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Potential characteristics that relate to teachers mathematics-related beliefs

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Potential characteristics that relate to teachers mathematics-related beliefs

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Abstract. A characteristic of the persons was very potential to affect the beliefs they held. This study examines whether there was a significant difference between the beliefs factors with characteristics such as gender, teaching experience, certification status, and grade level assignments. There were 325 primary school teachers in East Jakarta who participated in this research. MANOVA was applied to analyze the data. The findings of this study indicate that only on teaching experience, there was a significant difference between the beliefs held by the teachers, i.e. teachers who have 11-20 years teaching experience were more likely to think absolute than constructivism. Moreover, there was no difference between each belief they held with the other characteristics.

1. Introduction

All this time, research about teachers' beliefs is still very interesting to explore. Some researchers agree that teachers' beliefs might affect decision-making in instructional practices [1–5]. However, several researchers showed that there were complex relationships between teachers' beliefs and practices in mathematics class [1,2,6]. For example, Purnomo [2] found that several beliefs factors about mathematics might be in line with practices in the mathematics classroom, whereas other factors might be inconsistent with its practices. Besides, relationships between corresponding beliefs were not consistent. According to him, the inconsistency could be attributed to either internal or external factors. The possible internal factors were (1) teacher's knowledge about philosophy of mathematics and learning perspective; (2) teachers' resistance to change and innovation; (3) mathematics knowledge for teaching; and (4) experience. However, there have been few studies conducted to discern the effect of teachers' characteristics or internal factor, such as gender, experience, certification status, and grade level assignments on beliefs held.

Gender-related issues seem to be on going focus in mathematics education research [7]. Even though there have not been comprehensive literature that explicitly addresses issues of relationship between gender and teachers beliefs, several researchers consider gender issues to see its dependency on held beliefs [8–11]. Some of these studies found significant differences between male and female on beliefs related to mathematics. For example, Yazici and Ertekein [10] studied the differences of beliefs and anxiety of prospective elementary mathematics teachers based on gender. They found that in learning mathematics, male prospective teachers tend to be more instrumentalist than females according to their

mathematical beliefs. In addition, females have more mathematics teaching anxiety than male, especially for subject knowledge in mathematics and self-confidence.

Other possible characteristics affected teachers' beliefs are years of teaching experiences and grade level taught. Perry Wong, and Howard [12] revealed that teachers' beliefs might stem from and limited in cultural communities where teachers live and work, culture and traditions of education system, their own experience as students in school and teacher education program, and their experience as members of the school community. Thus, their years of teaching experience might be a factor that affects beliefs. In addition, Nisbet and Waren [9] found that a static view of mathematics tends to rise along with the grade level assignments, as well as the view of constructivism in mathematics. The reason lies in the fact that teaching complex and challenge mathematical content requires teachers to create classroom environments that consider application of materials, to encourage classroom discussion, and to explore and solve problems in real-world context. Hence, the more complex mathematical content taught by teachers are, the higher possible is that teachers hold beliefs that mathematics is a static and absolute knowledge.

There have not been comprehensive literature about the relationship between teachers' beliefs related to mathematics and their certification status. The reason might be that certified teachers are teachers expected to work professionally as they have multi-year experiences of teaching and involve in professional development program. Consequently, these might affect their beliefs about education.

The above description leads researchers to investigate the relationship between beliefs held by teachers and their characteristics such as gender, years of teaching experience, certification status, and grade level assignments.

2. Methodology

2.1. Participants and Contexts

This study employed survey cross-sectional research design to achieve the purpose. Participants of this study were 325 elementary school teachers in East Jakarta and conveniently selected. East Jakarta is one of six cities in the capital city of Jakarta whose characteristics tend to be similar. There were 69 public schools and six private schools that involved in this study. It consisted of 80.9% female and 17.5% male, while 1.5% were not reported. There were 22.5% aged less than 30 years, 19.4% was located in a range of aged 31-40 years, 19.4% was located in range of 41-50 years, and most of all ware aged over 50 years i.e. amounting to 35.4%, while 3.4% were not reported. Participants came from different ethnic groups, such as Javanese, Sundanese, Betawi, Minangkabau, Malay, Dayak, Bima, and so forth. Detail information of characteristic of the participants is presented in Table 1.

2.2. Data Collection and Analysis

We used the teacher's mathematics-related beliefs questionnaire which has been developed by Purnomo [3,13]. The questionnaire includes three sub-scale, namely, teachers' beliefs about the nature of mathematics (BN-M), teachers' beliefs about teaching mathematics (BT-M), and teachers' beliefs about assessment in mathematics (BA-M). Each of sub-scales consists of two factors. BN-M includes relevant and dynamic factors. BT-M includes relational and instrumental factors. BA-M includes integrated and isolated factors.

The data were analyzed descriptively to describe profiles of the beliefs in each internal factor. Furthermore, the data were analyzed using one way multivariate analyses of variance (MANOVA). Some of the basic assumptions for MANOVA are (1) the independence of observation, (2) multivariate normality of the dependent variable groups of the population, and (3) its homogeneity of variance-matrix group population covariance.

Table 1. Information about participants of the Study

Based on	Frequency	%

Gender	Male	57	17.5
	Female	263	80.9
	Not Reported	5	1.5
	Total	325	100
Certification Status	Yes	184	56.6
	Not yet	137	42.2
	Not Reported	4	1.2
	Total	325	100
Teaching Experience	≤ 3 years	40	12.3
	4-10 years	72	22.2
	11-20 years	71	21.8
	> 20 years	132	40.6
	Not Reported	10	3.1
	Total	325	100
Grade level assignments	Lower grade	140	43.1
	Upper Grade	170	52.3
	Not Reported	15	4.6
	Total	325	100

3. Results and Discussion

Based on analysis of the assumptions, some dimensions do not meet the criteria of multivariate normality, so Pillai's Trace tests were applied to interpret the results. Some researchers argue that Pillai test is very strong and resistant to data that violates the assumptions [14–17]. To answer the research questions. The results of the analysis were explicated based on each characteristic. It is followed by discussion and elaboration of study that related to the findings.

3.1. Gender

Summary of the descriptive data for each of the dimensions of the beliefs related to gender is shown in Table 2. In addition, the results of the MANOVA using the Pillai's trace test is presented in Table 3.

Table 2. Descriptive data for teachers' beliefs and gender

Subscale	**Factor**	**Male**		**Female**	
		M	SD	M	SD
BN-M	Relevant	4.928	0.075	5.036	0.035
	Absolute	4.146	0.151	4.047	0.070
BT-M	Relational	5.041	0.063	5.036	0.030
	Instrumental	4.800	0.100	4.604	0.047
BA-M	Integrated	5.094	0.062	5.132	0.028
	Isolated	4.862	0.084	4.755	0.039

Table 2 indicates that the mean obtained group of female was higher than male's group on two factors, namely the relevant factors (5.036 > 4.928) and integrated (5.132 > 5.094). For others beliefs factors, mean of male's group were higher than female's group. However, the differences are necessary to be statistically verified. MANOVA was conducted to see the difference and its summary is presented in Table 3.

Table 3. MANOVA results for teachers' beliefs and gender

Subscale	**Pillai's trace**	**F**	**Hypothesis df**	**Error df**	**p**	η^2

BN-M	0.006	1.006	2.000	315.000	0.367	0.006
BT-M	0.010	1.642	2.000	310.000	0.195	0.010
BA-M	0.005	0.758	2.000	310.000	0.469	0.005

Based on results of the analysis in Table 3, it can be concluded that there is no significant difference between the beliefs and gender. In other words, MANOVA results showed that gender factor has no significant effects on the teachers' beliefs.

3.2. Teaching Experiences

The descriptive analysis of each sub-scales and the characteristics of teaching experience are presented in Table 4. Proceed with the MANOVA's conclusion presented in Table 5.

Table 4. Descriptive data for teachers' beliefs based on teaching experience

Subscale	**Factor**	**≤ 3 year**		**4-10 years**		**11-20 years**		**≥ 20 years**	
		M	SD	M	SD	M	SD	M	SD
BN-M	Relevant	5.108	0.088	5.084	0.066	4.804	0.066	5.071	0.049
	Absolute	3.925	0.179	3.930	0.134	4.042	0.134	4.237	0.099
BT-M	Relational	5.029	0.075	5.047	0.056	5.046	0.057	5.038	0.042
	Instrumental	4.565	0.118	4.506	0.088	4.576	0.090	4.755	0.066
BA-M	Integrated	4.995	0.073	5.180	0.054	5.135	0.055	5.119	0.041
	Isolated	4.645	0.099	4.809	0.074	4.841	0.075	4.771	0.055

Based on Table 4, each sub-scale of the beliefs indicates that the view of constructivist held by participants tends to be more dominant than the traditional view. The mean for the sub-scales of constructivist views is in the range of 4,804 and 5,180. On the other hand, the mean for the sub-scales of traditional views is in the range of 3.925 and 4.841.

Table 5. MANOVA results for teachers' beliefs based on teaching experience

Subscale	**Pillai's trace**	**F**	**Hypothesis df**	**Error df**	**p**	η^2
BN-M	0.058	3.059	6.000	618.000	0.006	0.029
BT-M	0.022	1.111	6.000	610.000	0.354	0.011
BA-M	0.022	1.148	6.000	610.000	0.333	0.011

Different from the gender factor, according to Table 5, teaching experience factor has significant effects on teacher beliefs about the nature of mathematics ($p < 0.05$). However, different results are indicated by two other scales, i.e. beliefs about teaching and learning of mathematics and of assessment. The significant value generated by statistical tests Pillai Trace above requires for further analysis. To find out which of the factors that have significant effect on BN-M, MANOVA test was performed as follows.

Table 6. MANOVA results for BN-M

Factor	**df**	**F**	**p**	η^2
Relevant	3	4.557	0.004	0.042
Absolute	3	1.527	0.207	0.015

Table 6 shows that there is a statistically significant difference between years of teaching experience on a relevant factor, F = 4.557, p = 0.004. Further analysis was performed to discern the differences

across years of teaching experience using the Bonferroni's method of multiple comparisons (see Table 7).

Table 7. Bonferroni method of multiple comparisons

Length of teaching experience (I)	Length of teaching experience (J)	Selisih mean I – J)
3 years or less	4-10 years	0.0242
	11-20 years	0.3047*
	more than 20 years	0.0377
4-10 years	3 years or less	-0.0242
	11-20 years	0.2804*
	more than 20 years	0.0135
11-20 years	3 years or less	-0.3047*
	4-10 years	-0.2804*
	more than 20 years	-0.2669*
more than 20 years	3 years or less	-0.0377
	4-10 years	-0.0135
	11-20 years	0.2669*

*. the significant mean difference on the level of 5%.

Based on Table 7, it indicates that teachers who have11-20 years of teaching experience tend to hold traditional mathematics views. This is verified with a significant mean difference on the level of 5%.

3.3. Certification Status

Descriptive statistics for each sub-scale based on certification status can be seen in Table 8. Whereas, the results of MANOVA can be seen in Table 9.

Table 8. Descriptive data for teachers' beliefs based on certification status

Subscale	Factor	Non-certified		Certified	
		M	SD	M	SD
BN-M	Relevant	4.980	0.049	5.040	0.043
	Absolute	4.039	0.097	4.120	0.086
BT-M	Relational	5.093	0.040	4.990	0.036
	Instrumental	4.581	0.064	4.671	0.057
BA-M	Integrated	5.149	0.039	5.097	0.034
	Isolated	4.780	0.054	4.771	0.047

Table 8 shows that the mean for each of the constructivist view related factors ranges from 4.980 to 5.149, while for the traditional view related factors range from 4.039 to 4.780. The difference between certification status in each sub-scale is presented in Table 9.

Table 9. MANOVA results for teachers' beliefs and certification status

Subscale	Pillai's trace	F	Hypothesis df	Error df	p	η^2
BN-M	0.004	0.659	2.000	305.000	0.518	0.004
BT-M	0.019	2.996	2.000	305.000	0.051	0.019
BA-M	0.003	0.516	2.000	311.000	0.598	0.003

According to Table 9, it indicates that certification status does not have significant effect on beliefs held by the participants ($p > 0.05$).

3.4. Grade Level Assignment

Descriptive statistics for each sub-scale according to grade level assignment is presented in Table 10. Whereas, the MANOVA's result is summarized in Table 11.

Table 10. Descriptive data of teachers' beliefs and grade level assignment

Subscale	Factor	Lower grade		Upper Grade	
		M	SD	M	SD
BN-M	Relevant	4.971	0.048	5.053	0.044
	Absolute	4.000	0.096	4.119	0.087
BT-M	Relational	5.057	0.041	5.022	0.037
	Instrumental	4.663	0.064	4.608	0.058
BA-M	Integrated	5.139	0.038	5.131	0.035
	Isolated	4.798	0.056	4.737	0.051

Means for constructivist view related factors range from 4.971 (SD = 0.048) to 5.139 (SD = 0.038). Meanwhile, means for traditional view related factors range from 4.000 to 4.798. Further analyses to see the difference among factor of beliefs across grade level assignment is summarized as follows.

Table 11. MANOVA results of teachers' beliefs and grade level assignment

Subscale	Pillai's trace	F	Hypothesis df	Error df	p	η^2
BN-M	0.008	1.161	2.000	305.000	0.314	0.008
BT-M	0.002	0.334	2.000	305.000	0.716	0.002
BA-M	0.002	0.331	2.000	305.000	0.719	0.002

Based on Table 11 above, it indicates that there are no significant differences between the beliefs held by teachers and grade level assignment ($p < 0.05$)

Based on the above section, it can be concluded that there are no significant differences of each sub-scales of beliefs on gender, certification status, and grade level assignment. However, teachers who have teaching experience of 11-20 years are more likely to have absolute views

Gender issues often become an attractive factor to be explored. Although there is no rich literature for making a hypothesis related beliefs they held, it remains a compelling issue in the research topics. For example, Golafshani [8] in his doctoral dissertation raised the issue of gender and found that female mathematics teacher in Iran tend to possess more constructivist views than male teachers do. Similar findings were obtained from research conducted by Yazici and Ertekin [10] who studied the difference between beliefs and anxiety of mathematics' prospective teachers of basic mathematics education based on gender. They found that there were differences in the candidates' beliefs about learning math and male are more likely to have instrumentalist beliefs than female teachers do. Nevertheless, the finding of this study indicates that there are no gender differences in the elementary school teachers' beliefs. A plausible reason is that beliefs system from knowledge and experience rather than genetic factors. Further, there are no many comprehensive studies found in the literature investigating relation between beliefs and gender

Besides, it indicates that there is no significant difference between the beliefs held and years of teaching experience. However, there is a difference in beliefs about the nature of mathematics from 11-20 years experienced teachers who lead to hold more absolute mathematical views than any other group. Furthermore, it seems that the higher of years of teaching experience owned by teachers, the more they become absolutist. This finding can be attributed to teacher education that is not the same as the current situation. Teachers who have 11-20 years of teaching experience received education gradually, from the school of teacher education (equivalent to diploma), and lately prosecuted to educated at least Bachelor's degree. Besides, most of them come from non-graduate primary teacher education. In other words, their education has not been embedded with comprehensive mathematics views. Similar findings occur with the certification factor and grade level assignments. A plausible

reason is that certification was recognition of the teaching profession using portfolio assessment or a short educational experience, so it is having no effect on changing teachers' beliefs. To change their beliefs, it requires a comprehensive knowledge and encouragement. In the case of grade level assignment, the finding of this study was in line with the findings of Golafshani [8] which indicated that the grade level assignment did not affect significantly because topic and context of mathematics have no relation with system of beliefs.

4. Conclusion

The findings of this research indicate that it is only in the category of years of teaching experiences that have significant difference in beliefs in which 11-20 years experienced teachers tend to have absolutist views. However, there is no significant difference on beliefs based on other characteristics such as gender, certification status, and grade level taught

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