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Teaching Mathematics and Computer Science

Capturing how students' abilities and teaching experiences affect teachers' beliefs about mathematics teaching and learning

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Abstract. We developed an instrument to investigate the effect of students' abilities and teaching experiences on teachers' beliefs about teaching and learning of mathematics. In this pilot study, we used the instrument to measure the beliefs of 43 Indonesian math teachers and five additional teachers. Then, for further investigation, we interviewed those five additional teachers. Results from the 43 teachers' responses to the instrument show that in contrast to teachers with less than five years of teaching, teachers with more than five years elicit significantly different beliefs about mathematics teaching and learning in different contexts related to students' abilities. Teachers' reports in the further investigation indicate that teaching experiences with high and low ability students in teaching mathematics could be a possible explanation of this contrast.

Key words and phrases: beliefs about teaching and learning, social contexts, students' abilities, teaching experiences.

ZDM Subject Classification: C20.

Introduction

There are consistent findings showing a relationship between teachers' beliefs and practices (Anderson, White, & Sullivan, 2005; Ernest, 1989; Safrudiannur & Rott, 2017; Smith, Kim, & McIntyre, 2016; see Philipp, 2007 and Thompson, 1992 for overview of research on beliefs). Unfortunately, some researchers also found that teachers' beliefs may be inconsistent with their practices (Cross Francis, 2015; Raymond, 1997). However, such inconsistencies should not be a reason to doubt the influence of teachers' beliefs on their practices (Buehl & Beck, 2015)since there might be social contexts at school (Ernest, 1989) which may hinder teachers to act consistently with their beliefs. One example of the social contexts at school is the condition of students' abilities. Several studies have qualitatively shown the strong effect of students' abilities on teachers' beliefs and practices (Anderson et al., 2005; Beswick, 2018; Larina & Markina, 2019; Raymond, 1997; Safrudiannur & Rott, 2017).

Some researchers also argue that teaching experiences may influence teachers' beliefs and practices. For example, Page and Clark (2010) argue that it is important to understand and analyze teachers' experiences in teaching and learning of mathematics in studying their practices since the experiences may shape their beliefs about and their pedagogy on teaching mathematics.

Therefore, to investigate the influence of students' abilities and teaching experiences on teachers' beliefs about mathematics teaching and learning (particularly not on small numbers of teachers), we developed a new instrument for studying teachers' beliefs in their practice (abbreviated as the TBTP). In the instrument, we use rank-then-rate items, consider students' abilities as one of the social contexts at school, and also collect data on the number of years the participants have worked as math teachers. In this paper, we report the results of a pilot study in which we use the TBTP to measure Indonesian teachers' beliefs about mathematics teaching and learning. The research questions are: (1) What do teachers believe about teaching and learning of mathematics? Do they elicit different beliefs in different contexts related to students' abilities? (2) According to the number of teaching years, how and why do they elicit the different beliefs?

Theoretical framework

Beliefs about mathematics and about mathematics teaching and learning

Philipp (2007, p. 259) defines "beliefs as psychologically held understandings, premises, or propositions about the world that are thought to be true". Based on this definition, different teachers may have different beliefs about mathematics.

Ernest (1989, p. 250) proposes three views about mathematics: the instrumentalist view (mathematics is seen as "an accumulation of facts, rules, and skills to be used in the pursuance of some external end"), the Platonist view (mathematics is seen as "a static but unified body of certain knowledge"), and the problem-solving view (mathematics is seen as "a process of enquiry and coming to know, not a finished product, for its results remain open to revision"). Then, Ernest describes the association of those three views with beliefs about teaching and learning of mathematics, which we summarize in Table 1.

The nature of mathematics	Teaching and learning of mathematics	
	Teaching	Learning
Instrumentalist view	Teacher as an instructor	Students master skills correctly
Platonist view	Teacher as an explainer	Students understand conceptually
Problem-solving view	Teacher as a facilitator	Students construct knowledge

Table 1. Three views about mathematics by Ernest (1989, p. 250-251)

The effect of students' abilities on teachers' beliefs and practices

The association presented in Table 1 has not been demonstrated well empirically. As we pointed out in the introduction, the social contexts at school, specifically students' abilities (Anderson et al., 2005; Safrudiannur & Rott, 2017), may hinder teachers to act in a way that fits with their beliefs. Raymond (1997) found that students' abilities (as one of the immediate conditions of a classroom) have a stronger effect on teachers' practices than other external factors such as the expectation from other teachers or curricula and textbooks.
Besides influencing teachers' practices of teaching mathematics, the study from Beswick (2018) also reveals that students' abilities may affect teachers' beliefs. For example, many teachers believe that solving problems, which needs higher order thinking, is only appropriate for high-achieving students, not for low-achieving students (e.g Zohar, Degani, & Vaaknin, 2001; Anderson et al., 2005).

Experiences in teaching mathematics

Some researchers suppose that teachers' beliefs are shaped by their experiences (Philipp, 2007; Page & Clark, 2010), for instance, their experience in teaching mathematics. Some qualitative studies show that experiences in teaching contribute to teachers' beliefs and practices. For example, Page and Clark (2010) concluded that Alisa's (a teacher participating in their study) experiences in teaching mathematics, together with her experiences as a math learner, shape her beliefs about mathematics teaching and learning as well as her teaching pedagogy. Another qualitative study conducted by Strahan (1989) also indicates that more experienced teachers tend to have more various instructional strategies in teaching than less experienced teachers. Further, Huang, Li, and He (2010) also found that novice and experienced Chinese teachers have different concerns in teaching mathematics. Novice teachers concern more on the effectiveness of teachers' guidance, whereas experienced teachers concern more on the development of students' mathematical thinking and higher order thinking abilities.

However, results from some larger studies, a place for generalizing a thesis, show inconsistent findings with the results of the qualitative studies reported above: Teaching experiences (mostly stated by years of teaching) may have no influence on teachers' beliefs and practice. For example, in a study (N = 1500 teachers), Nisbet and Warren (2000) found that the number of teaching years does not influence teachers' beliefs about teaching mathematics. Drageset (2010) reports that years of teaching experience have no correlation with beliefs of the importance of emphasizing rules and correct answers in teaching mathematics and no correlation with beliefs of the importance of emphasizing reasoning, argumentation, and justification (N = 365). Wilkins (2008) also reports that years of teaching have no direct effect on teachers' instructional beliefs and instructional practice (N = 481, years of teaching have an indirect effect on both, but the degree of the indirect effect is negative). Similarly, Ren and Smith (2018) also report that years of teaching have no association with teachers' student-centred beliefs and teacher-centred beliefs (N = 396). With fewer participants (N = 25), Beswick (2005) also found a negative correlation between years of teaching and teachers' beliefs.

Trying to explain these phenomena, we argue that it is not about the weak relationship between teachers' beliefs and their experiences, but, perhaps, it is related to the methodological difficulties in measuring teachers' beliefs quantitatively.

Problems in measuring beliefs for a large sample of teachers

We observed that almost all quantitative studies with large numbers of teachers use Likert scale instruments for measuring beliefs (for example, all quantitative studies mentioned above). This could be problematic as some researchers questioned the accuracy of the use of Likert scale instruments for measuring beliefs (Philipp, 2007). For example, Di Martino and Sabena (2010) criticize the use of Likert scale items because teachers' responses may be distorted by social desirability. Social desirability plays a role if items being rated are viewed as inherently and socially positive by respondents (McCarty & Shrum, 1997). A respondent tends to rate socially positive items highly (McCarty & Shrum, 1997) to present him-/herself as a good person (Paulhus, 1991).

Another reason for some researchers to criticize the use of Likert scale instruments

is the fact that such instruments often provide less or no contexts (Ambrose, Clement, Philipp, & Chauvot, 2004; Philipp, 2007). Whereas, as we pointed out in the introduction, some studies have shown that social contexts at school, particularly students' abilities, may influence teachers' beliefs.
The study from Safrudiannur and Rott (2020) shows that the above-mentioned two weaknesses (amplifying social desirability and providing no contexts) of the use of Likert scale instruments for measuring beliefs may distort teachers' responses to such instruments, compared to interviews and observations (as other ways of measuring beliefs). Therefore, with the motivation to overcome those two weaknesses, we offer an approach in measuring beliefs quantitatively. We developed the TBTP which (i) uses rank-then-rate items and (ii) considers students' abilities as an external factor influencing teachers' beliefs. We explain more about our approach in the method section.

Method

Participants

To attend the research questions presented in the introduction, we conducted this pilot study by asking 43 Indonesian math teachers from several schools who came to a math competition to accompany their students to answer the TBTP. The students who participated in the competition should be the best students (high ability or HA students) chosen among many students in each participating school. Because they were the coaches of the students, we assume that they have experiences in teaching mathematics to HA and (low ability) LA students in their schools. The assumption is our reason to invite the 43 teachers to participate in this study.
Beside the main items of the TBTP (see below for details), we also asked them for their experience of teaching mathematics in years (x), by providing options: $x<2$ (less than two years), $2 \leq x < 5$ years, $5 \leq x < 10$ years, $x \geq 10$ years (more than or equal to ten years). These options are following the first four categories of seven categories of years of teaching by Wilkins (2008). Further, we chose five years as a mid-point because of a study by Saadati, Cerda, Giaconi, Reyes, and Felmer (2018). They found that teachers' traditional beliefs about teaching mathematics have an indirect effect on their self-efficacy beliefs ($N = 670$). They supposed that the finding took place since most of the participants of their study were teachers with more than five years of teaching mathematics.

For further investigation, we asked other five math teachers to complete the TBTP and then interviewed them: Elisa (female; with less than two years of experience as a teacher), Candra (male; with more than ten years of experience as a teacher), Fitria (female, more than ten years as a math teacher), Dony (male, more than two years but less than five years as a math teacher), Andre (male, more than ten years as a math teacher). However, in this paper, we only focus to discuss the cases of two teachers, Elisa and Candra, since the other three teachers' cases are similar with Candra's. We evaluate that the cases of Elisa and Candra are sufficient to show the interplay between teachers' beliefs, the condition of students' abilities, and their experiences in teaching.

Data collection and analysis

Instrument

We designed the TBTP by using rank-then-rate items instead of Likert scale items. The reason is to minimize the impact of social desirability. As we have mentioned before, because of the social desirability, respondents tend to give a high rate toward items viewed socially positive inherently. McCarty and Shrum (1997) have demonstrated that rank-then-rate items may decrease this tendency. There are ten rank-then-rate items in the TBTP, which are grouped into three themes (see Appendix). In this paper, we focus on the theme of teaching and learning of mathematics (Item 1-4). Each item has three statements (see Appendix). The first, second, and third statements are always associated with the instrumentalist, the Platonist, and the problem-solving views, respectively (following the association presented in Table 1). Cronbach's alpha coefficients of each view as a measure of the internal consistency are presented in the Appendix.

To answer an item, a respondent should assign a rank 1 (the most important), 2, or 3 (the least) to the three statements of the item. After that, the respondent should rate each statement based on his/her ranks (as an example, see Figure 1). We determine this rule by following the suggestion from Brown and Maydeu-Olivares (2012). They argue that if a respondent ranks a statement, for example, Statement R1, better than another statement, for example, Statement R2, the respondent should have a greater psychological score for R1 than for R2. Also, ranking data is reflected in the rating data (the better the rank, the higher the rate; see Figure 1).

Taking into account the influence of students' abilities, we devide each item in two contexts: in a class dominated by high ability (HA)/low ability (LA) students

Item 1: When you teach the formula in a class dominated by **HA students**, what is important for you?

RANK

Please order the three statements below by giving a rank 1 (the most important), 2, or 3 (the least important).

Statements	**Rank**
R1. You demonstrate […]	3
R2. You explain […]	2
R3. You let […]	1

RATE BASED ON YOUR RANK ABOVE

Please rate the level of importance of each statement .

Statements	abs. not imp.	not imp.	sl. not imp.	neu	sl. imp.	imp.	abs. imp.
Statement R1	1	2	3	4	5	6	7
Statement R2	1	2	3	4	5	6	7
Statement R3	1	2	3	4	5	6	7

Item 2: When you teach the formula in a class dominated by **LA students**, what is important for you?

RANK

Please order the three statements below by giving a rank 1 (the most important), 2, or 3 (the least important).

Statements	**Rank**
R1. You demonstrate […]	1
R2. You explain […]	2
R3. You let […]	3

RATE BASED ON YOUR RANK ABOVE

Please rate the level of importance of each statement.

Statements	abs. not imp.	not imp.	sl. not	neu	sl. imp.	imp.	abs. imp.
Statement R1	1	2	3	4	5	6	7
Statement R2	1	2	3	4	5	6	7
Statement R3	1	2	3	4	5	6	7

Item 1 and Item 2 have the same question and three statements (R1, R2, and R3), but the classes of the two items are different; abs.: absolutely, sl.: slightly, imp.: important, neu: neutral

Figure 1. An example of Candra's responses to Item 1 and Item 2 in the TBTP

(see Figure 1 for an example). The terms of HA and LA students are relative terms and "used in a somewhat loose way" (Zohar et al., 2001, p. 472). Zohar et al. (ibid) define high-achieving students and low-achieving students by pointing teachers to students' performances in lessons and academic scores on tests created by the teachers themselves (not standard tests). Thus, following their definition, we define HA and LA students as mentioned in the general note of the TBTP (see Appendix).

There will be two sets of data: ranking data and rating data. However, as suggested by McCarty and Shrum (1997), only the data from the rating procedure are used for data analyses. The ranking procedure aims to force respondents to contrast between statements (McCarty & Shrum, 1997) before they rate the statements. Thus, the procedure may increase the willingness of respondents to distinguish between statements (McCarty & Shrum, 1997; Brown & Maydeu-Olivares, 2012) and may reduce the impact of the social desirability (Paulhus, 1991). We will use paired t-tests to analyze the rating data.

Interview

We conducted semi-structured interviews (individually) to investigate Elisa's and Candra's beliefs about teaching and learning. In the interviews, we asked them to explain their responses to the TBTP and to describe how they usually teach mathematics. Example questions are:

(1) Based on our definition of HA and LA students in the TBTP, have you met HA students and LA students during your experiences in teaching mathematics? What are the differences between them? Have you taught mathematics in a class dominated by HA/LA students?

(2) Did you differentiate your answers for item 1 (teaching mathematics for HA classes) and item 2 (teaching mathematics for LA classes)? Why?

(3) Could you describe the abilities of your students in your classes? How did you teach mathematics in your classes generally?

The first author transcribed and translated the interviews into English. Using the translated transcripts, both authors independently interpreted the two teachers' beliefs and experiences in teaching by identifying their statements reflecting the beliefs and experiences. We also invited an expert from Indonesia (working as a lecturer and a researcher in the mathematics education department of a university in Indonesia) to do the interpretation by using the original transcript. Then, we discussed together for a final interpretation (a consensual validation).

Results and discussion

Teachers' responses to the TBTP

We present mean values of all teachers' rates (N = 43) to the items of the Theme "teaching and learning of mathematics" in Table 2. Interestingly, Table 2 shows that although statements R1 and S1 (demonstrating and memorizing formulas, see Appendix) are not regarded as socially positive in mathematics education, teachers rate them highly for LA classes, indicating the importance of those two statements. Moreover, still in LA classes, they lowly rate statements R3 and S3 (see Appendix) which are regarded as socially positive.

Further, the results of paired t-tests to compare mean values of statements addressing the instrumentalist view (R1 and S1) and the problem-solving view (R3 and S3) between HA and LA classes reveal that teachers (N = 43) significantly differ their teaching styles between HA and LA classes. These results confirm that teachers have different beliefs about mathematics teaching and learning in different contexts (cf. Schoenfeld, 2015) related to students' abilities.

However, Table 2 shows no differentiation between both contexts in the statements

Items	Statements (associated views)	Mean values (standard deviation) HA class	LA class	t-values
1 and 2	R1 (instrumentalist)	4.09 (1.66)	5.65 (1.13)	-6.19*
	R2 (Platonist)	5.02 (1.39)	5.44 (1.42)	-1.46
	R3 (Problem-solving)	5.33 (1.55)	3.47 (1.24)	6.35*
3 and 4	S1 (instrumentalist)	4.07 (1.49)	5.35 (1.15)	-4.99
	S2 (Platonist)	5.86 (1.19)	5.47 (1.32)	1.57
	S3 (Problem-solving)	5.44 (1.05)	3.79 (1.81)	5.52*

*significant for $p<0.008$ (which is the adjustment of alpha = 0.05 by Bonferroni's correction for six multiple t-tests, df=42, two-tailed)
All data in this table are also presented in Safrudiannur and Rott (2018)

Table 2. Teachers' responses to the TBTP and the results of paired t-tests (N=43)

addressing the Platonist view (R2 and S2). Seemingly, for our participants, explaining is an essential part of teaching mathematics in both contexts, and they want both HA and LA students to understand their explanations.

Tables 3 and 4 present the results regarding the instrumentalist and problem-solving views broken down by experience; teachers' rates are given according to their years of teaching. Interestingly, the results show the same trends of differentiating teaching styles between HA and LA classes for all groups of experience. However, those trends are statistically significant (using paired t-tests) only for teachers with more than five years in teaching mathematics. The results indicate that their styles in LA classes are more associated with the instrumentalist view and less associated with the problem-solving view than those in HA classes.

Statements	Teachers' rate of each category of teaching years (x): $x<2$ years (N=7) — Mean values (std. deviation) HA class	LA class	t-values	$2 \leq x <5$ years (N=10) — Mean values (std. deviation) HA class	LA class	t-values
R1	5.00 (0.82)	6.29 (0.49)	-3.06	4.60 (1.51)	6.00 (0.67)	-2.49
R3	4.43 (1.72)	3.86 (0.90)	1.08	5.40 (1.65)	3.90 (1.10)	2.86
S1	4.86(0.90)	6.00 (0.82)	-3.36	4.50 (1.51)	5.10 (0.88)	-1.03
S3	5.29 (1.50)	5.14 (1.46)	0.23	5.20 (0.92)	3.90 (1.79)	2.17

Table 3. Results of paired t-tests of the first two categories of teaching years

Statements	Teachers' rate of each category of teaching years (x)					
	$5 \leq$ x <10 years (N=9)			x $\geq$ 10 years (N=16)		
	Mean values (std. deviation)		t-values	Mean values (std. deviation)		t-values
	HA class	LA class		HA class	LA class	
R1	3.33 (1.50)	5.33 (1.50)	-3.79*	3.69 (1.89)	5.50 (1.09)	-4.78*
R3	5.33 (1.50)	2.78 (0.97)	4.41*	5.81 (1.33)	3.37 (1.50)	4.72*
S1	3.44 (1.33)	5.56 (1.67)	-4.12*	3.86 (1.67)	5.13 (1.09)	-2.66
S3	5.00 (0.87)	2.89 (1.76)	3.12	5.94 (0.93)	3.50 (1.71)	5.70*

*significant for p<0.008; R2 and S2 are excluded, because the differences are not significant (see Table 3); one teacher is excluded since the teacher does not state his/her years of teaching.

Table 4. Results of paired t-tests of the last two categories of teaching years

A further investigation

In this section, we discuss teachers' responses to the TBTP based on their interviews. We present Elisa's and Candra's responses to the TBTP in Table 5.

Items	Statements (associated views)	Elisa's rates		Candra's rates	
		HA class	LA class	HA class	LA class
1 and 2	R1 (instrumentalist)	5	7	2	6
	R2 (Platonist)	6	5	4	5
	R3 (Problem-solving)	4	4	6	1
3 and 4	S1 (instrumentalist)	3	5	3	4
	S2 (Platonist)	7	7	5	6
	S3 (Problem-solving)	6	4	7	2

Table 5. Elisa's and Candra's responses to the TBTP

Elisa

During her limited experiences as a teacher (less than 2 years), she never meets an HA class. She believes that it will be easy to explain math concepts to students in HA classes because they can understand fast (based on her experiences when she was a student). However, since she assesses that most of her students in her classes are LA students, she emphasizes the necessity of explaining math concepts slowly and repeating her explanations several times. Table 5 shows that she assigned R1 the highest rate for LA classes. She believes that it is better to teach students in LA classes by demonstrating and giving many examples.

> **Interviewer (I)**: "For LA classes, your answer to Item 2 shows that demonstrating the use of the formula and giving many examples [statement R1] is the most important. Why?"
> **Elisa**: "Because, in LA classes, if we want to teach concepts how to find the formula, it will be difficult for students to understand. I have tried it already. The students said, 'Miss, it is difficult, complicated'. Then, 'Miss, please, to the point' [she laughed]. So, I've tried to explain from the beginning how to find the formula for the area of a trapezoid by using the area of a rectangle. My students said, 'Please Miss, to the point'. But, in HA classes, although I never meet the classes, I think, they [HA students] can understand. Explaining concepts will be easier."
> **I**: "Do you usually teach like that in your classes?"
> **Elisa**: "Yes. Sometimes, the order is reversed. So, firstly, I showed how to use the formula, after that, I returned to the concepts."
> **I**: "How long is the explanation for the concepts?"
> **Elisa**: "It's not long, just little. I use time much more on the using of the formula, giving examples."

She also believes the necessity of memorizing formulas for her students (the rate of S1 is the highest for LA classes, see Table 5). She argued:

> **Elisa**: "The most important thing is, actually, [that] they memorize formulas. They must memorize formulas. If they don't, they won't know at all, and they can't do anything [solving tasks/problems]."

However, Table 5 indicates that she does not seem to differ her styles of teaching between HA and LA classes (in the interview, she acknowledged that when responding the TBTP, she is confident to answer items for LA classes but not for HA classes since she never meet an HA class). Her rates to R1 and R2 show that both statements are important in both HA and LA classes. Interestingly, her rates to R3 in both HA and LA classes are neutral. In the interview, she argues that discovery learning is the last choice for her. She never does a discovery learning since it is not appropriate for her students. Although she believes that HA students are fast to understand concepts, she is not sure whether discovery learning is suitable for them.

Candra

During his experiences as a teacher (more than 10 years), he assesses that most of his classes are LA classes. However, unlike Elisa, Candra reports that

he once had a class years ago in which the students showed good responses in his lesson. He enjoyed preparing and posing problems in that class. Moreover, he involved students in activities in discovering mathematics (consistent with his rate to R3 for HA classes, see Table 5) such as finding the total size of angles of a triangle by an experiment (cutting the angles and re-arranging them to form a straight angle).
He emphasizes that he sees the class condition first to decide how to teach math:

> **Candra**: "I see the condition first [to teach math]. If students' abilities are low, then I explain a topic classically: topic, examples, and exercises. But, when I assess that the abilities are good, we can see that from their responses, when they want more tasks, I usually give them problems of which the level of difficulty increases. I will see their responses first. If they have good responses, they often ask questions, and many of them understand. But, if lots of students don't understand, I think, it is useless to increase the level of problems. It is just a waste of time."

Candra's statements above indicate that he differs his teaching styles in different contexts of classes: a class of good students (HA students) and a class of LA students. In contrast to the HA class, he believes that the best way to teach mathematics in his ordinary classes is by explaining topics classically (students just listen and watch the explanation), giving many examples and exercises (consistent with his rate to R1 for LA classes, see Table 5). Providing math problems for LA students based on his experience is useless and wasting time.
Both Elisa's and Candra's reports in the interview indicate that their experiences in teaching mathematics for students - and especially the fact that many of them are LA students - seem to shape their beliefs about mathematics teaching and learning in her classes generally. For example, Elisa tries to explain concepts underlying the formulas to her LA students, but it does not work and make her students confused. She notes that it is better to demonstrate the use of formulas and give many examples and then exercises to ensure that their students understand what she teaches. Thus, she emphasizes that she uses much more time for demonstrating formulas and giving examples and exercises than for explaining concepts in her lessons. Similarly, Candra tries to give his students (he assesses that many of them were LA students) problems but waiting for them to solve the problems just spends much time ineffectively. Thus, he acknowledges that he seldom involves problem solving in his lessons.
The difference between Elisa and Candra is on their experiences with HA students. Elisa is a new teacher. She reports that she never meets a class with many

HA students. Whereas, Candra reports that he once met that class. He reports that his teaching styles in that class are different from his ordinary classes. In contrast with Elisa, Table 5 shows that Candra significantly differs his rates to R1, R2, and R3 between HA and LA classes. These two cases indicate that the interplay between social contexts at school, particularly related to students' abilities, and teachers' experiences in teaching seem to influence what teachers' beliefs about the best way to teach mathematics.

Conclusion, limitations and a further study

The results of the analyses of teachers' responses to the TBTP suggest that generally, teachers elicit different beliefs about mathematics teaching and learning in different contexts related to students' abilities. Their responses show that their teaching styles in HA classes are more associated with the problem-solving view than those in LA classes. Seemingly, those in LA classes are more associated with the instrumentalist view than those in HA classes.

Interestingly, when controlled for teaching experience, the differentiations are only statistically significant in the groups of teachers with more than five years of teaching but not in the groups of teachers with less than five years. From the interview, we found that teachers' experiences in teaching mathematics for HA/LA students seem to contribute to the tendency of eliciting different beliefs about mathematics teaching and learning in different contexts related to students' abilities.

Thus, we note that, in contrast to other self-report instruments for measuring beliefs quantitatively (particularly instruments employing Likert scale items), the consideration of students' abilities in the TBTP may give us insight into the influence of teaching experiences on teachers' beliefs about teaching and learning. Therefore, the results of this study are twofold: First, they confirm the hypotheses that beliefs are shaped by experience (cf. Thompson, 1992; Philipp, 2007). Second, and more importantly, the results suggest the importance of considering the social contexts at school, particularly related to students' abilities, in a quantitative instrument for measuring beliefs in order to investigate the interplay between teachers' beliefs and their experiences.

However, there is a limitation of this pilot study related to the characteristics of teachers in this study. Due to the convenience sampling, the profiles of teachers in this study may not represent the characteristics of teachers in general, and thus, in the future, we plan to do a study with a larger and randomized sample of mathematics teachers. The results of this pilot study lead us to hypothesize that students' abilities and experiences in teaching HA/LA students influence teachers' beliefs about teaching and learning of mathematics.

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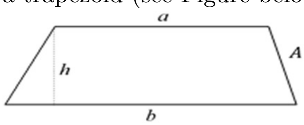
Appendix

The notes, items, and statements in the TBTP
General note: As a mathematics teacher, you have experience with high and low ability students in mathematics. Consider these definitions: *A high ability (HA) student is a student who generally shows good understanding in your lessons and regularly has high scores in your tests.* *A low ability (LA) student is a student who generally does not show good understanding in your lessons and often has low scores in your tests.* To answer all questions, you will be asked first to imagine that you have a class dominated by HA students and a class dominated by LA students.
Theme 1: Teaching and learning of mathematics **Note:**You are going to teach a lesson learning the formula to calculate the area of a trapezoid (see Figure below). Please imagine this situation to answer items 1 to 4.  $A = \frac{1}{2} \cdot (a + b) \cdot h$ **Items 1 and 2:** When you teach the formula in HA/LA classes, what is important for you? R1. You demonstrate how to use the formula correctly by giving some examples. R2. You explain concepts related to how to get or to prove the formula. R3. You let your students discover the formulas in their own ways. **Items 3 and 4:** When you teach the formula in HA/LA classes, what is important for students? S1. They memorise and use the formula correctly. S2. They understand the concepts underlying the formula from your explanation. S3. They can draw logical conclusions to deduce the formula.
Theme 2: Teaching and learning of problem solving (Items 5-8)
Theme 3: The nature of mathematics (Items 9-10)

Items 1=2 and 3=4; but with a different class (items 1 and 3 for an HA class and 2 and 4 for an LA class; as an example, see Figure 1).

Table 6. Structure of the TBTP

Views	**Statements**	α
Instrumentalist	R1 of item 1, R1 of item 2, S1 of item 3, S1 of item 4, and all first statements of items 5-10	0.83
Platonist	R2 of item 1, R2 of item 2, S2 of item 3, S2 of item 4, and all second statements of items 5-10	0.84
Problem-solving	R3 of item 1, R3 of item 2, S3 of item 3, S3 of item 4, and all first statements of items 5-10	0.79

Table 7. Cronbach's alpha coefficients of the TBTP (based on teachers' responses in this study)

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