



Teachers' and students' beliefs of mathematics at State Senior High School 5 Semarang

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Abstract

The aim of this research was to discover the relationship between teachers' and students' beliefs of mathematics. The sample considered of two teachers, twenty eight students from 10th grade natural science 6 (X IPA 6) and twenty eight students from 10th grade natural science 10 (X IPA10) at state senior high school 5 Semarang. The data were collected from questionnaires and guided interviews on beliefs about mathematics. The research results showed that both of the mathematics teachers had platonist beliefs. It was found specifically that 4.76% of students in class X IPA 6 consistently had instrumentalist beliefs, 85.71% were consistent with their platonist beliefs, and 9.52% consistently had problem solving beliefs; while in class X IPA 10, 4.76% consistently showed instrumentalist beliefs, 80.95% were consistent with their platonist beliefs, and 14.29% consistently had problem solving beliefs. This indicates that there is a relationship between teachers' and students' beliefs, namely in the tendency towards platonist beliefs; and also that the teacher's beliefs influence the student's beliefs.

Keywords: teachers' beliefs, students' beliefs, relationship between teachers' and students' beliefs, platonist beliefs, and mathematics.

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INTRODUCTION

Teachers, from Javanese Philosophy called as person who give meaning that their words and behavior, are followed and obeyed by the students. The development of future generations that have superior resources depends on the important role of a teacher in learning. Students often regard mathematics as a problem that only appears in school, a case both content of the material and person who taught it. This is where the teacher begins to play a role, a teacher's belief can help learners to become a superior generation. Widjajanti (2009) explains that teachers' beliefs and student beliefs are among the factors that influence mathematics learning achievement. If students always assume that mathematics is difficult, only containing theorems and belonging clever students; this makes excessive anxiety that ultimately affects the activity of learning mathematics class.

Therefore, a teacher must have a strong belief, because it will make the teacher's attitude in teaching to be calm and affect the students' confidence in Mathematics. If a teacher lacks confidence, how can the teacher teach the learners well?

The definition of belief has extensively been discussed by experts but there is no consensus about it in educational literature. Belief is the natural disposition of a person (Chong, Wong, & Quek, 2005), something that a person considers to be true, and this may originate from experience, reality, or only imagination (Chapman, 2015). A number of researchers have shown that belief is a concept that is related to attitude (Eagly & Chaiken, 1993; Goldin, Rösken & Törner, 2009). However, Griffin and Ohlsson (2009) consider that attitude and belief are two different concepts; attitude refers to the subjective evaluation of "positive" or "negative" behaviour, while belief



refers to the acceptance or rejection of a proposition. In contrast to the above opinion, Pehkonen and Pietila (2003) do not place belief in the affective domain of a person but somewhere in between the cognitive and affective domains, in a place they call the “twilight zone”, since belief is an interaction between a person’s thoughts and feelings that cannot be avoided. On one hand, belief is a highly subjective part of a person’s knowledge (Nurmi, Hannula, Majjala & Pehkonen, 2003). Goldin (2002) writes that every individual has his or her own emotions, attitudes, beliefs, and values/ethics/morals. Furthermore, Rokeach as mentioned by Leder and Forgasz (2002), stating that belief is a simple, conscious or unconscious statement as part of what a person says or does, usually preceded by the phrase “I believe that”. Schoenfeld (1992) illustrates that beliefs are the basis of a person's drive in behaving and understanding that an individual has for an event. Belief is the mental state of a person who is regarded as a truth and affects his words or behavior.

Eynde, Corte and Verschaffel (2002) explore mathematical beliefs based on the opinions of various experts, concerning teachers, preservice teachers, and students. Students’ beliefs about mathematics education can be categorized as: (1) beliefs about mathematics, (2) beliefs about themselves as mathematics learners, and (3) beliefs about the teacher’s role in mathematics teaching (Leder & Forgasz, 2002). Teachers’ beliefs about mathematics can also be divided into three categories: (1) problem solving, which views mathematics as a space for human discovery that is continually developing and where patterns emerge and are subsequently filtered to become knowledge, (2) platonist, which views mathematics as something static but comprising fields of knowledge that are interconnected, and (3) instrumentalist, which views mathematics as a set of tools that

are made up of facts and rules to be used in solving various problems (Beswick, 2012; Thompson, 1992) (See. Tabel 1).

Over the past few years, studies on teachers’ beliefs about mathematics have attracted the attention of numerous researchers (Beswick, 2006, 2012; Felbrich, Müller & Blömeke, 2008; Lerch, 2004; Mkomange & Ajegbe, 2012; Muhtarom et al, 2017a, 2017b; Ozturk & Guven, 2015; Thompson, 1992), but few of these studies focus on the relationship between teachers’ and their students’ beliefs about mathematics. Some researchers focus only on teachers’ beliefs about the nature of mathematics which influences the way they teach (Beswick, 2006; Felbrich, Müller & Blömeke, 2008; Mkomange & Ajegbe, 2012). Other studies are about how beliefs influence students in their acceptance of mathematics learning (Mkomange & Ajegbe, 2012; Pehkonen & Pietila, 2003). Positive beliefs motivate students to make a more concerted effort (Lerch, 2004; Ozturk & Guven, 2015), and these beliefs increase students’ success. Students who are strong in mathematics believe that their success is a result of having a good command of the subject matter, and having a good command of the subject matter is an important factor in forming their mathematical competence. This belief can encourage students to develop ideas enabling them to achieve better results. This means that motivation, metacognitive competence, and beliefs influence students’ efforts (Muhtarom, Juniati & Siswono, 2017a), while the belief that mathematics is a difficult subject has a negative impact on the student’s learning achievements. Muhtarom, Juniati and Siswono (2017b) suggests that teachers reflect upon their beliefs and ask their students what their beliefs are about mathematics. On the basis of this condition, the researcher intends to investigate the relationship between teachers’ and students’ beliefs about mathematics.

Table 1. Beliefs Description

	Beliefs about the nature of mathematics	Beliefs about teaching mathematics	Beliefs about learning mathematics
Instrumenta	Mathematics as a tool of facts, rules and skills	Focused content with emphasis on performance	Passive acceptance to knowledge
Platonist	Mathematics as a definite knowledge consists of abstract	Focusing content with emphasis on understanding.	Active construction of understanding.
<i>Problem Solving</i>	Mathematics as a dynamic field and expanding the creation of human	Focuses on the learners	Exploring the interests of each individual

METHOD

General Background of Research

This research describes the relationship between the beliefs of teachers and students about mathematics. Of course this is very important to be studied in more depth because it provides the consistency of the relationship of beliefs owned by teachers with their students so that it becomes the basis for teachers to be able to develop students' beliefs.

Sample of Research

The participants of the research are teachers and students from two 10th grade natural science classes (X IPA 6 and X IPA 10) at state senior high school 5 Semarang during the second semester of the academic year 2016/2017. The participants were purposely chosen given the following criteria: (1) one of the mathematics teachers had over 20 years' experience and the other had less than 20 years' experience; (2) the research subjects had in-depth knowledge about mathematics, and (3) the students were all from classes taught by the two teachers.

Instrument and Procedures

Sources of data in the study later are two teachers who teach class X in state senior high school 5 Semarang and students of class X which is managed by the teacher. Other data sources are related data from questionnaire by teacher and learner and interview result. Data collection was done on natural setting, primary data source, and more data collection technique in participant observation using questionnaire, in depth interviews and documentation.

Data were collected through questionnaires with multiple choice answers according to instrumentalist, platonist, and problem solving views. The instrument was developed and modified from the opinions of a number of researchers (Biasutti, 2012; Perry, Tracey & Howard, 2014; Zakaria & Musiran, 2010). The questionnaire was first validated by three validators who are experts in the field; from the results of the validation it was concluded that the questionnaire was suitable and could be used to measure the beliefs of teachers and students. The questionnaire consisted of three sections, about the nature of mathematics (BM), beliefs about the teacher's role in mathematics teaching (BT), and beliefs about mathematics learning (BL); each section contained ten questions.

The research data is collected in three stages. First stage which was held on March 14, 2017; and the second stage which was held on April 18, 2017 in the classroom of X IPA 6 and X IPA 10 at state senior high school 5 Semarang. The questionnaire given to the students and teachers that carried in two stages at different times aimed to identify the level of consistency of the subject's belief in math. The teachers and students were asked to complete the questionnaire by selecting answers according to their beliefs. Scores were ranged from 1.00 (instrumentalist) to 3.00 (problem solving) for each teacher and each student for all the questions answered, based on the following formula (Siswono, Kohar, Savitri & Hartono, 2017).

$$\text{score}(S) = \frac{\text{totalscore}}{\text{number of questions answered}}$$

The third stage was an interviews conducted in May 2017. Interviews are used as data collection techniques, further studies to find the problems to be researched and to know the things of the math teacher more deeply. Interviews were then held to obtain more detailed information on the beliefs of the teachers about mathematics. During the data retrieval process, there is no intervention given to all research subjects.

Data Analysis

Data analysis is the process of searching and arranging systematically the data obtained from questionnaires and interviews by organizing data, synthesizing and making conclusions. The scores obtained were then consulted with the guidelines of belief category according to Siswono's concept (Siswono, Kohar, Savitri & Hartono, 2017), as shown in Table 1.

Table 1. Rating of belief category.

Score (S)	Belief category
$1.00 \leq S < 1.67$	Instrumentalist
$1.67 \leq S \leq 2.33$	Platonist
$2.33 < S \leq 3.00$	Problem solving

FINDINGS AND DISCUSSION

Beliefs of class X IPA 6 teacher

The class X IPA 6 mathematics teacher at state senior high school 5 Semarang is Mr. AW (*pseudo name*), who has less than 20 years' experience teaching mathematics (11 years to be precise). As outlined in detail in Table 2, the

mathematics teacher of class X IPA 6, tends towards platonist beliefs, as seen in the results of the analysis of both the first stage and second stage of the questionnaire. In line with the results of the questionnaire, the analysis of data from the interview shows that he views mathematics in connection with other fields and as the basis for solving real problems. As a teacher, he believes that his students must be able to understand the material presented in the lessons and subsequently develop their own thoughts and ideas in a logical manner. In order to achieve this, the students are given motivation, instilled with confidence, discipline, and punctuality in the mathematics lessons. Interaction in the class is built upon the active involvement of the students, who are encouraged to ask questions and not be afraid to solve mathematics problems independently by connecting the material taught in previous lessons. Furthermore, the most important thing in the process of learning mathematics is to develop the students' power of reason so that they can become more creative in solving mathematics problems.

Beliefs of class X IPA 6 students

The questionnaire showing the response to beliefs about mathematics was completed by twenty eight (28) students from class X IPA 6 who were taught by Mr. AW, a teacher with less than 20 years' teaching experience. It is obvious that Table 3 showed the first stage of the questionnaire, it was found that 3 students, or 10.71%, had instrumentalist beliefs, 23 students, or 82.14%, tended to have platonist beliefs, and the rest had problem solving beliefs. From the second stage of the questionnaire completed by the students from class X IPA 6, it was found that 14.29% had instrumentalist beliefs, 71.43% of the students who answered the questions had platonist beliefs, and 4 students, or 14.29%, had problem solving beliefs. Of the 28 students who gave a response showing their beliefs about mathematics, it was observed that 75% of the students consistently held the same beliefs in the first and second stages of the questionnaire; the rest were inconsistent. Of the 21 students who displayed consistency in their beliefs: 1 student, or 4.76%, consistently held instrumentalist beliefs, 18 students, or 85.71%, consistently showed platonist beliefs, and 9.52% were consistent with their problem solving beliefs.

Beliefs of class X IPA 10 teacher

The mathematics teacher for class X IPA 10 at state senior high school 5 Semarang is Mr. EH (*pseudo name*), who has over 20 years' experience teaching mathematics. As outlined in detail in Table 4, the mathematics teacher of class X IPA 10 has a tendency towards platonist beliefs, as seen in the results of the analysis of both stage one and stage two of the questionnaire. In line with the results of the questionnaire, the analysis of data from the interview shows that he views mathematics as absolute and exact knowledge that can broaden perspective through skill. As a teacher, he believes that his students must be able to master the competence of the material in every lesson, and subsequently use whatever method they find easy for solving the mathematics problems. The first step of teaching mathematics begins with instilling the basic concepts in the student, then giving examples of problems to solve, followed by a discussion with questions and answers to help students who have not yet mastered the particular concept. Furthermore, the most important thing in the process of learning mathematics is first to understand the mathematics concept, because after a student has understood a concept, he or she will always be able to solve any other mathematics problems they are given.

Beliefs of class X IPA 10 students

The questionnaire showing the response to beliefs about mathematics was completed by twenty eight (28) students from class X IPA 10 who were taught by Mr. EH, a teacher with over 20 years' teaching experience. It is obvious that Table 5 showed the first stage of the questionnaire, it was found that 7.14% had instrumentalist beliefs, 22 students, or 78.57%, tended towards platonist beliefs, and 14.29% had problem solving beliefs. From the second stage of the questionnaire completed by students from class X IPA 10, it was found that 17.86% had instrumentalist beliefs, 67.86% of students gave answers showing platonist beliefs, and the rest had problem solving beliefs. Of the 28 students who gave responses showing their beliefs about mathematics, 75% were seen to be consistent in their beliefs in both stage one and stage two of the questionnaire; the rest were inconsistent. Of the 21 students who displayed consistency in their beliefs: 1 student, or 4.76%, consistently held instrumentalist beliefs, 80.95% were consistent with their platonist beliefs, and 14.29%

consistently displayed problem solving beliefs. It is clearly evident that both of the teachers have platonist beliefs about mathematics, and there is no doubt that the way in which mathematics is taught in the classroom by the teacher influences the way the students view mathematics, and vice versa. Platonist beliefs view mathematics is discovered, not created. Mathematical concepts, theorems and notations are thought to be determined beforehand and

they should be acquired in the process of learning (Muhtarom, Juniati and Siswono, 2017b); Teacher who has a platonist beliefs views teaching as an understanding of the concept, students 'understanding on the ideas, processes and students' understanding on the logical relationships between mathematical ideas, concepts and mathematical procedures based on logic (Beswick, 2012; Thompson, 1992; Zakaria & Musiran, 2010).

Table 2. Score from results of questionnaire about beliefs of class X IPA 6 teacher.

	Belief about nature of mathematics	Belief about teaching	Belief about learning	Score	Belief category
First stage data collection	22	20	23	2.16	Platonist
Second stage data collection	20	19	23	2.06	Platonist

Table 3. Score from results of questionnaire about beliefs of class X IPA 6 students

Students Code	First stage data collection			Score	Belief category	Second stage data collection			Score	Belief category
	BM	BT	BL			BM	BT	BL		
J-01	20	19	20	1.967	Platonist	15	18	14	1.567	Instrumentalist
J-02	18	15	14	1.567	Instrumentalist	23	18	15	1.867	Platonist
J-03	21	23	18	2.067	Platonist	18	18	19	1.833	Platonist
J-04	24	18	21	2.1	Platonist	24	17	22	2.1	Platonist
J-05	18	15	21	1.8	Platonist	18	20	25	2.1	Platonist
J-06	23	15	18	1.867	Platonist	26	16	24	2.2	Platonist
J-07	21	18	13	1.733	Platonist	21	15	13	1.633	Instrumentalist
J-08	24	21	22	2.233	Platonist	24	21	25	2.333	Problem solving
J-09	20	20	22	2.067	Platonist	20	16	18	1.8	Platonist
J-10	21	14	18	1.767	Platonist	22	16	16	1.8	Platonist
J-11	17	21	19	1.9	Platonist	17	18	19	1.8	Platonist
J-12	22	19	22	2.1	Platonist	18	19	17	1.8	Platonist
J-13	22	23	27	2.4	Problem solving	27	20	27	2.467	Problem solving
J-14	21	22	22	2.167	Platonist	23	21	14	1.933	Platonist
J-15	18	18	20	1.867	Platonist	19	18	22	1.967	Platonist
J-16	20	16	14	1.667	Instrumentalist	16	17	19	1.733	Platonist
J-17	18	21	19	1.933	Platonist	19	20	20	1.967	Platonist
J-18	26	19	17	2.067	Platonist	26	20	21	2.233	Platonist
J-19	27	25	29	2.7	Problem solving	30	28	30	2.933	Problem solving
J-20	17	16	14	1.567	Instrumentalist	14	12	15	1.367	Instrumentalist
J-21	22	21	19	2.067	Platonist	20	20	18	1.933	Platonist
J-22	17	18	16	1.7	Platonist	20	22	23	2.167	Platonist
J-23	21	19	19	1.967	Platonist	22	19	22	2.1	Platonist
J-24	21	16	14	1.7	Platonist	17	14	16	1.567	Instrumentalist
J-25	18	19	16	1.767	Platonist	20	17	17	1.8	Platonist
J-26	18	18	24	2	Platonist	20	20	23	2.1	Platonist
J-27	20	23	25	2.267	Platonist	24	22	26	2.4	Problem solving
J-28	23	20	20	2.1	Platonist	22	22	20	2.133	Platonist

Table 4. Score from results of questionnaire about beliefs of class X IPA 10 teacher

	Belief about nature of mathematics	Belief about teaching	Belief about learning	Score	Belief category
First stage data collection	25	21	23	2.3	Platonist
Second stage data collection	21	22	24	2.23	Platonist

Table 5. Score from results of questionnaire about beliefs of class X IPA 10 students

Students Code	First stage data collection			Score	Belief category	Second stage data collection			Score	Belief category
	BM	BT	BL			BM	BT	BL		
K-01	20	16	20	1.867	Platonist	16	17	23	1.867	Platonist
K-02	23	16	19	1.933	Platonist	21	15	18	1.8	Platonist
K-03	23	18	22	2.1	Platonist	22	18	25	2.167	Platonist
K-04	24	13	17	1.8	Platonist	21	14	14	1.633	Instrumentalist
K-05	20	24	22	2.2	Platonist	22	21	20	2.1	Platonist
K-06	23	17	22	2.067	Platonist	23	16	15	1.8	Platonist
K-07	19	21	25	2.167	Platonist	19	18	24	2.033	Platonist
K-08	21	23	18	2.067	Platonist	21	23	24	2.267	Platonist
K-09	21	17	23	2.033	Platonist	26	20	22	2.267	Platonist
K-10	15	17	13	1.5	Instrumentalist	17	17	15	1.633	Instrumentalist
K-11	19	21	22	2.067	Platonist	20	16	21	1.9	Platonist
K-12	24	18	20	2.067	Platonist	23	19	17	1.967	Platonist
K-13	30	26	25	2.7	Problem solving	30	27	24	2.7	Problem solving
K-14	19	22	21	2.067	Platonist	21	21	24	2.2	Platonist
K-15	21	16	22	1.967	Platonist	22	17	21	2	Platonist
K-16	24	19	20	2.1	Platonist	28	18	22	2.267	Platonist
K-17	19	18	14	1.7	Platonist	15	13	14	1.4	Instrumentalist
K-18	16	19	19	1.8	Platonist	14	15	17	1.533	Instrumentalist
K-19	24	22	24	2.333	Problem solving	28	22	24	2.467	Problem solving
K-20	27	20	23	2.333	Problem solving	25	18	26	2.3	Platonist
K-21	20	19	20	1.967	Platonist	24	19	22	2.167	Platonist
K-22	23	19	22	2.133	Platonist	21	21	22	2.133	Platonist
K-23	25	18	21	2.133	Platonist	22	19	20	2.033	Platonist
K-24	17	18	15	1.667	Instrumentalist	17	18	16	1.7	Platonist
K-25	23	20	26	2.3	Platonist	25	23	26	2.467	Problem solving
K-26	14	20	17	1.7	Platonist	14	20	14	1.6	Instrumentalist
K-27	18	20	16	1.8	Platonist	17	16	19	1.733	Platonist
K-28	27	26	25	2.6	Problem solving	25	26	27	2.6	Problem solving

Muhtarom, Juniati and Siswono (2017b) explains that the large number of university pre-service students to become mathematics teachers who hold platonist views is due to their mathematics experience at school, and university courses have also strengthened these beliefs. This is due to the three aspects which simultaneously influence the beliefs of a person about mathematics, namely the object of Mathematics Education, the classroom environment, and the individuals themselves (Eynde, Corte & Verschaffel, 2002). These three aspects

interact to the form of mathematical beliefs of the student. The implication of this interaction may change the students' beliefs because any person at any time may experience different development, change, or reinforcement of the beliefs s/he holds. Despite being influenced by a broad array of different factors, the formation of mathematical beliefs is more dominantly influenced by the classroom environment (Goldin, 2002).

The results of this research study show that teachers' beliefs about mathematics

influence the way they teach, and then influence the beliefs of the students (Beswick, 2006, 2012; Felbrich, Müller & Blömeke, 2008; Mkomange & Ajegbe, 2012). Although the research results show that a number of students do have different beliefs from their teachers. How teachers teach Mathematics in classroom, have influenced their students' beliefs, and vice versa. Even (Spangler, 1992) explains that there is a cyclic relationship between belief and learning that learning experiences tend to contribute to one's beliefs about what it means to learn math. Thus, belief in mathematics is an important thing that must be instilled in children early on as it can be the basis for disposition, the basis for action, the basis for change and the basis for learning (Chapman, 2015).

A teacher should facilitate students in giving material in order to make them really master the material given or must have belief in mathematics, while reacting to the students do not distinguish each other. If the effort is not implemented it will have negative impact to the students, such as the lack of confidence when solving the given problem, the fear or anxiety excessive when facing the lesson, repetition, and math test, and lack of student motivation. As what students believe when receiving materials, are mostly based on the experience gained during learning mathematics. In turn, beliefs about mathematics influence how they approach new knowledge of mathematics. Positive beliefs motivate students, giving to make more effort (Lerch, 2004; Ozturk and Guven, 2015). These beliefs increase student success. Students who are strong in mathematics believe that success is the impact of good material mastery, and mastery of the material is an important factor that shapes the ability of mathematics. Therefore, the learning of mathematics needs to be directed to assist the students in developing the ability of their thinking process in solving the problem, the students try to direct their mind to recall and utilize the mathematical procedure according to the problem to be solved.

This kind of understanding should always be emphasized in the learning of mathematics at all levels of education, because of its strong compatibility with mathematical thinking. In this condition, teacher acts as a facilitator and stimulator of learners, asks interesting questions and creates situations for exploration, challenges learners to think, and helps them develop their thinking. This is in line with the views of problem solving beliefs.

CONCLUSION

The process of formation of the beliefs of a student is influenced by the process of interaction with the student's social system, and especially the classroom environment that is encountered on the occasion of every learning activity. The fact that the beliefs of teachers and students are the same shows that the teacher has an influence on what his students believe. This research indicated that there is a relationship between teachers' and students' beliefs, namely in the tendency towards platonist beliefs; and also that the teacher's beliefs influence the student's beliefs. On the other hand, a student's beliefs about mathematics strongly determine how successful the student is in learning mathematics, and the teacher should therefore find out what the student's beliefs are about mathematics before designing a teaching plan.

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