Assessing the Mathematical Beliefs of Pre-Service Mathematics Teachers in Malaysia

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Abstract: The Mathematical Beliefs Scale (MBS) was administered to 623 pre-service mathematics teachers in Malaysia. The data were analyzed using exploratory factors analysis yielding two factors, namely, Constructivist Orientation (CO) and Traditional Orientation (TO). The results of the factor analysis and the high reliability estimates for the MBS and its subscale confirmed the hypothesis that the MBS can be used to assess beliefs of pre-service mathematics teachers in Malaysia.

Key words: Constructivist, mathematics teacher, mathematics belief, teacher-centred, student-centred

INTRODUCTION

The notion that mathematics teachers' beliefs toward mathematics teaching and learning influence their teaching practice has been suggested by researchers (Thompson, 1993). According to Golafshani teachers who hold the traditional absolutist view about mathematics teaching and learning are more likely to create teacher-centred instructional environment such as teaching mathematics as rules to be memorized. Teachers holding constructivist view of mathematics are expected to adopt student-centred environment by allowing students to explore and interact with each other while teachers act as a facilitator. This view is in line with current reform efforts (NCTM) that ask teachers to lead mathematical explorations and allow students to construct mathematics. According to Battista (1994), all efforts to make the mathematics curriculum consistent with the NCTM standards will fail if teachers' beliefs are not aligned with those of the reform movement. Pre-service teachers' beliefs about teaching and learning indicate something about the culture of the educational system that produced them.

Since, studies conducted in other countries have been successful in identifying pre-service teachers' beliefs, there is reason to believe that similar studies in Malaysia will also yield significant results. There is a need for validated pre-service mathematical beliefs instruments in Malaysia. This study was therefore designed to develop a reliable and valid instrument that can identify the beliefs of pre-service teachers. Understanding prospective teachers' mathematical beliefs is critical to teacher educators.

MATERIALS AND METHODS

Participants were 623 3rd and 4th years' pre-service teachers attending the undergraduate program at Malaysian Public University. Six universities were chosen from a list of public universities in Malaysia. There were 83 male and 540 female. Among the participants, 107 were 3rd year students and 516 were in their 4th year. The participants came from 4 ethnic groups including: 531 (85.2%) Malay; 60 (9.6%) Chinese, 18 (2.9%) Indian and 14 (2.2%) Sabah/Sarawak. The majority of the participants were from UPSI, i.e., 403 (64.7%); 59 (9.5%) UKM; 48 (7.7%) UPM; 46 (7.4%) UTM; 42 (6.7%) UM and 25 (4.0%) from USM.

Instrument development: The initial Mathematical Beliefs Scale (MBS) was developed with items generated from a review of the literature and other instruments that have been used in assessing pre-service teachers' beliefs. The items used were modified to be applicable to pre-service in terms of readability, clarity and meaning. Three Malaysian graduate students and two mathematics education lecturers were asked to evaluate the adequacy of the items. After the initial evaluation of items the instrument was tested with a pilot group of 55 students from one university in Selangor. Participants in the pilot study identified items that were difficult to understand, leading to modification of 10 items. After revision and modification of items, a pool of 42 items were included in the initial MBS to be used for data collection and statistical analysis. The items consisted of a 5-point Likert scale ranging from 1 (strongly disagree), to 5 (strongly agree).

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Procedures: Six universities were chosen from a list of public universities in Malaysia. After the universities were identified, the universities administration was approached to secure their approval and to provide a list of students in their 3rd and 4th year at the universities. The revised instrument was administered to participants at each university. During the administration, the purpose of the study was first explained to the participants and took between 20-30 min to complete. After completing the instrument, the participants were thanked for their participation.

Statistical analysis: A preliminary analysis was performed to screen the data for normality of the distribution. Exploratory factor analysis was performed to determine which factors account for pre-service teacher beliefs. Kaiser-Meyer-Olkin and Bartlett's test of sphericity were applied to test whether the sample is factorable. Principal axis factoring was conducted to extract factors since, this method identifies fewer underlying construct. Factors that met the Kaiser-Guttman retention criteria of eigenvalues >1.0 and were consistent with a Scree Plot test were identified and given a title. Further principal axis factor analyses were performed using both orthogonal (Varimax) and oblique (Promax) rotations to improve the interpretability of the factors. Estimates of alpha coefficients indicating internal consistency of the items within each factor and for the whole scale were then identified. Amount of variance accounted for by each factor and the total score were also assessed.

RESULTS AND DISCUSSION

Initial exploratory factor analysis using principal axis factor extraction method was performed on the set of 42 items to determine the number of factors. The appropriateness of factor analysis was supported by Bartlett's test of sphericity which was significant ($\gamma^2 = 5674.2$; p<0.001).

The Kaiser-Meyer-Olkin measure of sampling adequacy yielded a value of 0.85 indicating that the sample size was large enough to evaluate the factor structure (Tabachnick and Fidell, 2007). Twelve factors that met the Kaiser-Guttman criterion of eigenvalue >1.00 were extracted. An examination of the scree plot also suggested that as many as five factors could be interpreted. The five factors had an eigenvalue ranging from 6.6-1.5 and accounted for a total of 35.3% of the variance.

Further exploratory factor analysis using the Principal Axis Extraction Method was conducted specifying a five, four, three and two factor solution. The following criteria were applied in retaining a preliminary factor structure:

- Retaining factor loadings that exceeded 0.40
- Retaining factors that had at least three items per factor
- Deleting items with cross loading >0.30 after rotation
- The clinical interpretability of factors

Examination of the data indicated that the two factor model was the most suitable solution. The oblique rotation was used to maximize the variance of the coefficients since, the factors were hypothesized to be correlated. Based on the pattern matrix, items that cross loaded on more than one factor were eliminated from the analysis. The two factor model reduced the 42 items set to a 22 items set.

The first factor (15 items) was named constructivist orientation and accounted for 15.62% of the variance. The second factor (7 items) was named traditional orientation and accounted for 8.71% of the variance. The two factors together explained 24.33% of the variance. This low value of the total variance explained suggested that a large part of the variance was not explained by the two factor structure of the MBS.

Reliability estimates: In order to examine the reliability of the scale, the researcher tested the data using Cronbach's coefficient alpha. The reliability estimates of the subscales were 0.82 for constructivist orientation and 0.75 for traditional orientation (Table 1). This is above the acceptable level of 0.70 as recommended by Hair *et al.* (2006).

The overall reliability estimates of the subscales were 0.72. The findings of these analyses indicated that the two constructs can be reliably accesses as indicators of pre-service mathematical teacher beliefs.

The descriptive statistics of the measurement items are shown in Table 2 and 3. The mean scores range from 2.75-4.73. All of the items for the CO are above the mid-point of 3.00 however, most of the item for TO is <3.00. Only 1 item is above the mid-point of 3.00. This indicates that participants showed a stronger response

Table 1: Means, standard deviations and coefficient alpha reliability estimates

Scales	N	Mean	SD	Alpha
Constructivist orientation	15	66.16	4.76	0.82
Traditional orientation	7	23.08	4.80	0.75

Table 2: Descriptive statistics of the constructivist orientation items in the MBS

Item No.	Mean	SD	Skewness	Kurtosis
42	4.41	0.612	-0.819	1.428
33	4.33	0.609	-0.673	1.519
22	4.62	0.554	-1.442	3.397
20	4.43	0.625	-1.040	2.349
15	4.32	0.662	-0.752	0.941
10	4.15	0.598	-0.426	1.556
16	4.26	0.636	-0.657	1.374
29	4.56	0.558	-0.957	0.857
7	4.45	0.559	-0.588	1.047
40	4.25	0.621	-0.750	2.460
19	4.35	0.617	-0.609	0.488
6	4.73	0.480	-1.549	1.991
2	4.65	0.520	-1.066	0.022
39	4.29	0.682	-0.948	1.938
4	4.37	0.585	-0.489	0.455

Table 3: Descriptive statistics of the traditional orientation items in the MBS

Item No.	Mean	SD	Skewness	Kurtosis
36	2.88	1.120	0.235	-0.599
38	3.14	1.121	0.002	-0.717
23	2.85	1.140	0.115	-0.652
13	2.93	1.049	0.054	-0.333
35	2.75	1.043	0.174	-0.277
37	2.99	1.075	0.124	-0.518
3	2.81	1.081	0.122	-0.635

for CO factor. All standards deviations for the CO items are <1.00 indicating a narrow spread of item scores around the mean. On the contrary, all standard deviations for the TO items are >1.00 indicating a widespread of item scores around the mean.

Table 4 shows sample items for the two constructs, i.e, the constructivist orientation and the traditional orientation. The results of exploratory factor analysis revealed the presence of two factors suggesting that the two distinct components underlie the scores on the MBS. The results of the factor analysis and the high reliability estimates for the MBS and its subscale confirmed the hypothesis that the MBS can be used reliably to assess beliefs of pre-service mathematics teachers in Malaysia. The MBS will therefore contribute significantly towards the identification of pre-service teachers' beliefs in Malaysia.

Table 4: Sample items for constructivist orientation and traditional orientation

Sample items	Orientation
Constructivist orientation	
Item 42	Students need to work together in small cooperative groups where they have the opportunities to share mathematical ideas
Item 20	Mathematics should be presented to student in such a way that they can discover relationships for themselves
Traditional orientation	
Item 36	The emphasis on memorizing the procedures, rules and symbols is a key factor in teaching mathematics
Item 38	Teachers should teach the contents which enable students to pass exams

CONCLUSION

This study is an exploratory factor analysis of MBS using a sample (n = 623) of pre-service mathematics teachers. The results of this study shows two-factor solution. These are constructivist orientation (15 items) and traditional orientation (7 items).

LIMITATIONS

Some limitations should be noted in this study. First, the sample in this study comprised mainly of female students and secondly, the majority of students in this sample are from one university in Malaysia. While the researchers consulted other experts in naming the factors, it is possible that different peoples might think of other suitable terms for the factors.

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