

PRE-SERVICE TEACHERS' BELIEFS ABOUT MATHEMATICS

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Abstract

This study aims to explore pre-service teachers' beliefs about mathematics. Those beliefs are defined into beliefs about mathematics as nature, beliefs about learning mathematics, and beliefs about teaching mathematics. Furthermore, each of the dimensions is characterized as connectionist, transmission, or discovery. This is a survey study. All respondents were given a questionnaire involving nine rating statements using Likert Scale without the "neutral" level. The Cronbach Alpha value for the questionnaire is 0.71, which is considered to be good. In addition, to know more about the pre-service teachers' beliefs, they are also asked to elaborate the reasons of the rating they chose for each statement provided in the questionnaire. This study involved 65 pre-service mathematics teachers at a Mathematics Education Study Program of a private university in Indonesia. They were in the beginning of their fourth year at the university. Based on the results and discussion, it can be concluded that the pre-service mathematics teachers involved in this study tend to have discovery orientation on the dimension of mathematics as nature. On the other hand, both dimensions of learning mathematics and teaching mathematics have transmission orientation. In addition, mathematics is seen as an applicable discipline which demands understanding concepts and communicating ideas.

Keywords: *beliefs, mathematics, pre-service teachers*

Presenting Author's biography



Sri Rejeki is a junior lecturer of Mathematics Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta, Indonesia. Besides focusing on her studies of pre-service mathematics teachers' beliefs, she is also focusing on the studies of mathematics learning for lower secondary schools, particularly on designing and researching learning trajectories on the topic of measurement. The learning trajectories designed concerns with integrating the history of mathematics and ethno-mathematics in classroom

practices. With her colleagues, she wrote a book entitled "Mathematics Problem Solving". You can visit her at www.srirejeki345.wordpress.com.

1. Introduction

It is generally believed that good teachers bring positive effects on students' understanding. According to the good criteria of teachers mentioned in [1], there are four competencies which have to be mastered, namely pedagogical competency, individual competency, social competency, and professional competency. Hence, mastering all those four has become a big challenge for teachers. In this case, institutions of teacher education have also essential role to face this challenge.

Regarding the roles of institutions of teacher education, it has been well documented in [2] that an institution of teacher education is responsible to provide pre-service teachers who have the four competencies. Professional competency, which is mainly about the competency needed regarding the field of study, plays more important role than the other three. It is because to establish a good teaching, a teacher should have deep understanding about the subject matter, should have deep understanding on how to learn the subject, and should have deep understanding on how to teach the subject. Therefore, during the four year study of pre-service teachers, the institutions of teacher education in Indonesia provide more academic courses than pedagogic courses.

In the field of mathematics, which is commonly believed as the most difficult subject for primary or secondary school students, many academic and pedagogic courses are provided in every institution of teacher education. However, this does not guarantee that it will bring good teaching practices to schools. It is because there are many factors which influence teachers' practices, such as knowledge and beliefs [3, 4, 5, 6]. Moreover, pre-service teachers' beliefs about mathematics teaching and pedagogical content knowledge can influence the decisions or the selection method of teaching [7, 8, 9]. In another case, [10] found that teachers' beliefs were used in determining how teachers will teach either they realized it or not. For instance, when teachers believe that mathematics is mainly about memorizing formulas, then they will also emphasize memorization instead of understanding the mathematics itself.

Other researchers found that it is not guaranteed that enrolled students of mathematics study program in an institution of education have positive beliefs towards mathematics [11]. It was also explained in [11] that studies show that prospective teachers do not like mathematics, believe they will fail, and also believe that mathematics can only be understood by some students. Furthermore, other study found that pre-service teachers believe that mathematics consists of facts, procedures, and regulations which need to be memorized [9]. Thus, it is important to investigate the beliefs of pre-service teachers about mathematics. This is because the pre-service teachers' beliefs are important elements to be studied in each teacher education program [12]. In addition, according to Barlow and Reddish (2006) in [11] this could help them to develop and implement an effective teacher education program. *Therefore, this study aims at exploring pre-service mathematics teachers' beliefs about mathematics.*

2. Theoretical Background

Thompson in [9] defined beliefs as the understandings that one has about the interaction of mathematics and the world that one believes to be true. Some people may think that belief is knowledge. Yet, although they are closely related to each other, when comparing beliefs and knowledge, knowledge is a belief that is held with such certainty that it is considered a fact to that particular person [13]. Therefore, a statement that is a belief for some people may be deliberated knowledge for some others.

The historical approach for measuring beliefs is qualitatively through methods such as interviewing and observations [13]. However, according to Simon et al (2000) [13], as the demand of larger sample size grew, measurement of beliefs moved to survey because it was easier to evaluate compared to qualitative measures. Moreover, it is also explained in [13] that the survey usually used Likert Scale where the respondents select their level of agreement or disagreement with a given statement.

Regarding the method of measuring beliefs, in this study we provide a rating scale questionnaire, which is also using Likert Scale. In addition, the respondents, which are the pre-service

teachers, have to elaborate the reasons of every level for every statement they have chosen. In this case, the “neutral” level of Likert Scale was removed because the level is not really explainable.

In mathematics, Ernest (1991) in [15] argued that mathematics teachers’ belief system has three dimensions; namely mathematics as nature, learning mathematics, and teaching mathematics. Furthermore, in [16], it is characterized that the orientation of teachers towards each of these components as connectionist, transmission, or discovery. As it is mentioned in [16], connectionist orientation entails beliefs in the importance of both efficiency and effectiveness in mathematics. Transmission orientation involves beliefs in the importance of a collection of procedures, particularly in regard to paper pencil methods. Discovery orientation includes beliefs in the importance of students’ creation of their own methods and their ability in practical methods.

In this study, we were trying to explore pre-service mathematics teachers’ belief based on three dimensions, which are mathematics as nature, learning mathematics, and teaching mathematics. In addition, each of the dimensions is categorized into three orientations; namely connectionist, transmission, and discovery.

3. Methods

This is a survey study. All respondents in this study were given a questionnaire involving nine rating statements by using Likert Scale without the “neutral” level. For each dimensions of mathematics, the respondents were asked whether, and how strongly, they agree or disagree to each dimension using a point rating scale [5]. The questionnaire used in this study were adapted from Mathematics Beliefs Questionnaire (MBQ) including beliefs about mathematics as nature, beliefs about learning mathematics, and beliefs about teaching mathematics [11]. The Cronbach Alpha value for the questionnaire is 0.71, which is considered to be good [11]. In addition, to know more about students’ beliefs, in this study, the students must also elaborate the reasons of their choice. Those reasons will be analyzed descriptively.

This study involved 65 pre-service mathematics teachers in Central Java, Indonesia. They were enrolled in a four-year teacher education program at the Mathematics Education Study Program of a private university in Surakarta. This study was conducted in the beginning of their fourth year in the university. The students have completed almost all mathematics and pedagogical courses. Moreover, they have also finished the three-month project of teaching assistant in schools.

At the very beginning of the data analysis, all responses were grouped into four levels, namely strongly agree, agree, disagree, and strongly disagree. Afterwards, in order to know the tendency of students’ beliefs, we determine the percentage of the responses of each question for each level. Furthermore, the elaborated reasons of students for each question could be used as supporting arguments to derive the conclusions of those pre-service teachers’ beliefs about mathematics.

4. Results and Discussion

Beliefs about Mathematics as Nature

Regarding the beliefs about mathematics as nature, there are three statements given to students, which are: (1) mathematics is primarily an abstract subject; (2) mathematics is about reasoning in solving problems; and (3) mathematics is applicable. From the perspective of teachers’ orientation, each of the statement describes the connectionist, transmission, and discovery, respectively. Table 1 will describe the results.

Tab 1. Beliefs about Mathematics as Nature

Item	Strongly Disagree		Disagree		Agree		Strongly Agree	
	f	%	f	%	f	%	f	%
Mathematics is primarily an abstract subject	5	7.7	31	47.7	26	40	3	4.6

Mathematics is about reasoning in solving problem	3	4.6	2	3.1	42	64.6	18	27.7
Mathematics is applicable	1	1.5	1	1.5	35	53.9	28	43.1

The table shows that 44.6% of the pre-service mathematics teachers see mathematics as an abstract subject. At the same time, 92.3% of all think that mathematics is about reasoning in solving problems. Lastly, 97% of them agree that mathematics is applicable. Therefore, the results claim that on the belief about mathematics as nature, the pre-service teachers tend to see mathematics from the perspective of discovery.

However, as it is mentioned in [15] that an individual teacher's conception of mathematics teaching and learning might combine elements of each of connectionist, transmission, or discovery, even where they appear to be contradictory. It is shown from the large amount of pre-service teachers who also agree with the second statement (92.3%), as well as the small amount of those who agree with the first statement (44.6%).

Considering the respondents' reasons about their choice, most students who have discovery orientation can clearly see that mathematics is closely related to people's daily life and to other subjects. Selling and buying activities are the examples people's daily life, which one should apply mathematics; and physics is an example of other subject-used mathematics. However, from those reasons, what the respondents think about mathematics application is mainly related to accounting and arithmetic. These facts could be a recommendation for the institution of teacher education to provide better learning experience for the pre-service teachers. This is because university courses seem to have an effect on shaping the student teachers beliefs [18].

Beliefs about Learning Mathematics

Regarding the beliefs about learning mathematics, there are three statements given to students, which are: (1) time should be spent practicing computational procedures before students spend much time solving problems; (2) in learning mathematics, students should understand mathematics concepts, principles, and strategies; and (3) in learning mathematics, students should be able to provide reasons to support their solution. From the perspective of teachers' orientation, each of the statement describes the connectionist, transmission, and discovery, respectively. The results are described in this following table.

Tab 2. Beliefs about Learning Mathematics

Item	Strongly Disagree		Disagree		Agree		Strongly Agree	
	f	%	f	%	f	%	f	%
Time should be spent practicing computational procedures before students spend much time solving problems	2	3.1	9	13.8	47	72.3	7	10.8
In learning mathematics, students should understand mathematics concepts, principles, and strategies	1	1.5	2	3.1	36	55.4	26	40
In learning mathematics, students should be able to provide reasons to support their solutions	2	3.1	3	4.6	46	70.8	14	21.5

It can be seen from the table that the highest percentage (96.4%) is on the second statement, which states that in learning mathematics, students should understand mathematics concepts, principles, and strategies. Whereas, the second (92.3%) and the third (83.1%) are the statements, stating the importance of students' ability to provide reasons to support their solutions and time spending to practice computational procedures before students spend much time solving problems. Based on the results, it can be concluded that the pre-service teachers tend to see learning mathematics as transmission.

However, as it is mentioned in [15], an individual teacher's conception of mathematics teaching and learning might combine elements of each of connectionist, transmission, or discovery. It is shown from the large amount of pre-service teachers who also agree with the first and the second statements, which are 92.3% and 83.1%, respectively.

Regarding the reasons provided by the pre-service teachers, almost all of those think that understanding mathematics concepts, principles, and strategies is very important because it will make students easier to learn mathematics. This also means that students' understanding is the basic of learning mathematics.

Beliefs about Teaching Mathematics

Regarding the beliefs about mathematics as nature, there are three statements given to students, which are: (1) mathematics should be taught as a collection of concepts, skills, and algorithms; (2) in mathematics lessons, students should be encouraged to explain their mathematics ideas; and (3) mathematics instruction should involve the investigations and findings by students themselves. From the perspective of teachers' orientation, each of the statement describes the connectionist, transmission, and discovery, respectively. The results can be described as follows.

Tab 3. Beliefs about Teaching Mathematics

Item	Strongly Disagree		Disagree		Agree		Strongly Agree	
	f	%	f	%	f	%	f	%
Mathematics should be taught as a collection of concepts, skills, and algorithms	4	6.2	8	12.3	51	78.4	2	3.1
In mathematics lessons, students should encourage to explain their mathematics ideas	2	3.1	2	3.1	43	66.1	18	27.7
Mathematics instruction should involve the investigations and findings by students themselves	1	1.5	9	13.9	44	67.7	11	16.9

The table describes that the amount of pre-service students who think that the lessons should be taught as a collection of concepts, skills, and algorithms is 81.5%, that of those who think that in mathematics lessons, students should encourage to explain their mathematics ideas is 93.8%, and that of those who see mathematics instruction should involve the investigations and findings by students themselves is 84.6%. Based on the results, it can be seen that the highest percentage is on the second item. Therefore, it implies that the pre-service teachers tend to have transmission orientation on the dimension of learning mathematics.

However, as it is mentioned in [15], an individual teacher's conception of mathematics teaching and learning might combine elements of each of connectionist, transmission, or discovery. It can be seen from the percentage of pre-service teachers who also agree with the first and the third statements, which are nearly the same (81.5% and 84.6%).

The reasons of the importance of teaching mathematics as encouraging students to explain their mathematics ideas are mainly to support students for being active and able to communicate their thinking. However, some students who disagree about this perspective think that communication skill is impossible for students who are not good in mathematics. These facts could also be a recommendation for the institution of teacher education to provide better learning experience for the pre-service teachers. This is because university courses seem to have an effect on shaping the student teachers beliefs [18].

5. Conclusion

Based on the results and discussion, it can be concluded that the pre-service teachers involved in this study tend to have discovery orientation on the dimension of mathematics as nature. On the other hand, both dimensions of learning mathematics and teaching mathematics have transmission

orientation. On the perspective of mathematics as an applicable discipline, the pre-service teachers' perspective is limited to the activities related to economics or physics. While, most of them agree that learning mathematics demands understanding concepts, principles and strategies because all of those are the basic of mathematics. In addition, almost all of the pre-service teachers mentioned the importance of encouraging students to explain mathematics ideas in teaching mathematics because of the importance of mathematics communicating skills.

The points described in this study are the mathematics beliefs of the pre-service mathematics teachers who are in their fourth year of study. The beliefs might be different for first year pre-service teachers or for in-service teachers. Therefore, further studies might concern the beliefs of pre-service teachers who are in the earlier year of their studies or on the beliefs of in-service teachers who have several years' experiences of teaching mathematics. Therefore, we could also see how the courses in the institutions of teacher education influence the beliefs of pre-service mathematics teachers.

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