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Investigating factors influencing beliefs about teaching and learning: Students' abilities and experiences in teaching

Introduction and Background

Results in research on teachers' beliefs, particularly for large samples, are not always consistent with theories. For example, researchers argue that beliefs are sharped by experiences (Philipp, 2007). However, Nisbet and Warren (2000) found that the number of teaching years does not influence teachers' beliefs about teaching mathematics (N=1500 teachers). Corkin et al. (2015) found that teaching experience correlates with self-efficacy beliefs about teaching mathematics, but it does not correlate with teachers' beliefs about teaching behavior contributing to student success (N=151).

A possible explanation of this inconsistency is the complexity of teachers' beliefs which may be affected by the social context at school. For instance, teachers' beliefs about teaching and learning have a strong relationship with their beliefs about students (Beswick, 2018). Another explanation is on the methodology to measure beliefs. Most studies with a large sample of teachers use Likert scale items in their instruments. Some researchers criticize the accuracy of Likert scale instruments for measuring beliefs (Philipp 2007,) since Likert scale items amplify the *social desirability* and often provide *no contexts*. Safrudiannur and Rott (2018) have demonstrated that these two problems may distort teachers' responses.

We developed an instrument for studying **t**eachers' **b**eliefs in **t**heir **p**ractice (TBTP). To overcome the two problems, we use rank-then-rate items and consider students' abilities as one social context. In this study, we use the TBTP to measure beliefs about teaching and learning. The **research question** is "According to the number of teaching years, do teachers differentiate their styles of teaching in different contexts of students' abilities?"

Theories used in the constructions of the TBTP

We use the three views about the nature of mathematics by Ernest (1989) and the according associations of these views with beliefs about math teaching and learning to construct the TBTP (see Table 1).

Table 1: Three views about mathematics by Ernest (1989)

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

Method

The participants were 43 Indonesian math teachers (see Table 3 for their years in teaching in detail). We asked them to respond to ten rank-then-rate items (see Figure 1 as an example) which are grouped into three themes. In this report, we focus on Theme "Teaching and learning of mathematics".

Figure 1: An example of a response to Item 1 and Item 2 in the TBTP

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), 2, or 3 (the least).							
Statements							**Rank**
R1. You demonstrate […]							3
R2. You explain concepts […]							2
R3. You let your students […]							1
RATE BASED ON YOUR RANK ABOVE							
Please rate the level of importance of each							
Statements				**Rate**			
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 […]							
Statements							**Rank**
R1.							1
R2.							2
R3.							3
RATE BASED ON YOUR RANK ABOVE							
Please rate the level of importance […].							
Statement				**Rate**			
R1.	1	2	3	4	5	⑥	7
R2.	1	2	3	4	⑤	6	7
R3.	①	2	3	4	5	6	7

See the Appendix for the complete statements of R1, R2, and R3

Each item consists of three statements. The first, second, and third statements are always associated with the instrumentalist, the Platonist, and the problem-solving view, respectively (see Table 1 and the Appendix). Further, the consideration of students' abilities is by dividing the items of the theme into two conditions: in a class dominated by high ability (HA) students and in a class dominated by low ability (LA) students (as an example, see Figure 1). We defined the terms HA and LA students (see Appendix) following the definition from Zohar et al. (2001).

To respond to an item, a respondent firstly orders the three statements of the item by assigning a rank 1, 2, or 3, and then rating each of them from 1 to 7 based on his ranks (see Figure 1). Thus, there will be two sets of data: ranking and rating data. For data analyses, we only use rating data.

Results and Discussion

We present mean values of all teachers' rates to the items of Theme 1 ("teaching and learning of mathematics") in Table 2. Those mean values are compared using paired t-tests. The data show that the 43 teachers report significantly different teaching styles between HA and LA classes, indicating that they have different beliefs about mathematics teaching and learning in different contexts.

Table 2: The results of paired t-test

Items	Statements of Theme 1 (views associated with the statements)	Teachers (n=43) HA class Mean (sd)	Teachers (n=43) LA class Mean (sd)	t-values
1 and 2	R1 (Instrumentalist view)	4.09 (1.66)	5.65 (1.13)	-6.19*
	R2 (Platonist view)	5.02 (1.39)	5.44 (1.42)	-1.46
	R3 (Problem-solving view)	5.33 (1.55)	3.47 (1.24)	6.35*
3 and 4	S1 (Instrumentalist view)	4.07 (1.49)	5.35 (1.15)	-4.99*
	S2 (Platonist view)	5.86 (1.19)	5.47 (1.32)	1.57
	S3 (Problem-solving view)	5.44 (1.05)	3.79 (1.81)	5.52*

*significant for $p < 0.008$ (The adjustment of alpha = 0.05 by Bonferroni's correction for six multiple t-tests, df=42, two-tailed)

We further investigate the differentiation. We found that teachers with experiences of more than 5 years differentiate their teaching styles between HA and LA classes significantly. The data in Table 3 indicates that their styles in LA classes are more associated with the instrumentalist view than those in HA classes. In other words, those in HA classes are more associated with the problem-solving view than those in LA classes.

Table 3: The results of paired t-test for each year of teaching

State-ments	Years of teaching: < 2 years, n=7			2-5 years, n=10			5-10 years, n=9			≥ 10 years, n=16		
	HA	LA	t-val	HA	LA	t-val	HA	LA	t-val	HA	LA	t-val
R1	5.0	6.3	-3.1	4.6	6.0	-2.5	3.3	5.3	-3.8*	3.7	5.5	-4.8*
R2	5.9	6.0	-0.3	4.5	5.4	-1.1	4.6	4.9	-0.7	5.3	5.6	-0.7
R3	4.4	3.9	1.1	5.4	3.9	2.9	5.3	2.8	4.4*	5.8	3.4	4.7*
S1	4.9	6.0	-3.3	4.5	5.1	-1.0	3.4	5.6	-4.1*	3.9	5.1	-2.7
S2	6.1	5.3	1.9	6.5	5.5	2.0	5.6	5.0	1.6	5.4	5.7	-0.5
S3	5.3	5.1	0.2	5.2	3.9	2.2	5.0	2.9	3.1	5.9	3.5	5.7*

*significant for $p < 0.008$; HA/LA: mean values of teachers' rate for high/low ability class; t-val: t-values; 2-5 years (as well as 5-10 years): the years are equal to or more than 2 years but less than 5 years; One teacher did not state his/her years of teaching.

The limitation of this study is the number of our participants. It needs further investigation with a larger number to have a significant conclusion. However, the results of this study indicate that counting students' abilities as the social context may resolve the initial contradiction stated in the introduction. Further, the results lead us to hypotheses that teaching experiences may sharpen teachers' beliefs about students' abilities. Then, both the experiences and the beliefs about students may sharpen their beliefs about how to teach mathematics to their students.

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Appendix

Structure of 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.

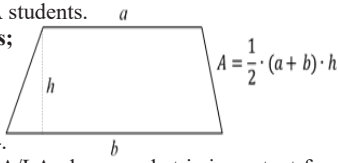
A low ability (LA) student is a student who generally does not show good understanding in your lessons and often has low scores in your tests.

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.



Please imagine this situation to answer items 1 to 4.

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 the 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.

- Items 1=2 and 3=4, but with a different class (questions 1 and 3 for the HA class and 2 and 4 for the LA class. As an example, see Figure 1).
- R1 and S1 are associated with the instrumentalist view; R2 and S2 are associated with the Platonist view; R3 and S3 are associated with the problem-solving view.