**	**1.75**	**0.95**	**6.89**	3.5
f-value		**5.31**		**0.76**		**2.34**		**2.47**		2.95	
Sig.		**0.003**		**0.521**		**0.082**		**0.07**		0.04	

We notice from Table 7 that the mean scores of junior students were 7.8 on the overall scale, and marked the highest on all. These are followed by a mean of 7.4 in sophomores, 5.9 in seniors, and finally 3.2 in freshmen.

Furthermore, the data shows that junior students had the highest mean scores in three of the four steps: “solving strategy”, “acting out a plan”, and “checking”, in descending order. To determine whether the values shown above are statistically significant, the F-value was calculated as shown in Table 7. The figures denote statistically significant differences on “understanding the problem” and on the overall scale as well.

In order to investigate the sources of difference in the study samples’ scores on the mathematical problem-solving scale as a whole, and on each of its problem-solving steps, the Researchers have performed Post Hoc Comparisons on students’ scores on the scale in relation to their different academic year in solving mathematical problems using Polya’s strategy, using Tukey’s Post Hoc testing. The calculations indicated that the mean of sophomore students’ performance in “understanding the problem” was higher than the mean values of freshmen and seniors, in favor in sophomores; furthermore, the findings show that the differences are statistically significant. The findings further indicate that there are statistically significant differences in sophomore and freshmen students’ performance on the overall Mathematical Problem-Solving scale, in favor of sophomores.

Table 8. Means and standard deviations of pre-service class teacher’ scores on mathematical problems solving scale using Polya’s strategy according to their secondary education stream

Secondary Education Stream	(n)	Understanding the Problem		Solving Strategy		Acting out a Plan		Checking		Overall Scale	
		Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	S.D
Scientific	**4**	**3.6**	**1.5**	**3.46**	**1.4**	**4.13**	**1.1**	**3.38**	**1.4**	**14.5**	5.5
Literary	**24**	**1.71**	**1.2**	**1.6**	**0.86**	**1.35**	**0.77**	**1.67**	**0.85**	**6.35**	2.67
Information Technology	**29**	**2.1**	**1.1**	**1.24**	**0.88**	**1.53**	**0.91**	**1.66**	**0.85**	**6.46**	3.1
Other	**8**	**1.77**	**0.44**	**1.25**	**0.76**	**1.8**	**0.91**	**1.48**	**0.7**	**3.33**	2.1
Overall	**65**	**1.97**	**1.2**	**1.51**	**0.02**	**1.66**	**1.07**	**1.75**	**0.95**	**6.89**	3.5
f-value		**3.44**		**7.5**		**11.88**		**5.05**		9.25	
Sig.		**0.02**		**000**		**000**		**0.003**		000	

We see from Table 8 that the mean values of students’ scores in the scientific stream on the Problem-Solving scale is 14.5, marking the highest among all, which is followed by the information technology stream with mean of 6.46, followed by the literary stream with a mean of 6.35, and finally with “other” streams, with a mean of 3.33. To determine whether these were statistically significant, the F-value was calculated as shown at the bottom of Table 8. From the analysis of variance of data in Table 8, it is clear that the F-values are statistically significant for all Mathematical Problem-Solving steps using Polya’s strategy, as well as on the scale as a whole.

To investigate the differences in pre-service class teacher’ mean scores in different secondary education streams on the mathematical problem-solving scale, the Researchers performed Post Hoc Comparisons on students’ mean scores on all steps of solving problems using Polya’s Strategy, using Tukey’s Post Hoc testing. The findings denote that students who had graduated from the secondary education program in the scientific stream surpassed all other students in all other streams in their abilities to solve mathematical problems in general, and to solve mathematical problems on all four steps of Polya’s strategy

To answer the fifth question “Do pre-service class teachers differ in their ability to solve mathematical problems in accordance with the five topics of mathematics (numbers and their operations, algebra and patterns, measurements, geometry, and data and probabilities) in relation to academic year and high school education stream?” Students’ mean scores and standard deviations were calculated on the following topics: (a) numbers and operations, (b) algebra and patterns, (c) measurements, (d) geometry, and (e) data and probabilities. Table 9 shows the data for each of these, as well as the scale as a whole.

Table 9. Means and standard deviations of pre-service class teacher' scores on mathematical problems solving scale on five mathematical topics

Topic	Numbers and operations	Algebra	Measurements	Geometry	Data and Probabilities	Overall Scale	F-value	Sig.
Mean	**1.3**	**1.5**	**1.6**	**1.4**	**1.1**	**1.4**	**2.9**	**0.02**
S.D	**0.73**	**0.89**	**0.88**	**0.95**	**0.95**	**0.99**		

The results above, shown in Table 9 indicate that students had a mean score of 1.6 in the topic of "measurements", followed by 1.5 in "algebra", by 1.41 in geometry, 1.3 in "numbers and operations", and 1.1 in "data and probabilities", which marked the lowest of all mean values. To investigate statistically significant differences in students' mean values on all five topics in mathematics, the F-value was calculated. Table 9 shows that the F-value is statistically significant at 0.02; this indicates that students' performance was better in "measurements" and "algebra", and weaker in "numbers and operations" as well as "data and probabilities".

To investigate whether students differed in their abilities to solve mathematical problems on all five mathematical topics included in their course, in relation to their academic year and secondary education stream, the mean and standard deviation values of their scores on all four academic years were calculated as shown below in Table 10.

Table 10. Means and standard deviations of pre-service class teacher' scores on mathematical problems solving scale on five mathematical topics according to their academic year variable

Academic Year	(n)	Numbers		Algebra		Measurement		Geometry		Data and Probabilities		Overall Scale	
		M	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	**S.D**	**M**	S.D
Freshman	**4**	**0.45**	**0.58**	**0.77**	**0.89**	**1.1**	**0.76**	**0.6**	**0.48**	**0.3**	**0.47**	**3.2**	2.7
Sophomore	**18**	**1.5**	**0.81**	**1.69**	**0.79**	**1.7**	**0.97**	**1.4**	**0.98**	**1.2**	**1.06**	**7.4**	3.7
Junior	**25**	**1.4**	**0.67**	**1.74**	**0.96**	**1.8**	**0.82**	**1.6**	**1.3**	**1.3**	**1.04**	**7.8**	3.8
Senior	**18**	**1.2**	**0.66**	**1.24**	**0.77**	**1.1**	**0.76**	**1.3**	**0.8**	**0.98**	**0.7**	**5.9**	2.3
Total	**65**	**1.3**	**0.73**	**1.5**	**0.89**	**1.6**	**0.89**	**1.4**	**0.95**	**1.1**	**0.09**	**6.9**	3.5
f-value		**2.55**		**2.38**		**3.01**		**1.48**		**1.28**		2.95	
Sig.		**0.06**		**0.08**		**0.04**		**0.32**		**0.29**		0.04	

Table 10 indicates that junior students' performance was the best among all, with a mean score of 7.8 on the scale as a whole, followed by sophomores with a mean of 7.4, seniors with a mean of 5.9, and freshmen with a mean of 3.2. To determine if there were any statistically significant differences in the mean values, the f-value was calculated as shown in Table 10, denoting that the differences in students' mean values in relation to different academic years were in fact significant in the topic of "measurements" and on the overall scale.

To determine the sources of differences in the study samples' mean scores on different mathematical topics and the mathematical problem-solving scale as a whole, the Researchers performed pair wise Post Hoc Comparisons. The results of the calculations indicated that junior students performed far better than seniors in the topic of "Measurement"; however, on the overall scale, sophomore and Junior students performed better than freshmen, and with statistically significant differences.

To determine whether students differed in their abilities to solve mathematical problems in relation to their Secondary Education stream, the mean and standard deviation values of students' scores were calculated for different Secondary Education streams, as illustrated below in Table 11.

Table 11. Means and standard deviations of pre-service class teacher' scores on mathematical problems solving scale on five mathematical topics according to their secondary education stream

Secondary Education Stream	(n)	Numbers		Algebra		Measurement		Geometry		Data		Overall Scale	
		Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	S.D
Scientific	**4**	**2.23**	**1.15**	**2.68**	**1.48**	**2.78**	**1.3**	**3.75**	**0.5**	**3.13**	**1.18**	**14.6**	5.4
Literary	**24**	**1.27**	**0.66**	**1.5**	**0.8**	**1.44**	**0.88**	**1.24**	**0.67**	**0.86**	**0.7**	**6.4**	2.67
Information Technology	**29**	**1.28**	**0.72**	**1.44**	**0.87**	**1.47**	**0.8**	**1.25**	**0.85**	**1.02**	**0.87**	**6.6**	3.69
Other	**8**	**1.03**	**0.51**	**1.36**	**0.4**	**1.6**	**0.6**	**1.36**	**0.62**	**0.96**	**0.7**	**6.3**	2.12
Total	**65**	**1.31**	**0.73**	**1.53**	**0.89**	**1.56**	**0.89**	**1.4**	**0.95**	**1.9**	**0.95**	**6.89**	3.5
f-value		**2.7**		**2.59**		**3.03**		**13.83**		**8.94**		9.2	
Sig.		**0,05**		**0.06**		**0.036**		**000**		**000**		000	

Table 11 indicates that students in the scientific stream had a mean value of 14.6 on the scale as a whole, marking the highest level of performance; followed by a mean of 6.6 in the information technology stream, then by 6.4 in the literary stream, and finally 6.3 in "Other" streams. To determine whether the differences among mean values were statistically significant, the f-value was calculated as shown in the table, indicating that students' mean values in secondary education stream were significant in "numbers", "measurement", "geometry", and "data", as well as on the scale as a whole, and in favor of students who had graduated from secondary education in the scientific stream.

To determine the sources of difference in the sample's mean values on different mathematical topics on the mathematical problem-solving scale, pair wise Post Hoc Comparisons were performed on their scores in relation to the secondary education stream, using Tukey's Post Hoc testing, which resulted in the following:

Students who had graduated from the scientific stream performed better compared to students who graduated from all other streams, in the topics of numbers and their operations. Furthermore, scientific stream students performed better in "algebra" as compared to information technology stream students. Moreover, scientific stream students performed better on the "measurement" topic as well, as compared to students who graduated from the literary and information technology streams. Finally, on the topic of "geometry" and that of "data and probabilities", scientific stream students performed better than students in all other secondary education streams.

4. Discussion

The study has concluded that university students' level in solving daily problems was "good", as up to 90.8% of the sample scored higher than 70% on the overall test.

As for students' skills on the dimensions of the problem solving scales, the results have shown that they had a high performance level in "identifying the problem", as well as in "decision making". This is consistent with the findings of Newell and Simons (1972), in that the decision-making process during problem solving is considered to be a mental activity inclusive of two types of thinking processes: comprehension and investigation; these two types are also part of the problem identification stage.

The findings have also shown that the variables of academic year and high school stream had no effect on students' daily problem solving skills.

The findings further indicated that students suffered from a clear lack and weakness in their mathematical solving abilities on the mathematical problem scale, marking a percentage of 46% students who had "low performance"—this being significantly high, meaning that up to almost half of the students in the sample face difficulties in solving mathematical problems. This goes in line with the findings of (Aljaberi, 2015), who found that university students were clearly weak in solving mathematical problems. This is also consistent with the findings of Şİrİn and GÜzel (2006), which showed similar results. The study has also found that this low performance was unaffected by any specific problem solving stage according to Polya's.

Moreover, the findings denoted significant differences in students' performance on the mathematical problem solving scale in relation to the give topics of mathematics; students' mean scores were highest in "measurement", "algebra", and "geometry" respectively, while they performed rather low in "numerals and processes", as well as in “data and probability”. This could be attributed to possibly academically deficient curriculums in the ways in which they deal with these topics in different academic levels. This could be an indication for curriculum developers to focus more on the topics of “numerals and their processes”, as well as “data and probability” in different academic stages, whether at school or university.

As for the impact of the academic year and high school stream on students’ ability to solve mathematical problems, the findings indicate that the former was significant; while in the latter; students who had graduated the scientific stream were generally more capable of solving mathematical problems at all stages according to Polya’s Strategy—as compared to all other streams.

Furthermore, the findings indicate that students did differ in their ability to solve mathematical problems in the five topics of mathematics in this study in relation to their academic year; juniors performed better than seniors in “measurements”, while sophomores and juniors generally performed better on the scale as compared to freshmen. Moreover, the findings indicated that students who had graduated the scientific stream in high school surpassed all other students in performance.

In relation to students’ abilities in solving mathematical problems and daily problems, the findings indicated that the two were not correlated; however, students’ high performance in solving daily problems but low performance in solving mathematical ones point out to a gap in transferring and using these acquired daily problem-solving skills knowledge and skills in solving mathematical ones. In other words, it is as though mathematical inclination and mathematical problem-solving skills are completely separated from students’ reality and daily life. Lave (1988) has asserted that succeeding in problem-solving and choosing appropriate strategies and measures differs alongside the given context; meaning that the inclusion of mathematical problems in daily contexts would support students’ learning process and helps reduce the gap between mathematics and reality. On the other hand, Mason (2003) suggests that mathematical problems exist in a reality that is separated from daily problems, asserting that students’ abilities in solving typical problems differ from their ability to solve problems which require a significant amount of time and cannot be solved through typical measures (being mathematical), as compared to daily problems that an individual has adapted to and grown used to solving. Mason further indicated that students’ attitudes toward mathematics play a significant role in their ability to learn mathematics, as it is a topic of a cognitive nature which an individual may have an attitude toward; daily problems, in contrast, touch on the life of the individual, where he or she is forced to adapt toward which no certain attitude could be adopted. Furthermore, daily problem solving skills are correlated with a group of different factors related to an individual’s personal characteristics, as asserted by Strough, Berg, and Sansone (1996).

Various studies have emphasized on the importance of teaching mathematical problem-solving skills to undergraduates, which is a skill essential to logical thinking. Solving mathematical problems does not only include learning the rules and coming up with the correct answer, but it is a logical process that employs induction, deduction, algorithms, specifying the requirements, and specifying steps to solving the problem; as well as designing a solving strategy that is unique to the learner. Thus, mathematical problem solving is an essential tool to developing an individual’s ability to solve daily problems (NCTM, 1989; Lester et al., 1994).

5. Recommendations

- Include some of the courses studied by pre-service class teacher exercises to develop their skills in solving problems;
- Enrich math courses taught to class teacher with Problems of real life;
- Employ problem-solving strategies in mathematics teaching for pre-service class teacher;
- Display mathematics curriculum content to take into account the use of problem-solving strategy and steps to solve the problem according to the George Polya strategy.

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