BELIEF AND MATHEMATICAL KNOWLEDGE FOR TEACHING AMONG PRE-SERVICE TEACHERS

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Abstract: Teacher’s belief (affective) and professional knowledge (cognitive) are generally known to be related and to impact instructional practice. However, in Malaysia, studies conducted regarding teacher’s belief and knowledge for teaching among pre-service elementary teachers are scarce. The present study investigates the relationship between mathematical knowledge for teaching (MKT), mathematics teaching efficacy beliefs (MTEB), and mathematical beliefs (MB). Using a structured questionnaire together with paper and pencil test adapted from the literature reviewed, data were collected from 187 pre-service elementary teachers in Institute of Teacher Education (ITE) Malaysia. Data were analysed using SmartPLS 3.0. The result of the structural equation model indicated that both personal mathematics teaching efficacy belief (β=0.175, p<0.05) and mathematics teaching outcome expectancy belief (β=0.405, p<0.001) was positively related to MKT. The second regression analysis was to examine the impact of mathematical belief on the MKT. The results showed that constructivist belief (β=0.36, p<0.001) was positively related to MKT, whereas traditional belief (β=0.107, p>0.1) was not related to MKT. Overall, the belief factors explaining a total of 39.4% variance in MKT. Implications from these findings to the successful teacher’s education program implementation in Malaysia were further elaborated.

Keywords: personal mathematics teaching efficacy belief, mathematics teaching outcome expectancy belief, mathematical knowledge for teaching, constructivist belief, traditional belief.

INTRODUCTION

The National Council of Teachers of Mathematics (NCTM) (2000) states that one of the principles of mathematics education is to enhance mathematical knowledge for teaching to become an effective teacher. Issues related to the knowledge of mathematics teachers and their role in classroom practice have been a major issue in mathematics education from the past (Wasserman, 2018). In addition, according to Fitzallen (2015) the mastery of mathematical content knowledge also contributes to the success in the implementation of four disciplines namely Science, Technology, Engineering and Mathematics (STEM).

The framework of mathematics teacher knowledge can be divided into two parts, the content knowledge and content knowledge for teaching mathematics framework (Holmes, 2012). According to Holmes (2012), the content knowledge framework consists of Bloom's Taxonomy (Bloom, Englehard, Furst, Hill, & Krathwohl, 1956), Instrumental and Relational Understandings (Skemp, 1978); Procedural and Conceptual Understandings (Hiebert & Carpenter, 1992) and Cognitive Complexities (Porter, 2002). Content knowledge for teaching frameworks include Shulman's (1986), Type of Teachers Knowledge and Ball's (2000) Mathematical Knowledge for Teaching Framework.

The concept of pedagogical content knowledge (PCK) was introduced by Shulman (1986) as so-called "a missing paradigm" in the study of teaching and teacher education. Shulman has criticized the lack of attention given to the content of lessons related to teaching and evaluation of pre-service teachers as well as studies on the effectiveness of teachers and teaching. By
introducing the PCK concept, Shulman intends to emphasize the content of lessons learned in teaching and teacher education and aims to address the differences between content and pedagogy (Depaepe, Verschaffel, & Kelchtermans, 2013).

The mathematical knowledge for teaching (MKT) is the concept of mathematical knowledge required by a teacher to teach effectively. It includes assessing student responses, responding to questions raised by students, preparing assignments and making lesson plans (Ball, Thames, & Phelps, 2008). According to Austin (2015), the concept of MKT developed by Ball et al. (2008), is a multi-dimensional construct consisting of subject matter knowledge (SMK) and pedagogical content knowledge (PCK).

Ernest (1989) has stated that, the differences between mathematics teachers are not only because of their knowledge, but also related to their beliefs. This is because it is possible for two different teachers to have similar knowledge, but they might be teaching the students with different approach. Teacher's beliefs have become a popular field in education-related studies because of their relationship to knowledge to teach (Thompson, 1992). According to Cross (2009) beliefs are conscious or unconscious opinions and views of the individual about himself, about the world or about his place in the world. According to Ernest (1989), there are generally three categories of beliefs associated with mathematics teachers, namely beliefs about the nature of mathematics, belief in teaching and learning, and beliefs related to principles of education. For this research, we are focusing on the belief in teaching and learning, which is also known as mathematical belief (MB) (Beswick, 2012).

In the Malaysian context, empirical studies related to the knowledge of mathematics teachers are less widely known. Among the studies conducted on the knowledge of mathematics teachers in Malaysia were by Zulkpli, Mohamed, & Abdullah, 2017; Leong, Chew, & Abdul Rahim, 2015; Mohd Yusof & Zakaria, 2015; Suffian & Abdul Rahman, 2010; Tengku Zainal, Mustapha, & Habib, 2009; and Hassan & Ismail, 2008). The findings from the critical analysis that have been carried out on previous studies indicate that most previous studies are more focused on measuring the level of competence on teacher knowledge. Hence there is a need to conduct a study on MKT of mathematics teachers in Malaysia in the context of the factors that influence them.

An excellent mathematics teacher should master both domain of mathematical knowledge for teaching, either in terms of content knowledge or pedagogical content knowledge (Ball et. al., 2008). This is because the mastery of MKT is important indicator of the success of a teacher education program (Tatto, Rodriguez, & Lu, 2015). In addition, it also affects the mathematical achievement of a pupil (Goos, 2013). However, according to Leong et al. (2015) the level of MKT among pre-service teachers in Malaysia is low. The low level of MKT among pre-service teachers will contribute to the implementation of less effective teaching and learning processes (Ball et al., 2008). Hence there is a need to conduct a study to identify the factors that affect MKT among pre-service teachers.

There are several studies that have been conducted to identify the factors affecting teacher’s knowledge. Among them are studies by Meschede, Fiebranz, Möller and Steffensky (2017) and Dunekacke, Jenben, Eilerts and Blomeke (2016); who studied the influence of mathematical belief on teacher’s knowledge. Besides that, there are also some studies exposed that other factors such as mathematics teaching efficacy belief are also can influence teacher’s knowledge. Among them are studies carried out by Norton (2017); Shi (2016); Austin (2015); Swars, Smith, Smith and Hart (2009) shows that mathematics teaching efficacy belief (MTEB) also can affect the mathematical knowledge for teaching. Hence, this study implements a MKT model (Ball et al., 2008), mathematical belief model (Ernest, 1989) and the Social Cognitive Theory from Bandura (1989) to examine the role of mathematics belief and MTEB in influencing MKT among pre-service teachers in Malaysia, by using structural equation modelling (SEM).
SIGNIFICANCE OF THE STUDY

Significance of this study is seen in terms of its contribution to theory and practice. The findings have contributed significantly to the body of knowledge by producing a comprehensive model to explain the factors affecting MKT among pre-service teachers. This model has combined both factors from the context of mathematics belief and mathematics teaching efficacy belief.

This study was also one of the studies on the factors affecting MKT among pre-service teachers in ITE by using SEM method. Therefore, the result of this study can be used by various stakeholders such as the Ministry of Education (MOE) Malaysia, especially the MITE who is responsible for the training of future math teachers. The MITE can use the findings from this study as a guideline in developing a teacher education program capable of producing competent mathematics teachers. In addition, the findings of this study can also be used as references to other higher education institutions who are responsible for training potential math teachers to ensure that future teachers will master the MKT before they are placed in school.

Findings from this study can also be utilized by pre-service teachers who are studying in ITE and in any other higher education institutions to understand the factors that affect their MKT. Through that understanding, it will be able to create awareness for them to appreciate every opportunity they earned during the teacher education program.

Furthermore, the findings of this study can also be used as a reference to future researchers who study the factors affecting pre-service teachers’ knowledge. The findings of this study are also expected not only relevant in the context of factors affecting pre-service teacher knowledge in mathematics, but it also includes teachers' knowledge in other disciplines. Hence this study is very significant to be carried out to contribute towards theory and practical.

THEORETICAL BACKGROUND AND RESEARCH MODEL

There are several models being used to study the role of mathematical belief and MTEB in influencing CK, PCK and MKT by previous researchers. A number of studies on teacher’s knowledge have been examined using the Shulman (1987) model, Fennema and Franke (1992) model and Ball et al. (2008) model. However, the conceptual framework of the most influential teachers in the context of mathematics education is through the overlapping of some mathematical knowledge constructs for teaching (MKT) or content knowledge for the teaching of mathematics (CKTM) covering both content knowledge (CK) and pedagogical knowledge content (PCK) (Ball et al., 2008; Hill, Ball, & Schilling, 2008; Hill, Rowan, & Ball, 2005).

MKT means the mathematical knowledge needed to carry out the work of teaching mathematics. In short, a mathematics teacher needs to know more, and different mathematics not less (Ball et. al., 2008). MKT covers three categories that relate to teachers’ CK: (1) common content knowledge (CCK), (2) specialized content knowledge (SCK), and (3) horizon content knowledge (HCK). Another set of three categories within MKT concern teachers’ PCK: (4) knowledge of content and students (KCS), (5) knowledge of content and teaching (KCT), and (6) knowledge of content and curriculum (KCC) (Ball et. al., 2008).

A study conducted by Swars, Hart, Smith, Smith and Tolar (2007) found that mathematical beliefs factor has influenced teacher knowledge. The study was conducted among 103 elementary pre-service teachers. Additionally, recent studies conducted by Ren and Smith (2017) also found that teachers' belief factor influenced the mastery of mathematical knowledge for teaching among teachers. The findings from the study on 396 early teachers found that there was a significant relationship between traditional beliefs and mathematical knowledge for teaching.

Furthermore, the research conducted by Meschede, Fiebranz, Möller and Steffensky (2017) on teachers teaching elementary science has proven that the beliefs in teaching and learning had influenced the teacher's knowledge. The findings from their research had found that constructivist belief factor influenced the teachers' knowledge (β=0.52, p<0.001). While the traditional beliefs factor also had a significant relationship with the teacher’s knowledge (β= -
0.37, \( p<0.001 \)). Therefore, this study will also examine the influence of mathematical beliefs on the MKT among pre-service teachers in ITE.

H1: Constructivist belief has a significant relationship with mathematical knowledge for teaching.

H2: Traditional belief has a significant relationship with mathematical knowledge for teaching.

Previous studies have shown that MTEB variables influence the teacher’s knowledge. Among them are studies by Shi (2016) on the teachers from United States (US) found that the personal mathematics teaching efficacy belief (PMTEB) has influence their knowledge. Besides that, the study conducted by Austin (2015) on 42 prospective mathematics teachers in US also found that PMTEB have influenced their pedagogical content knowledge. In addition, the study by Swars et al. (2009) also found that PMTEB and mathematics teaching outcome expectancy belief (MTOEB) influence teachers’ PCK significantly.

The study by Newton, Evans, Eastburn and Leonard (2007) on 55 pre service teacher’s in US found that there was a significant relationship between PMTEB and mathematics content knowledge (MCK), but there was no significant relationship between MTOEB and MCK. This result was quite different with study done by Swars et al. (2007) because their finding shows that there was a significant relationship between PMTEB and MTEOB with mathematics teacher’s knowledge.

According to Briley (2012) the pre service teacher’s mathematical belief are also affected by their efficacy belief. Result from the studies conducted among 95 elementary pre-service teachers’ in US found that stronger beliefs in their capabilities to teach mathematics effectively were more likely to possess more sophisticated beliefs as well as were more likely to have more confidence in solving mathematics problems. Besides that, finding from the study found that mathematical beliefs also had a statistically significant effect on mathematics teaching efficacy and on mathematics self-efficacy. Another study conducted by Swars et al. (2007) also found that MTEB can affect teacher’s belief. Thus, the significant relationship between mathematical beliefs and mathematics teaching efficacy should be acknowledged by mathematics teacher educators. Hence, this study will also examine the influence of MTEB on the mathematical belief MKT among pre-service teachers at ITE.

H3: Personal mathematics teaching efficacy belief (PMTEB) has a significant relationship with mathematical knowledge for teaching.

H4: Mathematics teaching outcome expectancy belief (MTOEB) has a significant relationship with mathematical knowledge for teaching.

H5: Personal mathematics teaching efficacy belief (PMTEB) has a significant relationship with constructivist belief.

H6: Personal mathematics teaching efficacy belief (PMTEB) has a significant relationship with traditional belief.

H7: Mathematics teaching outcome expectancy belief (MTOEB) has a significant relationship with constructivist belief.

H8: Mathematics teaching outcome expectancy belief (MTOEB) has a significant relationship with traditional belief.
METHOD

Data Collection

Data was collected from 187 preservice teachers using a structured questionnaire and paper and pencil test. Both measures were adapted from previous research done by other researchers. We have used the clustered random sampling method to collect the data. This method was chosen because this study was conducted on populations involving large areas. The population of this study involves pre-service teachers who are currently pursuing Mathematics Education Program from semester 6 to 8 nationwide. Hence the sample of the study has been divided into several groups based on ITEs involved in the training of pre-service teacher in mathematics education. It was found that 13 out of 27 ITEs nationwide were involved in the training of pre-service teachers in mathematics education. Thus, the sample was divided into 13 groups, and then the sample selection from the cluster was randomly made to ensure that each sample had the same opportunity to be selected as a sample of the study (Acharya, Prakash, Saxena, & Nigam, 2013). The justification for the selection of all pre-service teachers of mathematics education in semesters 6 to 8 is that they have followed most courses offered and have undergone practicum training Phase 1. In addition, their selection as the study population is due to the issues studied have a direct connection with them.

Measures

The measure for MTEB and MTOEB was adapted from Enochs, Smith and Huinker (2000). It contains 13 items that measure PMTEB and 8 items that measure MTOEB. Permission to adopt the instrument has been applied and granted approval. They reported the reliability for the instruments were $\alpha = 0.88$ for PMTEB, while for MTOEB were 0.75. This illustrates that items are suitable for measuring the constructs. This is because the Cronbach alpha value for the constructs exceeds 0.70 (Cronbach, 1951).

Mathematical belief measures were adapted from Zakaria et al. (2009). The instrument has been developed to measure mathematical beliefs among teachers in constructivist and traditional approaches. It contains 12 items, which is 8 items that measure constructivist beliefs and 4 items that measure traditional beliefs. Findings from Confirmatory Factor Analysis conducted by Adnan, Abdullah and Che Ahmad (2014) on the instrument indicates that the items are suitable for measuring mathematical beliefs. They reported the comparative fit index (CFI) value for the mathematical belief construct was 0.983.

Whereas MKT test was adapted from Hill, Schilling and Ball (2004). It consisted of 32 multiple choice items. They reported the level of reliability of items that measure CK of primary school mathematics teacher for number and operation topics $\alpha = 0.784$, while for PCK was $\alpha = 0.888$ (Hill et al., 2004). This illustrates the level of reliability of both constructs is good. The validity of the items used in the MKT test has been determined by items analysis. Item analysis has been carried out to distinguish good items with poor items. Item analysis is intended to produce a high-quality test (Considine, Botti, & Thomas, 2005). Item analysis will be able to provide information regarding the response to each item whether they are able to answer or not that item. It also provides information on how each item works, whether the item is easy or difficult. In addition, an item analysis can discriminate between higher performance groups and lower performance groups (Si-Mui Sim & Raja Isaiah Rasiah, 2006). ANATES 4.0.9 (Karno & Wibisono, 2004) software was used to analyse the MKT test items.

Sample

The study sample was consisted of 187 pre-service teachers from ITE (65.7% were female). Majority of the preservice teachers involved in this study are Chinese (42.8%), whereas Malays about 21.9%, Indian 18.7% and others 16.6%. The CGPA obtained was quite high, which was almost 99% of them got the CGPA above 3.00. This showed that their academic achievements were good.
Table 1: Descriptive statistics results of participants

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>64</td>
<td>34.2</td>
</tr>
<tr>
<td>Female</td>
<td>123</td>
<td>65.8</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malay</td>
<td>41</td>
<td>21.9</td>
</tr>
<tr>
<td>Chinese</td>
<td>80</td>
<td>42.8</td>
</tr>
<tr>
<td>Indian</td>
<td>35</td>
<td>18.7</td>
</tr>
<tr>
<td>Others</td>
<td>31</td>
<td>16.6</td>
</tr>
<tr>
<td><strong>Cumulative Grade Point Average (CGPA)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.75 – 4.00</td>
<td>26</td>
<td>13.9</td>
</tr>
<tr>
<td>3.00 – 3.74</td>
<td>159</td>
<td>85.0</td>
</tr>
<tr>
<td>2.00 – 2.99</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>0 – 1.99</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Data Analysis**

For this study, the researcher has used the SmartPLS 3.0 (Ringle, Wende, Becker, 2015) software to analyse the data. SmartPLS 3.0 was used to analyse the data for this study because it was suitable to answer the research question. According to Hair, Ringle and Sarstedt (2011) if the research goal is exploratory so we should use PLS-SEM. When analysing the data we have followed the analysis procedure as suggested by Hair, Hult, Ringle and Sarstedt (2017). Firstly, we analyse the measurement model and then followed by analysing the structural model. This is to make sure the measures used in the study are reliable and valid to answer the research questions.

**Measurement Model**

When using multiple measures for an individual construct, the researcher should take into consideration the extent to which the measures demonstrate convergent validity (Hulland, 2002). Hair et al. (2017) has stated that a composite reliability (CR) of 0.70 or above and an average variance extracted (AVE) of more than 0.50 are considered acceptable. The result of Confirmatory Factor Analysis (CFA) stated in Table 2 shows that all the composite reliability values are above 0.70 and the AVE is all above 0.50. Therefore, based on the CFA result obtained, we can conclude that convergent validity for this measurement model has been fulfilled.

Table 2: Result of CFA for measurement model

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Internal Reliability (Cronbach Alpha)</th>
<th>Convergent Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Factor Loading</td>
<td>Composite Reliability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Mathematics Teaching Efficacy</td>
<td>PMTEB5</td>
<td>0.811</td>
<td>0.681</td>
</tr>
<tr>
<td>Belief (PMTEB)</td>
<td>PMTEB9</td>
<td></td>
<td>0.747</td>
</tr>
<tr>
<td></td>
<td>PMTEB10</td>
<td></td>
<td>0.620</td>
</tr>
<tr>
<td></td>
<td>PMTEB11</td>
<td></td>
<td>0.742</td>
</tr>
<tr>
<td></td>
<td>PMTEB12</td>
<td></td>
<td>0.683</td>
</tr>
<tr>
<td></td>
<td>PMTEB13</td>
<td></td>
<td>0.806</td>
</tr>
</tbody>
</table>
Besides convergent validity, the researcher also needs to take into consideration about discriminant validity in order to make sure the items used to measure a certain construct are different with another construct in the model. According to Fornell and Larcker (1981) discriminant validity can be established by calculating the square root of the AVE. Besides that, Hair et.al (2017) also stated that discriminant validity also can be established by assessing the cross loading and heterotrait-monotrait ratio of correlations (HTMT) value. For this study we are only used square root of the AVE to assess the discriminant validity.

Table 3: Discriminant validity

<table>
<thead>
<tr>
<th>Constructs</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) PMTEB</td>
<td>0.715</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) MTOEB</td>
<td></td>
<td>0.739</td>
<td></td>
<td></td>
<td>N/A*</td>
</tr>
<tr>
<td>(3) CB</td>
<td>0.321</td>
<td>0.004</td>
<td>0.712</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) TB</td>
<td>0.06</td>
<td>0.035</td>
<td>-0.006</td>
<td>0.828</td>
<td></td>
</tr>
<tr>
<td>(5) MKT</td>
<td>0.331</td>
<td>0.425</td>
<td>0.417</td>
<td>0.13</td>
<td>N/A*</td>
</tr>
</tbody>
</table>

Note:  
* Single item measures

Structural Model and Hypothesis Testing

Structural model analysis are not only tests hypotheses but also estimates path coefficients of constructs by examining the relationship between the dependent and independent variables and the amount of variance which can be explained by the independent variables ($R^2$) as well as by the overall model. Table 4 and Figure 2 shows that H1, H3, H4 and H5 were significant.
The results demonstrated that, (1) constructivist belief had a positive effect on MKT ($\beta=0.36$, $p<0.001$); (2) PMTEB had a positive effect on MKT ($\beta=0.175$, $p<0.05$); (3) MTOEB had a positive effect on MKT ($\beta=0.405$, $p<0.001$) and (4) PMTEB had a positive effect on constructivist belief ($\beta=0.323$, $p<0.001$). The results of the structural model analysis are illustrated in Figure 2. Overall, the model explained 39.4% of the variance in mathematical knowledge for teaching (Table 5).

![Figure 2: Structural model]

### Table 4: Summary of hypothesis tests

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Standardized coefficients (β)</th>
<th>t-value</th>
<th>Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1. CB → MKT</td>
<td>0.36**</td>
<td>5.666</td>
<td>Yes</td>
</tr>
<tr>
<td>H2. TB → MKT</td>
<td>0.107</td>
<td>1.491</td>
<td>No</td>
</tr>
<tr>
<td>H3. PMTEB → MKT</td>
<td>0.175*</td>
<td>3.128</td>
<td>Yes</td>
</tr>
<tr>
<td>H4. MTOEB → MKT</td>
<td>0.405**</td>
<td>6.397</td>
<td>Yes</td>
</tr>
<tr>
<td>H5. PMTEB → CB</td>
<td>0.323**</td>
<td>5.298</td>
<td>Yes</td>
</tr>
<tr>
<td>H6. PMTEB → TB</td>
<td>0.057</td>
<td>0.560</td>
<td>No</td>
</tr>
<tr>
<td>H7. MTOEB → CB</td>
<td>-0.023</td>
<td>0.322</td>
<td>No</td>
</tr>
<tr>
<td>H8. MTOEB → TB</td>
<td>0.030</td>
<td>0.283</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: *p-value < 0.05; **p-value < 0.001

### Table 5: Squared multiple correlations ($R^2$) of the proposed research model

<table>
<thead>
<tr>
<th>Constructs</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Knowledge for Teaching</td>
<td>0.394</td>
</tr>
<tr>
<td>Constructivist Belief</td>
<td>0.104</td>
</tr>
<tr>
<td>Traditional Belief</td>
<td>0.004</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

The purpose of this study was to test a model of factors affecting mathematical knowledge for teaching among preservice teachers in Malaysia. Due to that, this study examined the relationship between mathematical belief (in term of constructivist belief and traditional belief) and MKT, and the impact of mathematics teaching efficacy belief (MTEB) on MKT and mathematical belief.

The results of the multiple regression analysis for this study are not consistent with those found in a similar study by Meschede et al. (2017). The result from their study found that both dimensions of mathematical belief were positively related to teachers’ knowledge, but for this study the traditional belief are not related to mathematical knowledge for teaching. Besides that, the findings are also consistent with Swars et al. (2007) findings which stated that there is a significant relationship between preservice teachers’ mathematical belief and their mathematical knowledge for teaching. Another study conducted by Ren and Smith (2017) also found that there was a significant relationship between mathematical belief and teacher’s knowledge.

The findings from this study and the previous study clearly shows that the mathematical beliefs factor can influence their level of mathematical knowledge for teaching. Hence it is important for the stake holders, especially MITE to take the necessary steps to improve the level of mathematical beliefs of pre-service teachers, especially in the aspects of constructivist belief. In addition, besides improving the level of knowledge, mathematical beliefs are also able to affect the mathematical achievement of a student. The findings from research conducted by Suthar, Tarmizi, Midi and Adam (2010) on 473 university students in Malaysia found that mathematical beliefs factor has influenced their mathematical achievement. The MITE should recognize the importance of mathematical beliefs factor on the level of MKT among pre-service teachers. Hence, more precise work should be done to improve the mathematical beliefs of pre-service teachers. Among the efforts undertaken by the MITE are to provide a wider range of learning opportunities to pre-service teachers. This is because the findings from previous study show that the opportunities to learn factor has influenced the mathematical beliefs of a pre-service teacher (Ayieko, 2014).

Results from this study also shows that there was a significant relationship between PMTEB and MTOEB with MKT. This finding confirms that pre-service teachers with high positive MTEB will also master the MKT learned during their teacher’s education program. The findings of the third and fourth hypothesis testing were supported by some findings from previous studies. Among the findings are from the study conducted by Swars et. al. (2007), they found that MTEB is one of the factors that influence the MKT of a pre-service teacher in the United States. The study conducted by Newton et. al. (2007) found that only PMTEB factors had significant relationship with teacher’s knowledge. The MTOEB factor was found to have no effect on a teacher's knowledge. Meanwhile, the study by Swars et. al. (2009) is parallel to the findings of this study as it is found that the MTEB factor influences the mastery of the knowledge of a pre-service teacher. Additionally, studies by McCoy (2011) also found that MTEB factors influenced teachers’ MKT. A study conducted on 101 pre-service teachers in the United States found that there was a significant relationship between MTEB and MKT.

Findings from other studies also support the findings of this study, including studies by Austin (2015) and Shi (2016). The findings from Austin (2015) show that there is a significant relationship between PMTEB and MKT of a pre-service teacher. The study was conducted on 42 pre-service teachers in the United States. Meanwhile, a study by Shi (2016) was conducted on teachers in China and America also found that MTEB factors influenced the MKT level of a pre-service teacher in the United States.

However, it is different for pre-service teachers in China. The findings of Shi (2016) show that the MTEB factor does not affect teachers’ MKT. Recent studies conducted by Depaepe and König (2018) on 342 pre-service teachers in Germany also found that self-efficacy beliefs factor did not affect the knowledge of teachers. According to them, the level of self-efficacy of pre-service teachers is difficult to predict because of experience factor.
The model tested in this study shows that PMTEB and MTOEB can account for 10.4% of the variance in constructivist belief while about 39.4% of the variance in mathematical knowledge for teaching. These results suggest that the tested model is able to predict the mathematical belief and teachers’ knowledge.

The contributions of this study towards Institute of Teachers Education (ITE) and implementers are there was a need for both of them to provide necessary mathematical and efficacy belief to the pre-service teachers in order to ensure they can increase their MKT. If preservice teachers’ MKT is low because of lack of mathematical and efficacy belief, it will affect the teacher education program implementation. Enough and adequate opportunities to learn that can enhance pre-service teacher’s belief provided by the ITE seem to bring a greater teacher education program to the pre-service teachers.

LIMITATIONS AND FURTHER RESEARCH

This study empirically tested the effect of mathematics teaching efficacy belief and mathematical belief on mathematical knowledge for teaching. Although the finding of this study was really useful, there are certain limitations regarding this study. Therefore, our findings need to be interpreted appropriately. The first consideration was that the sample size used in this study need to be take into account when generalizing the results of the study. This is because this study only involved a small sample size (N=187). Besides that, this study is only focused on testing the effect of MTEB and mathematical belief on mathematical knowledge for teaching. There might be any other related variables that can affect MKT.

In the future, this study can be expanded by (1) integrating the influence of opportunities to learn (OTL) on the MKT among pre-service teachers, such as OTL mathematics content, OTL general pedagogy, OTL through teaching practice and OTL mathematics pedagogy on the MKT among pre-service teachers and (2) expanding the model by adding other relevant variables found from latest literature. Besides that, future studies also can make a comparison of mathematical knowledge for teaching between pre-service and in-service teachers considering the fact that in-service teachers should have a better mathematical knowledge for teaching due to their teaching experiences.

CONCLUSION

The purpose of this study was to identify the factors that affect mathematical knowledge for teaching among pre-service teachers at ITE. According to the findings, we found that both mathematical belief and mathematics teaching efficacy belief are significant factors influencing mathematical knowledge for teaching among pre-service teachers in Malaysia. The findings of this study may enable the teacher education program provider to take into consideration on these variables that will influence mathematical knowledge for teaching. In addition, this study may provide an empirical justification for the ITE to develop a strategic plan that can improve the teacher education program by focusing on the pre-service teachers’ belief. In the future, there was a need to conduct further research to enhance this study. We believe this study are able to give a preparatory knowledge and comprehension on the role of mathematics teaching efficacy and mathematical belief in maximizing the mastery of mathematical knowledge for teaching.
REFERENCES


