Establishing Validity of the Thai Mathematics Teaching Efficacy Beliefs Instrument

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This article presents our work in translating the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) from English to Thai and our resulting investigation of validity with Thai preservice teachers. The translation process occurred over several meetings between two U.S. mathematics educators and one Thai mathematics educator. To check for reliability the instrument was translated into Thai, back-translated into English, and then cognitive interviews were conducted with native Thai speakers to check for accuracy, meaning, and readability. We used the newly translated Thai-Mathematics Teaching Efficacy Beliefs Instrument (T-MTEBI) to measure teacher efficacy beliefs as they related to Thai preservice mathematics teachers. Eight of the questions measure Mathematics Teaching Outcome Expectancy (MTOE). The mean of the scores on these questions was computed to form a MTOE score for each student. The remaining 13 questions measure Personal Mathematics Teaching Efficacy (PMTE). The mean of these scores was computed to obtain the PMTE score for each student. The mean of all 21 questions was computed to find an overall efficacy score for each student. The results of this study showed that the newly constructed T-MTEBI produced reliability and validity measures comparable to the original MTEBI (Enochs, Smith, & Huinker, 2000).

During the last five decades mathematics educators from around the world have been working together to better understand the teaching and learning of mathematics (Hsieh et al., 2011; Mullis, Martin, Foy & Arora, 2012). As part of this process researchers continue to work on creating instruments that produce reliable and valid results across cultures and languages. In this article, we are interested in sharing the process of taking an existing instrument created in one language and translating it for use in another language and culture. The goal is to create a version of the instrument which preserves the form, meanings, and function of the original instrument while remaining valid and reliable in the new lingo-cultural context. If this can be achieved, then the new version of the instrument may be used effectively with a new population of subjects, and the possibility of cross-cultural comparisons is made available.

In particular, one area of need for mathematics education is close scrutiny of measures for teaching-efficacy of preservice mathematics teachers. Research has indicated that self-efficacy beliefs are context specific (Bandura, 1997) and that preservice teachers do not have the same level of teaching confidence across all contexts (Siwatu, 2011). As a group of researchers from Thailand and the United States we have many research questions about what elements in our preservice programs might give our students a greater confidence in their mathematics teaching. We would like to study these questions both qualitatively and quantitatively, but to achieve this goal we need a comparable quantitative instrument of preservice teachers' mathematics teaching efficacy that elicit reliable and valid results from both settings.

The study described here is built on the knowledge of previous work done in the United States in the development of a sound instrument for preservice mathematics teaching efficacy, called the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). The systematic process we followed to create Thai-Mathematics Teaching Efficacy Beliefs Instrument (T-MTEBI) and study the reliability and validity of its results is described here. Efficacy is an important area of research with a long history that has informed education policy and teaching decisions. In the next section we look specifically at some of the major findings in efficacy research that support the creation of an instrument of this kind and to serve as a basis for future research collaborations between mathematics educators in Thailand and the United States.

Review of Efficacy Research

Teacher efficacy has been defined as the extent to which teachers believe they can strongly influence student achievement and motivation in learning (Ashton, 1985; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). For a little more than three decades, educational researchers have been working to define the construct of teacher efficacy, clarify its conceptual underpinnings, and measure its relationships.

The construct of teacher efficacy has its theoretical beginnings in Rotter's (1966) social learning theory. Rotter's work was the inspiration for a small part of a study done by the Rand Corporation (Armor et al., 1976) in which they measured teacher efficacy by summing scores of two items on a survey. The first item asked teachers whether environmental and motivational factors of students could be overcome by teachers, as a general group, measuring what is now referred to as teaching outcome expectancy (TOE). The second item asked, from the first person perspective, about the degree to which the teacher was confident in getting through to the most difficult students, measuring what is now referred to as personal teaching efficacy (PTE). Throughout the 1980s and 1990s teacher efficacy was further influenced by Bandura's social cognitive theory (Bandura, 1977, 1986, 1993, 1997).

In 1984, Gibson and Dembo applied Bandura's psychological construct of self-efficacy to the teaching field and foresaw that teachers' sense of efficacy could account for variations in teaching ability. Bandura defined self-efficacy as a person's judgment of how well he or she could perform an action to deal with a situation (1997). He claimed that when one has low self-efficacy, less effort might be given, and one will encounter more stress from the demands of having to perform the action. When applied to the act of teaching, efficacy is more specifically thought of as the teacher's beliefs about his or her ability to influence student learning. These beliefs can affect the amount of effort a teacher gives toward teaching and the amount of stress a teacher encounters in the classroom.

From these theoretical bases, research on teacher efficacy has been found to have significant influence on teacher practice and student learning (Smith, 1996). Early research found a positive correlation between a teacher's sense of efficacy and whether or not the teacher stayed in the field (Glickman & Tamashiro, 1982). Teacher efficacy has also been found to be related to the amount of pedagogical change a teacher exhibited and the fidelity with which teachers integrated methods learned from professional development attended (Berman, McLaughlin, Bass, Pauly, & Zellman, 1977). Further, teachers with greater levels of efficacy have been found to produce higher measures of student achievement (Allinder, 1995; Ashton & Web, 1986), persist in working with struggling students (Ashton & Webb, 1986; Gibson & Dembo, 1984), and be more willing to try innovative curriculum (Guskey, 1988).

As efficacy research grew, evidence and refinements to the construct indicated a necessity to look more closely at the role played by the context and subject matter as well as the appropriate level of specificity for measuring teacher efficacy (Tschannen-Moran et al., 1998). Furthermore, it is important to understand the effects of preservice teacher training on teacher efficacy and what aspects appear to be rigid or malleable in a particular subject domain, such as mathematics. The MTEBI was developed to better investigate subject matter specific teacher efficacy (Enochs, et al., 2000), and has been implemented by many in the field. Using this mathematics specific instrument, researchers have found that preservice teachers' sense of PTE and TOE increased significantly when taking an integrated mathematics/science course, while those students in a nonintegrated course had no change (Moseley & Utley, 2006). Another study by Utley, Moseley, and Bryant (2005) showed an increase in teaching efficacy as preservice teachers participated in mathematics methods coursework but a slight decline in teaching efficacy by the end of student teaching. Other studies using the MTEBI found that preservice teachers' mathematics self-efficacy was highly correlated to confidence in teaching mathematics (Bates, Kim, & Latham, 2011; Kahle, 2008) and mathematics self-concept (Isiksal, 2010), but negatively related with mathematics anxiety (Gresham, 2008; Swars, Daane, & Giesen, 2006). Research by Brown (2012) involved students who came to the university at an older age to study to be a teacher. Brown found a positive correlation between the age of the student and mathematics-teaching efficacy. As shown, the literature has established significant relationships between mathematics teacher efficacy and several qualities necessary for successful teaching and learning of mathematics.

More often than not, research has supported Gibson and Dembo's (1984) prediction that teachers who continue to wrestle with the difficulties of the teaching profession have high measures of general and PTE, while those with low measures do not persist and often leave the profession. Teaching efficacy has been connected to the mathematics which teachers teach and what their students end up learning (Peterson, Fennema, Carpenter, & Loef, 1989). Furthermore, low teaching efficacy acts as a factor in preservice teachers' reluctance to teach mathematics (Wenner, 2001). It is, therefore, important for teacher educators to determine the level of their preservice teachers' efficacy and design programmatic elements that actively promote higher levels of teaching efficacy.

To further the research knowledge of preservice teachers' mathematics teaching efficacy and further refine its constructs based on the cultural and place contexts of Thailand and the United States, an instrument that produces reliable and valid mathematics teaching efficacy results needs to be carefully developed. Such an instrument can lead to the design of multiple research studies, the results of which can then be carefully compared with mathematics efficacy studies in each country. With this ultimate goal in mind we translated the MTEBI instrument into the Thai language and performed an initial study of reliability in the Thai preservice teacher context to answer our research question. Does the T-MTEBI produce measures of reliability and validity comparable to the original MTEBI?

Method

General Stages

To achieve the goal of producing a translated version of the previously established instrument that closely preserves the meaning and intent of items of the original instrument, the researchers followed this process.

Stage one. At least two independent researchers fluent in both languages with a thorough understanding of the intent of the instrument were engaged in the process. One performed a translation of the original instrument and the other independently translated it back into the original language (without referencing the original instrument). The final version in the original language was then checked against the original version for preservation of meaning.

Stage two. Cognitive interviews were conducted with subjects from the target population who were fluent in the target language and who tested the translated instrument. The purpose of these interviews was to determine if the original meaning of the items was preserved in translation. Corrections in the translation were then made when necessary. This stage should be repeated if significant changes are made to the items in stage three.

Stage three. The translated instrument was used in a quantitative data trial and statistical tests were performed to establish the validity and reliability of the translated instrument with the target audience. These statistical tests are then used to determine problems and adjustments are made to the translation. Stage two and three are then repeated to improve the instrument.

Instrument Translation and Modification

Translation began with the 21-item English version of the MTEBI (Enochs et al., 2000). The MTEBI has a Likert scale of five response categories: strongly agree, agree, uncertain, disagree, and strongly disagree. MTEBI has two subscales associated with Bandura's (1997) theoretical framework; personal mathematics teaching efficacy (PMTE) and mathematics teaching outcome expectancy (MTOE). Of the 21 items, 13 are about PMTE and eight about MTOE. The MTEBI was previously shown to produce reliable and valid outcomes by Enochs et al. (2000) for the assessment of mathematics teaching self-efficacy and outcome expectancy with preservice elementary teachers in the United States.

Stage one. Three researchers worked together to translate the English version of the MTEBI into the Thai version (T-MTEBI). One researcher was a native English speaker and two researchers were native Thai speakers. All three researchers speak fluent English. Two researchers work in universities in the United States and the other researcher works at a university in Thailand. The researcher in Thailand translated the MTEBI into the T-MTEBI. The T-MTEBI was then back translated into English by the native Thai researcher working in the United States. The original English translation was then cross-checked with the back translated version by the native English-speaking researcher for consistency of meaning. Due to cultural and linguistic variance, some small differences in the wording of the T-MTEBI were necessary to preserve the meaning of each item to the greatest extent possible.

Stage two. Cognitive interviews (Desimone & Le Floch, 2004) about the translated items were conducted with a group of six Thai preservice mathematics teachers to determine translation coherence. The interviewees read each item explaining what they believed the question meant and how they would respond. We noted which items were inappropriately understood for the intended meaning, and for these items interviewees gave feedback on ways to modify the wording to preserve the intended meaning.

One difficulty of language translation involves accounting for nuances of meaning that are not directly transferable from one language to another. For example, in the original MTEBI preservice mathematics teachers are asked to consider what they believe about the kind of teacher they will be in the future. The original MTEBI uses the future tense phrase "I will" in 10 of the 21 items. For example, item number two says, "I will continually find better ways to teach mathematics." To account for this belief about future actions we used the Thai phrase "When I become a teacher…" This change was made because cognitive interviews revealed that some of the Thai preservice teachers interpreted the statements to be speaking about actual teachers, and since they are not yet teachers, the original MTEBI statement did not make sense to them.

Other item modifications took place based on the necessity of closely preserving the intent of the item through the Thai language. These items were 1, 15, 18, and 21. For item one the English item was worded affirming that "When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort."

In the T-MTEBI the item was written as "When students cannot learn math as well as expected it might be due to not enough supplemental support provided by the teacher." Keeping in mind that many times different languages do not have literal word-for-word translations, the Thai researchers made this change to keep the logical meaning of the statement and write it in a way that would be clear to Thai preservice teachers. Item 15 in the English version used the word "manipulative," which is a technical term in education literature. The item read, "I will find it difficult to use manipulatives to explain to students why mathematics works." An agreeable response for this item on the MTEBI indicated a low level of efficacy as manipulatives are seen as potentially powerful learning aids for students. In the T-MTEBI the question was written to align with the intent of the English version but did not use the word manipulatives and instead asked for a rating on the preservice teachers' ability to find "a good method with physical objects" to explain why math works. Similarly, item 18 uses the English word "principal" in conjunction with the willingness of preservice teachers to undergo a teaching evaluation when it said, "Given a choice, I will not invite the principal to evaluate my mathematics teaching." This particular scenario may not be meaningful to all Thai preservice teachers since there are different methods of accountability for teachers in Thailand. In the T-MTEBI the context of inviting the principal was dropped while keeping the intent of the English version by stating "If there are options, I do not want to have an evaluation of my mathematics teaching." Item 21 of the English version contained a cultural analogy in the expression "to turn students on to mathematics." This was modified in the T-MTEBI to "make students interested in the subject of mathematics" thereby preserving the intended meaning yet necessarily using different words that are more commonly understood by Thai preservice teachers.

Stage three. In this study, stage three went through two iterations. For the purpose of examining reliability and validity evidence of the translated Thai MTEBI (T-MTEBI) instrument two quantitative data trials were conducted with Thai preservice mathematics teachers from a university in western Thailand. The site was chosen because students from many locations in Thailand come to the university to study in the mathematics teaching program. The mathematics teacher preparation program spanned a 5-year period. From these two data trials the T-MTEBI evolved into its final version found in Appendix A.

Data trial 1. After the initial translation, the T-MTEBI was given to a sample of 262 preservice mathematics teachers (66 male and 196 female). Participants ranged from first-year students to fourth-year students (40 first-year, 116 second-year, 60 third-year, and 46 fourth-year). As will be further elaborated on in the analysis section of this article, a confirmatory factor analysis revealed a cluster of low item-total correlations on the positively worded PMTE questions. The research team made small language modifications to these questions prior to the second data trial.

Data trial 2. After these modifications were made to the translation of the T-MTEBI, steps were taken to ensure instrument translation reliability for these modifications. We conducted cognitive interviews (Desimone & Le Floch, 2004) about the translation with two mathematics educators that were native Thai speakers and were not associated with this research project. Both of the mathematics educators are native Thai and speak Thai and English fluently. Both had studied in the United States as graduate students in mathematics education programs. During these interviews both of the Thai mathematics educators confirmed that the translation was accurate, readable, and preserved the intended meaning.[1]

The final version of the T-MTEBI (Appendix A) was given to a sample of 272 preservice mathematics teachers (68 Male and 204 Female). Participants ranged from first-year students to fourth-year students (38 first-year, 39 second-year, 127 third-year, and 68 fourth-year).

Analysis

The T-MTEBI asked participants to respond to 21 statements about mathematics teaching efficacy using a five point Likert scale. A value of 1 was awarded for Strongly Disagree up to a 5 for Strongly Agree for the positively worded items and the scale was reversed for negatively worded items so that a higher score consistently corresponds to a higher degree of efficacy. This is a common scoring procedure for efficacy measures (Enoch & Riggs, 1990). The mean of the scores for the eight items, 1, 4, 7, 9, 10, 12, 13, and 14, was computed as the MTOE score. Similarly, the scores for the remaining 13 items were averaged to find the PMTE score.

Minitab was used to perform a confirmatory factor analysis to test the validity of the instrument used with the population of Thai preservice teachers. Since one goal of this project is to develop a Thai instrument as close as possible to the MTEBI the focus on the data analysis is not on addition or removal of items but rather on determining if the existing collection produces reliable results with Thai preservice teachers. To this end the analysis focuses primarily on item to total score correlations within each of the two domains. If each of these items to total correlations are reasonably high then they are collectively measuring the same construct. They should also be free of any obvious bias.

Other measures of reliability and validity were computed via performing an SAS confirmatory analysis. Here we report Cronbach's alpha, Bentler Comparative Fit Index (CFI), and the Chi-Squared/degrees of freedom ratio and compare these with the corresponding measures from the initial tests of the MTEBI. Cronbach's alpha is a number between 0 and 1 measuring internal consistency reliability. Higher alpha values indicate that the items in each of the two domains are more consistently measuring the same construct. The Bentler CFI is an incremental index with values from 0 to 1where higher values are preferred. The CFI is comparing the fit of the model to the fit of an independent model where the variables are assumed to be uncorrelated. The Chi-Squared/degrees of freedom ratio is an absolute index where lower values are desired. The Chi-Squared statistic measures the difference between the observed and predicted covariance matrices. Its sensitivity to sample size is corrected by dividing by the degrees of freedom.

Results

Data Trial 1

In data trial 1, the T-MTEBI instrument preserved the positive/negative wording of items from the original English MTEBI version of the instrument. This means that if an item was stated negatively such as, "I will *not* be effective in managing mathematics activities" in the MTEBI then it was also worded negatively in the translated T-MTEBI. A confirmatory factor analysis of the results of data trial 1 indicated a difference in the responses of positively and negatively worded items. This difference in mean score on the two groups of PMTE items is significant with a *t*-test *p*-value of 0 to over 30 decimal places (Matney, Panarach, & Jackson, 2013). As can be seen in Table 2, the questions for PMTE included both positively and negatively worded questions. The item-total correlations for the positively worded PMTE questions (2, 5, 11, 16, and 20) clustered together around .30, which is considered to be a low correlation and a ground on which to drop items from consideration (Robinson, Shaver, & Wrightsman, 1991). This did not occur when the English version was used with the initial U.S. participants (Enochs et al., 2000). Conversely, all other items in data trial 1 had viable item total correlations. On reconsidering the translation it was decided to modify the T-MTEBI so that all of the MTOE items were worded positively as they were in the original English and change the PMTE items to all be worded negatively. Thus, for data trial 2 the PMTE items numbered 2, 5, 11, 16, and 20 were reworded negatively.

Table 1
Summary Statistics T-MTEBI Data Trial 2

	MTOE	PMTE
Mean	3.89 [3.84, 3.94]	3.77 [3.71, 3.82]
Standard Deviation	.41 [.38, .45]	.46 [.43, .51]
Minimum	2.38	1.69
Q_1	3.63	3.54
Median	3.88 [3.88, 4.00]	3.85 [3.77, 3.85]
Q_3	4.13	4.00
Maximum	4.88	4.85

Data Trial 2

For data trial 2 a total of $n = 272$ participants completed the translated T-MTEBI (Appendix A) as part of the validation study. Basic summary statistics for the MTOE and PMTE scores were computed using Minitab and are given in Table 1. Notice that the scores were very positive in both measures with means of 3.89 for MTOE and 3.77 for PMTE. Median scores were 3.88 for MTOE and 3.85 for PMTE. The sample size is large enough to assume that the distribution of sample means is approximated well by a normal distribution.

Ninety-five percent confidence intervals can be found in Table 1. Q_1 and Q_3 were computed using the Minitab method. Results of this SAS confirmatory analysis are displayed in Table 2. For comparison the corresponding statistics are given as reported in the original validation study of the English version of the MTEBI by Enochs et al. (2000) and corresponding statistics from the data trial 1 of the T-MTEBI are given as well. Cronbach's alpha values for the data trial 2 administration of the T-MTEBI were .65 for MTOE and .84 for PTME, both of which are in the acceptable range but are slightly under the corresponding alpha values of .75 for MTOE and .88 for PTME from the original MTEBI study.

Item-total score correlations were computed for each item. Notice that the T-MTEBI has a higher mean of the item-total correlations within the MTOE scores than the original English MTEBI study (mean of .53 vs. .47). This gives evidence that items within the MTOE are measuring the same construct on the T-MTEBI at least as well as if not better than they do on the original English MTEBI. Similarly, the T-MTEBI had a higher average item-total correlation for PMTE than the original MTEBI study (.62 vs. .56). Other computed measures of total fit include the Bentler CFI of .801 which is an improvement over .628 from data trial 1 and is comparable to the corresponding measure of .869 from the original study of the English MTEBI version of the instrument. The Chi-Squared/ degrees of freedom ratio is 2.43 which is an improvement over 3.24 from the previous version and comparable to the

Table 2
Confirmatory Factor Analysis

Item	Original Wording	Data Trial 2 T-MTEBI				Data Trial 1 T-MTEBI Item-Total Correlations	English MTEBI Item-Total Correlations
		Median	Mean	Standard Deviation	Item-Total Correlations		
Mathematics Teaching Outcome Expectancy							
1	P	4.0	4.24	.52	.28	.44	.49
4	P	4.0	4.12	.72	.59	.61	.49
7	P	3.0	3.29	1.00	.54	.54	.42
9	P	4.0	3.89	.92	.66	.52	.42
10	P	4.0	4.32	.67	.46	.59	.48
12	P	4.0	3.61	.80	.53	.64	.45
13	P	4.0	3.88	.71	.57	.48	.53
14	P	4.0	3.80	.80	.62	.48	.49
Mean		3.9	3.89	.77	.53	.54	.47
Personal Mathematics Teaching Efficacy							
2	P	4.0	3.59	.78	.62	.28	.36
5	P	4.0	3.44	.86	.60	.33	.54
11	P	4.0	3.47	.79	.48	.25	.59
16	P	4.0	3.69	.67	.68	.34	.62
20	P	4.0	4.05	.71	.58	.32	.47
3	N	4.0	4.00	.74	.72	.65	.62
6	N	4.0	3.86	.77	.60	.56	.56
8	N	4.0	3.86	.71	.71	.68	.55
15	N	4.0	3.68	.86	.60	.62	.50
17	N	4.0	3.78	.71	.65	.59	.62
18	N	4.0	3.82	.76	.55	.65	.58
19	N	4.0	3.90	.71	.62	.64	.65
21	N	4.0	3.83	.77	.61	.67	.61
Mean		4.0	3.77	.76	.62	.50	.56

corresponding value of 2.34 from the original study of the English MTEBI version. The average of the Item-Total Correlations are better than the corresponding measures from the original study of the English version, and the Cronbach's alpha, the Chi-Squared/degrees of freedom ratio, and the Bentler CFI are comparable to those of the original study of the English version of the instrument.

Conclusions

The findings here remain consistent with prior research validating the English version of the MTEBI (Enochs et al., 2000). Although the validation of instruments is a process that is ongoing, the analysis provided here shows the T-MTEBI (Appendix A) to elicit valid and reliable assessment outcomes of mathematics teaching efficacy and its two scales of MTOE and PMTE with Thai preservice mathematics teachers. Other studies using the T-MTEBI should continue to specify their study specific reliability and validity. We encourage the use of the T-MTEBI alongside other research tools to garner more clarity on what kinds of experiences change Thai preservice teachers' mathematics teaching efficacy and why.

Using both the MTEBI and the T-MTEBI researchers in both Thailand and the United States can work together to understand preservice teachers' mathematics teaching efficacy. More specifically, researchers can more closely consider how program elements and the major elements of mathematics methods courses in both countries change preservice teachers' mathematics teaching efficacy. Research should be done on socio-cultural aspects of preservice teachers' efficacy in both Thailand and the United States and how these aspects relate to mathematics teaching efficacy measures.

Building on prior research, these instruments allow a comparative gateway through which to study the relationship between course work and mathematics teaching efficacy (Moseley & Utley, 2006; Utley et al., 2005) in Thailand and the United States. Researchers from these two countries might start by exploring results related to previous studies such as, the relationship between mathematics self-efficacy and confidence in teaching mathematics (Bates et al., 2011; Kahle, 2008) and the relationship between mathematics anxiety and mathematics teaching efficacy (Gresham, 2008; Isiksal, 2010; Swars et al., 2006). For ourselves, building on this research study, we look to work with others to better understand how mathematics teaching efficacy might be measured and interpreted within the framework of differing cultures. In working through this process we noticed the informative power of both the cognitive interviews and the statistical analysis and advise other researchers to include both of these in their instrument translation research. Furthermore, we hope that the general method employed in this study will provide insight to researchers desiring to translate other established instruments into multiple languages making them available for wider use and thereby broadening our understanding of many aspects of learning across various cultures.

A copy of the final version of the T-MTEBI and the original English MTEBI is found in Appendix A. Instructions on coding and scoring the T-MTEBI are found in Appendix B.

References

Allinder, R. M. (1995). An examination of the relationship between teacher efficacy and curriculum-based measurement and student achievement. *Remedial & Special Education*, *16*, 247–254.

Armor, D., Conroy-Oseguera, P., Cox, M., King, N., McDonnell, L., Pascal, A., . . . Zellman, G. (1976). *Analysis of the school preferred reading programs in selected Los Angeles minority schools*. (Report No. R-2007-LAUSD). Santa Monica, CA: Rand Corporation. (ERIC Document Reproduction Service No. 130 243).

Ashton, P. T. (1985). Motivation and the teacher's sense of efficacy. In C. Ames & R. Ames (Eds.), *Research on motivation in education* (Vol.*2*, pp. 141–171). Orlando, FL: Academic Press.

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York: Longman.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychology Review*, *84*, 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117–148.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman and Company.

Bates, A. B., Kim, J., & Latham, N. (2011). Linking pre-service teachers' mathematics self-efficacy and mathematics teaching efficacy to their mathematical performance. *School Science and Mathematics*, *111*(7), 325–333.

Berman, P., McLaughlin, M., Bass, G., Pauly, E., & Zellman, G. (1977). *Federal programs supporting educational change. Vol. VII Factors affection implementation and continuation* (Report No. R-1589/7-HEW). Santa Monica, CA: The Rand Corporation (ERIC Document Reproduction Service No. 140 432)

Brown, A. B. (2012). Non-traditional pre-service teachers and their mathematics efficacy beliefs. *School Science and Mathematics*, *112*(3), 191–198.

Desimone, L. M., & Le Floch, K. C. (2004). Are we asking the right questions? Using cognitive interviews to improve surveys in education research. *Education Evaluation and Policy Analysis*, *26*(1), 1–22.

Enochs, L., & Riggs, I. (1990). Further development of an elementary science teaching efficacy belief instrument: A preservice elementary scale. *School Science and Mathematics*, *90*(8), 694–706.

Enochs, L., Smith, P., & Huinker, D. (2000). Establishing factorial validity of the Mathematics Teaching Efficacy Beliefs Instrument. *School Science and Mathematics*, *100*(4), 194–202.

Gibson, S., & Dembo, M. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, *76*(4), 569–582.

Glickman, C., & Tamashiro, R. (1982). A comparison of first-year, fifth-year, and former teachers on efficacy, ego development, and problem solving. *Psychology in Schools*, *19*, 558–562.

Gresham, G. (2008). Mathematics anxiety and mathematics teacher efficacy in elementary pre- service teachers. *Teaching Education*, *19*(3), 171–184.

Guskey, T. R. (1988). Teacher efficacy, self-concept, and attitudes toward the implementation of instructional innovation. *Teaching and Teacher Education*, *4*, 63–69.

Hsieh, F. J., Law, C. K., Shy, H. Y., Wang, T. Y., Hsieh, C. J., & Tang, S. J. (2011). Mathematics teacher education quality in the TEDS-M: globalizing the views of future teachers and teacher educators. *Journal of Teacher Education*, *62*(2), 172–187.

Isiksal, M. (2010). The relationship among mathematics teaching efficacy, math anxiety, and mathematical self-concept: The case of Turkish pre-service elementary teachers. *The Asia-Pacific Education Researcher*, *19*(3), 501–514.

Kahle, D. K. (2008). How elementary school teachers' mathematical self-efficacy and mathematics teaching self-efficacy relate to conceptually and procedurally oriented teaching practices. (Unpublished doctoral dissertation), Columbus: The Ohio State University.

Matney, G., Panarach, Y., & Jackson, J. (2013). *Translating mathematics efficacy. Proceedings of the 6th East Asia Regional Conference on Mathematics Education*. Phuket, Thailand.

Moseley, C., & Utley, J. (2006). Effect of an integrated science and mathematics content-based course on science and mathematics teaching efficacy of pre-service elementary teachers. *Journal of Elementary Science Education*, *18*(2), 1–14.

Mullis, I., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMMSS 2011 international results in mathematics*. Amsterdam, Netherlands: International Association for the Evaluation of Educational Achievement.

Peterson, P., Fennema, E., Carpenter, T., & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. *Cognition and Instruction*, *6*, 1–40.

Robinson, J., Shaver, P., & Wrightsman, L. (Eds.). (1991). *Measures of personality and social psychological attitudes*. New York: Academic Press.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs*, *80*, 1–28.

Smith, J. P. (1996). Efficacy and teaching mathematics by telling: A challenge for reform. *Journal for Research in Mathematics Education*, *27*(4), 387–402.

Swars, S. L., Daane, C. J., & Giesen, J. (2006). Mathematics anxiety and mathematics teacher efficacy: What is the relationship in elementary pre-service teachers? *School Science and Mathematics*, *106*(7), 306–315.

Siwatu, K. O. (2011). Preservice teachers' sense of preparedness and self-efficacy to teach in America's urban and suburban schools: Does context matter? *Teaching and Teacher Education*, *27*(2), 357–365.

Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research*, *68*, 202–248.

Utley, J., Moseley, C., & Bryant, R. (2005). Relationship between science and mathematics teaching efficacy of pre-service elementary teachers. *School Science and Mathematics*, *105*(2), 82–87.

Wenner, G. (2001). Science and mathematics efficacy beliefs held by practicing and prospective teachers: A 5-year perspective. *Journal of Science Education and Technology*, *10*(2), 181–187.

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Appendix A

Questions of the Thai Mathematics Efficacy Beliefs Instrument (T-MTEBI)

1) นักเรียนเรียนคณิตศาสตร์ได้ดีเนื่องจากครูให้ความใส่ใจเพิ่มขึ้น
2) ข้าพเจ้าไม่สามารถหาวิธีการที่ดีในการสอนคณิตศาสตร์ได้
3) ถึงแม้ว่าจะพยายามอย่างมาก ข้าพเจ้าก็ไม่สามารถสอนคณิตศาสตร์ได้ดี
4) ถ้าผลการเรียนคณิตศาสตร์ของนักเรียนดีขึ้น นั่นเป็นผลมาจากวิธีการสอนที่มีประสิทธิภาพของครู
5) ข้าพเจ้าเห็นว่า เป็นการยากที่จะหาวิธีสอนคณิตศาสตร์ให้นักเรียนเข้าใจได้ดี
6) ข้าพเจ้าไม่สามารถเฝ้าสังเกตและดูแลกิจกรรมเกี่ยวกับคณิตศาสตร์ได้อย่างมีประสิทธิภาพ
7) ถ้านักเรียนมีผลสัมฤทธิ์ทางการเรียนคณิตศาสตร์ต่ำ เนื่องจากครูส่วนใหญ่สอนไม่เข้าใจ
8) ข้าพเจ้าไม่สามารถสอนคณิตศาสตร์ได้อย่างมีประสิทธิภาพ
9) ถ้านักเรียนมีความรู้พื้นฐานทางคณิตศาสตร์น้อย สามารถแก้ไขได้โดยใช้วิธีการสอนที่ดี
10) นักเรียนที่เดิมมีผลสัมฤทธิ์ทางการเรียนคณิตศาสตร์ต่ำ เรียนได้ ดีขึ้น เนื่องจากเอาใจใส่ที่เพิ่มมากขึ้นจากครู
11) ข้าพเจ้ามีความเข้าใจในเนื้อหาคณิตศาสตร์ไม่เพียงพอที่จะสอนนักเรียนทุกคน
12) โดยทั่วไปครูจะรับผิดชอบในผลสัมฤทธิ์ทางการเรียนคณิตศาสตร์ของนักเรียน
13) ผลสัมฤทธิ์ทางการเรียนคณิตศาสตร์ของนักเรียนจะเกี่ยวข้องโดยตรงกับประสิทธิภาพของครูผู้สอนวิชาคณิตศาสตร์
14) ถ้าผู้ปกครองแสดงความเห็นว่าบุตรหลานของตนชอบเรียนคณิตศาสตร์ เป็นไปได้ว่าครูผู้สอนมีประสิทธิภาพ
15) ข้าพเจ้าเห็นว่าเป็นเรื่องยากที่จะหาสื่อหรืออุปกรณ์ช่วยในการอธิบายให้นักเรียนเข้าใจในวิชาคณิตศาสตร์ได้
16) ข้าพเจ้าไม่สามารถตอบข้อสงสัยของนักเรียนทุกคนในขณะที่เรียนคณิตศาสตร์ได้
17) ข้าพเจ้าไม่มั่นใจว่า จะหาทักษะที่ดีมาใช้ในการสอนคณิตศาสตร์ทุกเนื้อหาได้
18) ถ้าสามารถเลือกได้ ข้าพเจ้าไม่อยากให้มีการประเมินการสอนคณิตศาสตร์
19) เมื่อนักเรียนไม่เข้าใจในเนื้อหาคณิตศาสตร์ ข้าพเจ้าไม่รู้จะหาวิธีใดที่จะช่วยให้นักเรียนเข้าใจดีขึ้น
20) ข้าพเจ้าไม่ชอบให้นักเรียนถามขณะที่กำลังสอน
21) ข้าพเจ้าไม่รู้ว่าจะทำอย่างไรให้นักเรียนทุกคนสนใจในวิชาคณิตศาสตร์

Questions of the Mathematics Efficacy Beliefs Instrument (MTEBI)

1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
2. I will continually find better ways to teach mathematics.
3. Even if I try very hard, I will not teach mathematics as well as I will most subjects.
4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.
5. I know how to teach mathematics concepts effectively.
6. I will not be very effective in monitoring mathematics activities.
7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
8. I will generally teach mathematics ineffectively.

9. The inadequacy of a student's mathematics background can be overcome by good teaching.

10. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.

11. I understand mathematics concepts well enough to be effective in teaching elementary mathematics.

12. The teacher is generally responsible for the achievement of students in mathematics.

13. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.

14. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.

15. I will find it difficult to use manipulatives to explain to students why mathematics works.

16. I will typically be able to answer students' questions.

17. I wonder if I will have the necessary skills to teach mathematics.

18. Given a choice, I will not invite the principal to evaluate my mathematics teaching.

19. When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.

20. When teaching mathematics, I will usually welcome student questions.

21. I do not know what to do to turn students on to mathematics.

Appendix B

T-MTEBI Scoring Instructions

Step 1. Item Scoring: Items must be scored using the following designations: Strongly Agree = 5; Agree = 4; Uncertain = 3; Disagree = 2; and Strongly Disagree = 1.

Step 2. The negatively worded items must be reversed (i.e., replaced by subtracting the score from step 1 from 6). Reserving the following items will produce consistently high scores for preservice teachers who have high mathematics teaching efficacy and low scores for preservice teachers with low mathematics teaching efficacy. The negatively worded items are items numbered 2, 3, 5, 6, 8, 11, 15, 16, 17, 18, 19, 20, and 21.

Step 3. Items for the two scales of MTOE and PMTE are dispersed randomly throughout the instrument. The items for MTOE are items numbered 1, 4, 7, 9, 10, 12, 13, and 14. The items for PMTE are items numbered 2, 3, 5, 6, 8, 11, 15, 17, 18, 19, 20, and 21.

The mean of the scores on the MTOE items is the MTOE score and the mean of the scores on the PMTE items is the PMTE score. It is important that scale scores are not averaged prior to the recoding in step 2 above.