Preservice Teachers' Beliefs about Mathematics Education: Implications for Future Classroom Instruction

Eliseo P. Marpa[1]
Faculty of Teacher Development
Philippine Normal University Visayas
Marpa.ep@pnu.edu.ph
09292376117

Jerry B. Tolentino[2]
Faculty of Teacher Development
Philippine Normal University North Luzon
Tolentino.jb@pnu.edu.ph
09166551126

Abstract
This research paper examines preservice mathematics teachers' beliefs about mathematics education. It is argued that teachers' beliefs have implications for classroom instruction. To address this problem, a descriptive method of research was employed, administering the developed questionnaire to the 69 randomly selected preservice mathematics teachers. Statistical tools such as mean and standard deviation were utilized to answer the problems formulated in this study. Findings show that preservice mathematics teachers strongly agree in almost all of the issues concerning beliefs about mathematics education. But, they do not believe that a teacher's role in the classroom is to give definitions, formulas, and rules in doing mathematics. They also disagree that a single assessment can determine students' performance.

Keywords: Beliefs, Mathematics Teaching, Mathematics learning, Preservice Mathematics Teachers, Implications, Classroom Instruction

1. Introduction

Beliefs about mathematics and mathematics education have been an issue of how it influences instruction and practices in the teaching of mathematics. Along this line, a substantial body of research indicates that mathematics teachers' beliefs about mathematics education are related to their instructional practices (Stipek et al., 2001; Lamichhane, 2017; Mansour, 2008). Thus, the researchers believed that mathematics teachers' sets of belief systems play a vital role in how instruction is being dealt with in the mathematics classroom, especially in the teaching of mathematics.

Handal and Herrington (2003) argued that teachers' beliefs play a vital role, like classroom instructions and implementations of mathematics curricular reform. Boz (2008) supported by saying that "for enhancing the quality of mathematics teaching and learning, we should understand the ideas held by the teachers and how these ideas or beliefs have reflected in their instructional practices." Likewise, Sapkova (2013) stated that teaching practice occurs because of the influence of teachers' beliefs to guide their thinking interactions in the classroom. These authorities are conclusive that mathematics teachers' instructional practices are influenced by their belief system of teaching the subject.

On the other hand, mathematics teachers' beliefs do not only influence instructional practices but indirectly influenced students learning behavior and achievement. Ghazali and Sinnakaudan (2014), for instance, contend that apart from monitoring numeracy standards, no attempt was made to explore what are the beliefs of Malaysian primary school teachers' beliefs towards mathematics teaching and learning. They stressed that it is important to understand teachers' beliefs since, ultimately, these beliefs lead to students' achievement in mathematics.

In addition, Minarni, Retnawati, and Nugraheni (2018) expressed that there was a relationship between teachers' belief and teaching practice and student achievement. They likewise contend that mathematics beliefs have a strong influence on mathematics teaching practice. The quality of teaching practices then can improve student achievement (Hill, Ball, Schilling, 2008 & Hill, Rowan, Ball, 2005). In other words, teachers' beliefs also have a crucial role in classroom instruction and student achievement.

The scenarios presented above are also the contentions of the researchers as a mathematics teacher in higher education, more especially in a teacher training institution. Preservice teachers, as what was observed, have developed their beliefs towards mathematics education. These beliefs and their ability to learn it is a reflection of mathematics instructors' and professors' beliefs of teaching and learning (Mosvold & Fauskanger, 2014). As stated by Campbell et al. (2014), classroom instructional practice and student learning are influenced by the belief of teachers' teaching mathematical knowledge. The importance of teacher beliefs and the relation between knowledge and beliefs influence a wide variety of cognitive processes, including memory, comprehension, deduction and induction, problem representation, and problem solution. Thus beliefs would ultimately prove to be the most valuable construct for preservice teachers.

Also, classroom instructional practice and student learning are influenced by the belief of teachers teaching mathematical knowledge. The importance of teacher beliefs and the relation between knowledge and beliefs influence a wide variety of cognitive processes, including memory, comprehension, deduction and induction, problem representation, and problem solution. Thus beliefs would ultimately prove to be the most valuable construct for preservice teachers (Campbell et al., 2014).

In this junction, it is evident that beliefs about mathematics teaching and education were already explored by researchers but rarely are done among preservice teachers. It is in this context that the researchers were interested in conducting an investigation on preservice teachers' beliefs about mathematics education and looking into its implication for future classroom instruction.

2. Research Objectives

The following are the research objectives of this study:

1. To determine the preservice mathematics teachers' beliefs about mathematics education in terms of:
    1.1 the learning of mathematics
    1.2 the teaching of mathematics
    1.3 mathematics assessment
2. To determine the implications of the findings for future classroom instruction.

3. Assumptions

This study assumes that preservice teachers have established beliefs about mathematics and mathematics education. These beliefs are expected to influence preservice future teachers' mathematics instruction.

4. Research Methodology

4.1 Research Design

This study employed a descriptive-survey methodology. The descriptive-survey is the most appropriate because the researchers determined and describe preservice

mathematics teachers' beliefs towards mathematics education in terms of mathematics learning, mathematics teaching, and mathematics assessment. According to Latin and Berg (2004), descriptive research is typified by observations or descriptions of the status of a condition or situation. Investigators using this method do not manipulate variables or make things happen.

4.2 Subjects

The subjects of the study were the 81 mathematics preservice of Philippine Normal University Visayas. However, only 69 of them were considered as the actual participants of the study. They were determined using Raesoft sampling calculators. Of the 69 actual participants, 29 were males, while 45 were females. Considering preservice teachers area of specialization, 38 were enrolled Bachelor of Mathematics Education (BME) while 31 were enrolled Bachelor of Mathematics and Science Education (BMSE).

4.3 Research Instrument

The research instrument utilized in this study consisted of two parts. Part I deals with the participants' profiles, such as sex and area of specialization. Part II is a 40-item, 5-point Likert Scale which determined the beliefs of the preservice mathematics teachers on (a) mathematics learning, (b) mathematics teaching, and (c) mathematics assessment. Each of the domains consisted of 10 items with alternatives such as strongly agree, agree, uncertain, disagree, and strongly disagree.

4.3.1 Validity of the Research Instrument

The research instrument used in this study was subjected to validity using Lawshe's Content Validity Ratio (CVR). The CVR (content validity ratio) proposed by Lawshe (1975) is a linear transformation of a comparable level of agreement on how many "experts" within a panel rate an item "essential."

The research instrument was presented to five jurors considered experts in the field of mathematics education and research. The result indicated that 19 of the 40 items have the CVR of 0.60, while 21 have the CVR of 1.00. This means that experts agreed that the items are essential and are able to measure what the researchers intended to measure.

4.3.2 Reliability of the Research Instrument

In the conduct of the reliability, the research instrument was pilot tested to the Bachelor of Early Childhood (BEC) preservice teachers of Philippine Normal University Visayas. These dry run participants were not the actual participants of the study. To determine the reliability coefficient, the researchers employed Cronbach Alpha. In this regard, the computed reliability coefficient using Cronbach alpha was 0.86. This coefficient of reliability indicates that the research instrument was reliable to a high degree.

5. Data Collection

The researchers collected data by using the developed research instrument used to measure preservice mathematics teachers' beliefs in terms of mathematics learning, mathematics teaching, and mathematics assessment. The researchers utilized the following steps of data collection:

a. The letter was sent to the director for academics asking permission for the conduct of the research instrument to the target participants.
b. Sufficient copies of the questionnaires were reproduced.

c. The researchers conducted the researcher with permission from the subject teachers, the research instrument to the target participants.
d. After an hour, the questionnaires were retrieved, and data were then encoded to the Microsoft Excel and processed using SPSS.

6. Data Analysis

To answer the research objectives, the researchers employed the mean and standard deviation.

7. Results and Discussion

7.1 Preservice Mathematics Teachers' Beliefs about Mathematics Education

7.1.1 Preservice Mathematics Teachers Beliefs about Mathematics Education in Terms of Mathematics Learning

On the belief about mathematics in terms of mathematics learning, preservice teachers strongly agree *(M = 4.55, SD = 0.53)* that a demonstration of sound reasoning is required in learning mathematics. Preservice mathematics teachers believed that students should have excellent reasoning skills. The flow of reasoning should be logical because mathematics requires logical reasoning. Proving, for instance, need sound reasoning. In this regard, Francisco and Maher (2005) expressed that the importance of students building arguments to support their solutions to problems and then defending these arguments is undisputed. This is also supported by Resnick (1987), arguing that mathematical reasoning is the critical skill that enables a student to make use of all other mathematical skills.

Resnick (1987) added that with the development of mathematical reasoning, students recognize that mathematics makes sense and can be understood. They learn how to evaluate situations, select problem-solving strategies, draw logical conclusions, develop and describe solutions, and recognize how those solutions can be applied. Mathematical reasoners can reflect on solutions to problems and determine whether or not they make sense. They appreciate the pervasive use and power of reasoning as a part of mathematics. These statements prove that reasoning is one of the important elements of mathematics learning. Preservice teachers feel that they need to have this element for future use as future mathematics teachers.

Preservice teachers also strongly agree *(M = 4.33, SD = 0.72)* that mathematics is mastered through a collection of algorithms, rules, and procedures. It has always been considered that mathematics is a set of rules and procedures. It is even conceived as formulatics. Once students have mastered rules and procedures, then it can be inferred that students have mastery of mathematics. However, some proponents negate this claim. Burgin (2004), for instance, contends that any activity is based on actions and operations organized by procedures and algorithms. That is why procedures and algorithms are fundamental for the development of different logic, their study, and application.

Furthermore, preservice mathematics teachers strongly agree *(M = 4.32, SD = 0.65)* that in mathematics, skill in computation precedes word problem-solving. This means that students need to have computational skills first before they can master word problem-solving. This is also the belief of the researchers, the researchers, as mathematics teachers believe that students to develop mastery of the elements of word problem-solving need to have mastery of the rudiments of computations or in other words, they need to have computational skills. However, Fuch et al. (2008) cited that the major

distinction between computation and problem solving is the addition of linguistic information that requires children to construct a problem model. Whereas a computation problem is already set up for a solution, a word problem requires students to use the text to identify missing information, construct the number sentence, and derive the calculation problem for finding the missing information.

In addition, participants strongly agree *(M = 4.49, SD = 0.61)* that models and visual aids facilitate learning in mathematics. Marpa (2019), in his study on comparative analysis of performance in scientific measurement of the grade nine students in the three types of tests, revealed that the use of the learning aid such as conversion factor table and calculator improves their level of performance in the third tests. On the other hand, Shabiralyani et al. (2015) articulated that education is necessary for everybody. Education is very vital; deprived of education, no one can lead a good life. Teaching and learning are important elements of education. The teacher uses different approaches to teach their students and their active learning. Over time, altered methods and techniques are entered in the field of education, and teachers use different kinds of aids to make effective learning. Visual aids arouse the interest of learners and help the teachers to explain the concepts easily. Visual aids are those instructional aids that are used in the classroom to encourage students learning the process.

In the same manner, preservice mathematics teachers strongly agree *(M = 4.57, SD = 0.58)* that learning mathematics requires drill and practice. Lehtinen, Hakkarainen, and Palonen (2014) stressed that deliberate practice is a practice that intentionally aims at improving one's skills and competencies. It is not a mechanical or repetitive process of making the performance more fluid. Instead, it involves a great deal of thinking, problem-solving, and reflection for analyzing, conceptualizing, and cultivating developing performance. This includes directing and guiding future training efforts that are then fine-tuned to dynamically evolving levels of performance.

Further, it is widely accepted that mathematics learning requires a practice that results in effortless conducting of lower-level processes (such as quick and accurate whole number arithmetic with small numbers), which relieve cognitive capacity for more complex tasks. However, the typical training of mathematical skills in educational contexts can be characterized as drill-and-practice that helps automatize basic skills, but often leads to inert routine skills instead of adaptive and flexible number knowledge. So it is very clear for preservice mathematics teachers that constant practice will enable them to near perfection. Besides, it is always conceived that to master the craft of mathematics, students should still deal with constant practice.

Consequently, preservice mathematics teachers strongly agree *(M = 4.55, SD = 0.56)* that mathematics is best learned when one works in collaboration with others. Boaler (2002) expressed that students' experiences in mathematics class, including their experiences with collaborative learning formats, can affect their identities as learners and doers of mathematics. Cobb, Gresalfi, and Hodge (2009), in an interview to show how students in two classes with very different pedagogical approaches constructed identities differently in terms of their mathematical obligations to each other, their opportunities to exhibit agency and their view of the teacher as a mathematical authority. But even in a class where student interaction is a central component of instruction and where the teacher seeks to establish a community approach to learning, students may construct mathematical identities that are individualistic and passive. These identities are influenced not only by the nature of instruction but also by their beliefs about the purpose of collaboration in their mathematics class, as well as their beliefs about mathematical

understanding more generally. These beliefs may be resistant to change and may constrain the ways that students can engage in collaborative work.

Although some of the items are responded "agree" yet this is reflective of the fact that they still believe that online references help learn mathematics better; textbooks are necessary for learning mathematics; the use of calculator aids in the learning of mathematics and; students can learn to apply mathematics only after they have mastered the basic skills.

Table 1: Preservice Teachers' Beliefs about Mathematics Learning

Beliefs on Mathematics Learning	***M***	***SD***
1. Online references help learn mathematics better.	4.17	0.71
2. A demonstration of sound reasoning is required in learning mathematics	4.55	0.53
3. Mathematics is mastered through a collection of algorithms, rules, and procedures.	4.33	0.72
4. Textbooks are necessary for learning mathematics.	4.17	0.66
5. In mathematics, skill in computation precedes solving world problems.	4.32	0.65
6. The use of calculator aids in the learning of mathematics.	4.13	0.68
7. Models and visual aids facilitate learning in mathematics.	4.49	0.61
8. Learning mathematics requires drill and practice.	4.57	0.58
9. Mathematics is best learned when one works in collaboration with others.	4.55	0.56
10. Students can learn to apply mathematics only after they have mastered the basic skills.	4.03	0.92

Note. The mean scores are interpreted as follows: 1.00 – 1.80 (Strongly Disagree); 1.81 – 2.60 (Disagree); 2.61 – 3.40 (Uncertain); 3.41 – 4.20 (Agree); and 4.21 – 5.00 (Strongly Agree)

7.1.2 Preservice Mathematics Teachers Beliefs about Mathematics in Terms of Mathematics Teaching

Considering mathematics preservice teachers' beliefs about mathematics teaching, Table 2 reflects that they strongly agree *(M = 4.65, SD = 0.48)* that teachers should negotiate social norms with the students to develop a supportive learning environment in which students can construct their knowledge. Participants strongly agree *(M = 4.29, SD = 0.79)* that mathematical models can be created to explain natural phenomena. With the principle of relativity, speed of light, Newton's law of gravitation, and many others sparkle the minds of preservice mathematics teachers to believe that mathematical models can explain natural phenomena.

Similarly, mathematics preservice teachers strongly agree *(M = 4.61, SD = 0.60)* that an effective teacher makes mathematics easy for students by guiding them step by step through problem-solving to ensure that they are not frustrated or confused. Preservice mathematics teachers believe that teachers need to guide students in their mathematics classes. In doing tasks in word problem solving, the mathematics teacher is always on guard what students are doing, guiding them step by step in solving word problems. Most students give up pretty quickly. At best, they seek help from another student or the teacher. At worst, they shut down, seeing their failure as more evidence that they aren't good at math. Neither of these behaviors will serve students in the long run. Likewise, preservice teachers strongly agree *(M = 4.60, SD = 0.49)* that the role of the teacher is to engage students in tasks that promote reasoning and problem solving and

facilitate discourse that moves students toward a shared understanding of mathematics. Mathematics teachers have significant roles in the development of students' critical minds. This is why they are in the classroom. Mathematics teachers should develop the skill of reasoning. According to Francisco and Maher (2005), the importance of students building arguments to support their solutions to problems and then defending these arguments is undisputed. This means that students making arguments in solving the problem is very important.

Furthermore, they strongly agree *(M = 4.68, SD = 0.48)* that an effective teacher provides students with appropriate challenges, encourages perseverance in solving problems, and supports productive struggle in learning mathematics. Preservice mathematics teachers should not only have skills in teaching, but he or she must also have an effective aspect in the teaching of the subject. Mathematics is conceived to be difficult for many students. Some have developed negative attitudes towards it. Others have developed anxiety when they are inside of the mathematics classroom. In relation to this observation, mathematics teachers commonly observed that students are mathematically capable yet disinterested and disengaged from the subject, perceiving it to be boring, irrelevant, and challenging (Berman, Spangers, & Varro, 2008). Likewise, Ellis (2011) and Rojan (2008) contend that learning mathematics is not fun for a majority of students studying in public and private schools but a nightmare. Mathematics curriculum contains specialized knowledge which needs certain attitudes, a frame of mind (analytical and logical thinking), and efforts on the part of the learner. Lack of ability is not the reason why students are not participating in mathematics as a subject. According to several national and international studies, students appear to be capable and performing relatively well in knowledge and skills areas (ACER, 2008; Thompson & Fleming, 2004). However, they do not engage themselves well in mathematics. These contentions encouraged mathematics teachers to understand these behaviors and feelings of the students. Besides, he or she has to do something minimizing these realities in the mathematics classrooms.

Similarly, mathematics preservice teachers strongly agree *(M = 4.58, SD = 0.50)* that mathematics teaching should focus on developing learners' understanding of concepts and procedures through problem-solving, reasoning, and discourse. Understanding concepts as believed by the preservice mathematics teachers is essential for the learners to develop. This concerns much of how teachers teach the concepts, especially in doing mathematics in the classroom. Along with this contention, mathematics teachers are using techniques or strategies on how to teach this to their students, such as through problem-solving, reasoning, and discourse. This means that understanding the concept and knowing the procedures on how to do it are important in mathematics as perceived by the majority of the preservice teachers.

Further, they strongly agree *(M = 4.45, SD = 0.63)* that the role of the mathematics teacher is to transmit mathematical knowledge and to verify that learners have received this knowledge. It is always said that the most important figure in the classroom is the teacher. NCTM (2016) expressed that a math teacher is someone who inspires their students to look beyond the pages of the textbook to become problem solvers and critical thinkers. Their boundless passion and dedication impact each and every student in the mathematics classroom. NCTM also articulated that as a math teacher, you are ensuring that your students will have the knowledge and skills that will help them not only succeed in the classroom but also be empowered by mathematics to become productive citizens of our democratic society. Mathematics teachers, whether they like it or not, should transmit

knowledge to their learners and affirmed that this knowledge was received by their students.

Likewise, participants strongly agree *(M = 4.39, SD = 0.62)* that mathematics is taught in an organized and sequential manner. Preservice mathematics teachers believe that mathematics should be taught in the classroom in a sequential manner, which means that topics or subject matter are taught in an organized manner. The sequence of topics is observed and can also mean that one topic is a prerequisite of another. As quoted by Ozarka (2017), "I believe that math content is not the problem, nor is it the students, but rather the way it is commonly taught. Math involves logic, reasoning, critical thinking, and tenacity. These are all things that people love to do". He added that other times, math is shown as a series of steps to be memorized and followed rather than understood and applied to new situations.

However, the participants disagree *(M = 2.16, SD = 1.11)* that the role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use this information to solve mathematics problems. Mathematics preservice teachers are reflective on this because this situation is more traditional where teachers are the center of the educative process nowadays, mathematics teachers are mere facilitators of learning. Students are the center of the educative process. The purpose nowadays of education is to develop the child is critical thinking and word problem-solving skills.

Table 2: Preservice Teachers' Beliefs about Mathematics Teaching

Beliefs on the Teaching of Mathematics	**M**	**SD**
1. Teachers should negotiate social norms with the students to develop a cooperative learning environment in which students can construct their knowledge.	4.65	0.48
2. Mathematical models can be created to explain natural phenomena.	4.29	0.79
3. The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use this information to solve mathematics problems.	2.16	1.11
4. An effective teacher makes the mathematics easy for students by guiding them step by step through problem-solving to ensure that they are not frustrated or confused.	4.61	0.60
5. The role of the teacher is to engage students in tasks that promote reasoning- and problem solving and facilitate discourse that moves students toward a shared understanding of mathematics.	4.62	0.49
6. The affective teacher provides students with appropriate challenges, encourages perseverance in solving problems, and supports productive struggle in learning mathematics.	4.65	0.48
7. Mathematics teaching should focus on developing learners' understanding of concepts and procedures through problem-solving, reasoning, and discourse.	4.58	0.50
8. The role of the mathematics teacher is to transmit mathematical knowledge and to verify that learners have received this knowledge	4.45	0.63
9. Teachers should recognize that what seem like errors and confusions from an adult point of view are students' expressions of their current understanding	4.09	0.61
10. Mathematics is taught in an organized and sequential manner.	4.39	0.62

Note. The mean scores are interpreted as follows: 1.00 – 1.80 (Strongly Disagree); 1.81 – 2.60 (Disagree); 2.61 – 3.40 (Uncertain); 3.41 – 4.20 (Agree); and 4.21 – 5.00 (Strongly Agree)

7.1.3 Preservice Mathematics Teachers Beliefs about Mathematics Education in Terms of Mathematics Assessment

Table 3 reflects the mean and standard deviation of mathematics preservice teachers' beliefs about mathematics assessment. As shown in this table, preservice mathematics teachers strongly agree *(M = 4.41, SD = 0.69)* that mathematical understanding and processes can be measured through the use of a variety of assessment strategies and tasks. Herrington, Reeves, and Oliver. (2006) cited that multiple sources of assessment will involve different ways of presenting tasks to students as well as different forms of probing assessment information so that valid inferences about students' progress can be made.

Likewise, preservice mathematics teachers strongly agree *(M = 4.54, SD = 0.53)* that assessment is a process that should help students become better judges of their work, assist them in recognizing high-quality work when they produce it and support them in using evidence to advance their learning. In this regard, self-assessment plays an essential role in assessment, most especially when students want to track their performance in mathematics. Boud and Falchikov (2007) contend that assessment focused on future learning reportedly improves both short- and long-term outcomes by helping students to make "increasingly sophisticated judgments about their learning." This statement can be taken to mean that assessment is an integral part of the learning process that must play an essential role in instructional design.

Similarly, preservice mathematics teachers strongly agree *(M = 4.36, SD = 0.64)* that assessment is an ongoing process that is embedded in instruction to support student learning and make adjustments to instruction. This means that in the classroom, mathematics teachers can't do away with assessment because the very purpose of it is to provide feedback to the teachers and the students themselves. According to the National Council of Teachers of Mathematics (NCTM, 2000), "assessment should support the learning of important mathematics topics and furnish useful information to both teachers and students." Although tests may be part of an effective program of assessment, "assessment should be more than merely a test at the end of instruction to see how students perform under certain conditions; rather, it should be an integral part of instruction that informs and guides teachers as they make instructional decisions."

Furthermore, preservice mathematics teachers strongly agree *(M = 4.29, SD = 0.47)* that multiple data sources are needed to provide an accurate picture of the teacher and student performance. This means that student performance is an accumulation of multiple data. Mathematics teachers should provide students with varied learning activities to arrive at valid and reliable information about student academic performance. Barge (2012) concisely provided the rationale for using multiple data sources in teacher evaluation when they stated, "no single data source works for all persons because good teaching comes in a variety of forms and styles." Multiple data sources enable the supervisor to obtain a more accurate picture of performance and assist the teacher in increasing student success. Besides, Stronge and Tucker (2003) affirmed that using multiple data sources in the teacher evaluation process offers numerous advantages over single-source data collection processes. Advantages cited are (a) a more complete portrait of a teacher's performance; (b) data collection in more naturally occurring situations; (c) integration of primary and secondary data sources in the evaluation; (d) greater objectivity and reliability in documenting performance; (e) documentation of performance that is more closely related to actual work; (f) a more legally defensible basis for evaluation decisions; and (g) more teacher support and involvement in teacher

evaluation when they feel that it is pertinent to their own performance and fair in its use of information in their individual case.

However, preservice mathematics teachers disagree that single assessment can be used to make important decisions about students and teachers. This is true because no one believes that a single assessment can point out the performance or can point out the attributes of the learners. Along this line, classroom assessment and grading practices have the potential not only to measure and report learning but also to promote it. Furthermore, Benbow in Handal (2003) found that preservice elementary teachers thought of mathematics as a discipline based on rules and procedures to be memorized and that there is usually one best way to arrive at an answer.

Table 3: Preservice Teachers' Beliefs about Mathematics Assessment

Beliefs on Mathematics Assessment	**M**	**SD**
1. Mathematical understanding and processes can be measured through the use of a variety of assessment strategies and tasks.	4.41	0.69
2. Assessment is a process that should help students become better judges of their work, assist them in recognizing high-quality work when they produce it, and support them in using evidence to advance their learning.	4.54	0.53
3. A single assessment can be used to make important decisions about students and teachers.	2.55	1.14
4. The primary purpose of assessment is accountability for students through report card marks or grades.	3.59	1.02
5. Assessment is an ongoing process that is embedded in instruction to support student learning and make adjustments to instruction.	4.36	0.64
6. Assessment is something that is done to students.	4.10	0.83
7. Multiple data sources are needed to provide an accurate picture of the teacher and student performance.	4.29	0.57
8. Only multiple-choice and other "objective" paper-and-pencil tests can measure mathematical knowledge reliably and accurately.	3.23	1.24
9. Assessment in the classroom is an interruption of the instructional process.	3.25	1.21
10. Assessment is an ongoing process that is embedded in instruction to support student learning and make adjustments to instruction.	4.48	0.61

Note. The mean scores are interpreted as follows: 1.00 – 1.80 (Strongly Disagree); 1.81 – 2.60 (Disagree); 2.61 – 3.40 (Uncertain); 3.41 – 4.20 (Agree); and 4.21 – 5.00 (Strongly Agree)

7.2. Implications of Preservice Teachers' Beliefs about Mathematics Education for Classroom Instruction

The results of this study have implications for classroom instruction considering preservice mathematics teachers' beliefs about mathematics learning, mathematics teaching, and mathematics assessment.

Why students are in school because they want to learn what is intended for them to learn, learning, therefore, is one of the most important constructs fundamental to the students. Thus, it is essential to note to look into the implications of preservice

mathematics teachers' beliefs towards mathematics learning. The results that preservice mathematics teachers strongly agree in almost all of the issues on mathematics learning suggests that students should be equipped with the knowledge, information, and ideas all about concerning issues on the teaching of mathematics. This should be given prior attention because this will be handed down from generation to generation.

The reason why mathematics teachers teach the subject, it is because they want to impart knowledge and skills to the students. The results showing preservice mathematics teachers' strong agreement on the majority of the issues on the teaching of mathematics reflect that mathematics teachers are an essential figure in the classroom. The success of the teaching-learning depends on them. They have important roles in developing critical thinking skills and the reasoning power of the students. Thus, teachers should also equip themselves with the knowledge and skills of how to transmit mathematical knowledge and to verify that learners have received this knowledge.

On the other hand, findings showing disagreement on the role of the teacher of telling students precisely what definitions, formulas, and rules they should know and demonstrate how to use this information to solve mathematics problems suggest reflections from the mathematics teachers. Although the trend is to guide students in the process of learning, however, mathematics teachers need to intervene in the students during the process of learning. Concepts that are vague to the students should be clarified and simplified. Queries concerning the process of learning should be handled in a positive and accommodating manner.

Assessment is one of the most critical aspects of the process of students learning because it informs mathematics teachers whether or not learning has taken place. Thus, findings that preservice mathematics teachers strongly agree in almost all aspects of assessment in the mathematics classroom should be keenly observed. See to it that academic or whatever performance related to classroom and school should be determined using multiple assessment methods. Likewise, self-assessment should be encouraged among students for them to reflect on their learning, and mathematics teachers need to develop skills in guiding students on how to evaluate themselves.

On the other hand, preservice teachers' disagreement that a single assessment can be used to make important decisions about students and teachers reflects an actual practice in assessment. Mathematics teachers should refrain from exercising an individual assessment. Instead, mathematics teachers are encouraged to utilize various and multiple assessment strategies so that concrete evidence of student performance can be attained.

8. Conclusion

Mathematics is considered as one of the most important subject areas in the elementary, secondary, and even tertiary education curriculum. It concerns how teachers teach and the way students learn. It was conceived by mathematics educators that beliefs play a significant role in mathematics learning and teaching. The learning outcomes of students are strongly related to their beliefs and attitudes about mathematics.

Preservice mathematics teachers beliefs that a demonstration of sound reasoning is required in learning mathematics and is mastered through a collection of algorithms, rules, and procedures. Likewise, they believe that skills in computation precede solving world problems, and learning mathematics require drill and practice. Furthermore, they believe that models and visual aids facilitate learning in mathematics. This means that all of these important attributes influence mathematics learning.

Concerning preservice mathematics teachers' beliefs about mathematics teaching, they believe that teachers should negotiate social norms with the students to develop a

cooperative learning environment in which students can construct their knowledge. They also believe that mathematical models can be created to explain natural phenomena. Likewise, they believe that an effective teacher makes mathematics easy for students by guiding them step by step through problem-solving to ensure that they are not frustrated or confused and the role of the teacher is to engage students in tasks that promote reasoning- and problem-solving and facilitate discourse that moves students toward a shared understanding of mathematics. Furthermore, they believe that an effective teacher provides students with appropriate challenges, encourages perseverance in solving problems, and supports the productive struggle in learning mathematics. They also added that mathematics teaching should focus on developing learners' understanding of concepts and procedures through problem-solving, reasoning, and discourse.

However, preservice mathematics teachers are not convinced of the idea of telling the students to memorize the definition, formulas, and rules correctly. They should know and demonstrate how to use this information to solve mathematics problems. They believe that students can learn mathematics better if they are taught to think critically. Definitions and formulas are always there as an aid for a better understanding of the concepts in mathematics.

Responses of preservice mathematics teachers indicate that their beliefs of mathematical understanding and processes can be measured through the use of a variety of assessment strategies and tasks. They likewise believe that assessment is a process that should help students become better judges of their work, assist them in recognizing high-quality work when they produce it and support them in using evidence to advance their learning. They also believe that assessment goes hand in hand with instruction. They also believe that assessment utilized multiple data sources to provide a more accurate picture of students' performance. However, they do not believe that a single assessment can be used to make important decisions about students and teachers.

9. Acknowledgments

The authors would like to express their appreciation to their families, students, co-teachers, Philippine Normal University Visayas, and Philippine Normal University North Luzon for the opportunity and support, and above all, to God Almighty, for without Him, they are nothing.

10. The Authors

The authors are a doctoral student at Philippine Normal University-Manila under the customized scholarship program. They are faculty members of the Philippine Normal University Visayas and Philippine Normal University North Luzon teaching mathematics subjects in undergraduate and graduate schools.

11. References

Australian Council for Educational Research (2008).*Trends in International Mathematics and Science Study*. Viewed 29 September 2008.http://www.acer.edu.au/ timss/results.html

Barge, J. D. (2012). Documenting teacher performance with multiple data sources. Georgia Department of Education Teacher Keys Effectiveness System Fact Sheets, page 73 of 101

Boaler, J. (2002). The development of disciplinary relationships: Knowledge, practice, and identity in mathematics classrooms. In Proceedings of the 26th Annual Meeting of the International Group for the Psychology of Mathematics Education (pp. 113-120). Norwich, England.

Boud, D., and Falchikov, N. (2007). Developing assessment for informing judgment. In D. Boud & N. Falchikov (Eds.), Rethinking assessment in higher education: Learning for the longer term (pp. 181-197). London: Routledge.

Boz, N. (2008). Turkish Preservice Mathematics Teachers' Beliefs About Mathematics Teaching.. *Australian Journal of Teacher Education, 33*(5).

Burgin, M. (2004). Axiomatic Theory of Algorithms: Computability and Decidability in Algorithmic Classes, Preprint in Mathematics LO/0409142, (electronic edition: http://arXiv.org)

Campbell, P. F., Rust, A. H., Nishio, M., DePiper, J. N., Smith, T. M., Frank, T. J., … Choi, Y. (2014). The relationship between teachers' mathematical content and pedagogical knowledge, teachers' perceptions, and student achievement. Journal for Research in Mathematics Education, 45(4), 419–459. doi:10.5951/ jresematheduc.45.4.0419

Christenson, S. L., Reschly, A. L., Appleton, J. J., Berman, S., Spanjers, D., & Varro, P. (2008). Best practices in fostering student engagement. In A. Thomas, & J. Grimes (Eds.), *Best practices in school psychology V* (pp. 1099-1120). Washington, DC: National Association of School Psychologists.

Cobb, P., Gresalfi, M., and Hodge, L. L. (2009). Analyzing the identities that students develop in mathematics class. Journal for Research in Mathematics Education, 40(1), 40-68.

Ellis, A.B. (2011). Generalization promoting actions. How classroom collaborations can support students mathematical generalizations. Journal for Research in Mathematics Education, 42(4), 308-345.

Francisco, J.M., and Maher, C.A. (2005). Conditions for promoting reasoning in problem-solving: Insights from a longitudinal study. Journal of Mathematical Behavior, 24, 361-372.

Futch, L. et. al. (2008). Problem Solving and Computational Skill: Are They Shared or Distinct Aspects of Mathematical Cognition? J Educ Psychol. 1; 100(1): 30–47. doi:10.1037/0022-0663.100.1.30.

Ghazali, M. and Sinnakaudan, S. (2014). A Research on Teachers' Beliefs about Mathematics Teaching and Learning between Sekolah Kebangsaan (SK), Sekolah Jenis Kebangsaan Cina (SJKC) and Sekolah Jenis Kebangsaan Tamil (SJKT). Journal of Education and Practice. Vol.5, No.31, 2014

Handal B. (2003). Teachers' Mathematical Beliefs: A Review. The Mathematics Educator2003, Vol. 13, No. 2, 47–57.

Herrington, J., Reeves, T. C., and Oliver, R. (2006). Authentic tasks Online: a synergy among learner, task and technology. Distance Education, 27(2), 233–247.

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking Pedagogical Content Knowledge: Conceptualizing and Measuring Teachers' Topic-Specific Knowledge of Students. Journal for Research in Mathematics Education, 39, 372-400.

Hill, C. H., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42, 2*, 371-406.

Lamichhane, B. (2017). Teachers' beliefs about mathematics and instructional practices. The Saptagandaki Journal, Vol. VIII

Latin, R.W. and Berg, K. E. (2004). Essentials of research methods in health, physical education, exercise science, and recreation. Lippincott Williams & Wilkins, 2nd Edition.

Lehtinen, E. , Hakkarainen, K. and Palonen, T. (2014). Understanding Learning for the Professions: How theories of learning explain coping with rapid change. In S. Billett, H. Gruber & C. Harteis (Eds). International Handbook of Research in Professional Practice-based Learning (199-224). Springer.

Mansour, N. (2009). Science teachers beliefs and practices: issues, implications and research agenda. International Journal of Environmental & Science Education Vol. 4, No. 1, January 2009, 25-48

Marpa, E. P. (2019). Comparative analysis of performance in scientific measurement of the grade nine students in the three types of written test. Philippine Normal University Visayas, Cadiz City, Philippines.

Mosvold, R. and Fauskanger, J. (2014). Teachers' Beliefs about Mathematical Knowledge for Teaching Definitions. International Electronic Journal of Mathematics Education. Vol.8, No.2-3

National Council of Teachers of Mathematics (2000). Principles and standards for school mathematics. Reston, VA: Author.

National Council of Teachers of Mathematics (2016). Annual meeting and exposition, April 13-16, San Francisco.

Ozarka, C. (2017). Teaching Math in the 21st Century: Changing the Focus from Calculations to Critical Thinking. Blog.learningbird.com.

Resnick, Lauren. *Education and Learning to Think.* Washington, DC: National Academy Press, 1987.

Rojan, T. (2008). Mathematic learning in the junior secondary schools: Students access to significant Mathematical ideas. In L. D. English (Ed.). Handbook of International Researcher in Mathematical Education (pp. (pp. 143-164). London: Lawrence Erlbaum Associates

Sapkova, A. (2014). Study on Latvian mathematics teachers' espoused beliefs about teaching and learning and reported practices. International Journal of Science and Mathematics Education 11(3) · June 2013

Shabiralyani, J., Hasan, K. S., Hamad, N., and Iqbal, A. (2015). Impact of visual aids in enhancing the learning process case research: District Dera Ghazi Khan. Journal of Education and Practice, Vol.6, No.19.

Stronge, J. H., and Tucker, P. D. (2003). Handbook on teacher evaluation: Assessing and improving performance. Larchmont, NY: Eye on Education.

Stipek, D., Givvin, K., Salmon, J., and MacGyvers, V. (2001). Teachers' beliefs and practices related to mathematics instruction. Teaching and Teacher Education 17. pp. 213 -226

Thomson, S. & Fleming, N. (2004).*Summing it up: Mathematics Achievement in Australian Schools in TIMSS 2002* (TIMSS Australia Monograph No 6).Camberwell, Victoria:ACER