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Translating Mathematics Efficacy

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TRANSLATING MATHEMATICS EFFICACY

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This paper presents our work in translating the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) from English to Thai and our resulting initial investigation with 262 Thai pre-service teachers. The MTEBI underwent confirmatory factor analysis indicating two independent scales of Personal Mathematics Teaching Efficacy and Mathematics Teaching Outcome Expectancy (Enochs, Smith, Huinker, 2000). The translation process occurred over several meetings between two US educators and one Thai educator. To check for reliability the instrument was translated into Thai and back translated into English.

We used the newly translated Thai Mathematics Teaching Efficacy Beliefs Instrument (T-MTEBI) to measure teacher efficacy beliefs as they related to 262 Thai pre-service mathematics teachers in years 1 through 4. This instrument contains 21 questions rated on a Likert scale: Strongly Disagree, Disagree, Uncertain, Agree, Strongly Agree. 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 thirteen 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 for Thai pre-service teachers the T-MTEBI has acceptable internal consistency but needs more development among its items as respondents show a significant duality in the way they respond to positively and negatively worded items. Implications and suggestions for further research are discussed.

Keywords: Efficacy, Mathematics, Teaching, Translation

BACKGROUND AND THEORETICAL FRAMEWORK OF EFFICACY

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, Conroy-Oseguera, Cox, King, McDonnell, Pascal, Pauly, & Zellman, 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 1980's and 1990's 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 and the amount of stress a teacher encounters.

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), the amount of pedagogical change a teacher exhibited and project methods integrated into the classroom from grant workshops teachers attended (Berman, McLaughlin, Bass, Pauly, Zellman, 1977), a teacher's production of higher measures of student achievement (Allinder, 1995; Ashton & Web, 1986), a teacher's persistence in working with struggling students (Ashton & Webb, 1986; Gibson & Dembo, 1984), and willingness 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 pre-service teacher training on teacher efficacy and what aspects appear to be rigid or malleable in a particular subject domain, such as mathematics. A reliable and valid instrument called the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) was developed to better investigate subject matter specific teacher efficacy (Enochs, Smith, & Huinker, 2000). Using this mathematics specific instrument, researchers have found that pre-service teachers' sense of PTE and TOE increased significantly when taking an integrated mathematics/science course, while those students in a non-integrated course had no change (Moseley & Utley, 2006). Another study by Utley, Moseley, and Bryant (2005) showed an increase in teaching efficacy as pre-service 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 pre-service 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 correlated 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. 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 personal teaching efficacy, while those with low measures do not persist and often leave the profession. Teaching efficacy has been connected with what mathematics the teachers teach and what their students end up learning (Peterson, Fennema, Carpenter, & Loef, 1989). Furthermore, low teaching efficacy acts as a factor in pre-service teachers' reluctance to teach mathematics (Wenner, 2001). It is therefore important for teacher educators to determine the level of their pre-service teachers' efficacy and design programmatic elements that actively promote higher levels of teaching efficacy.

In order to further the research knowledge of mathematics teaching efficacy and further refine its constructs based on the cultural and place contexts of Thailand, a reliable and valid mathematics teaching efficacy instrument needs to be developed. Such an instrument can lead to the design of multiple research studies, the results of which then can be carefully compared with mathematics efficacy studies in other countries. With this ultimate goal in mind we set out to translate the MTEBI instrument into the Thai language and performed an initial study of reliability in the Thai pre-service teacher context.

METHODOLOGY

Instrument Translation and Modification

The translation began with the 21 item English version of the MTEBI (Enochs et al., 2000). The instrument has a Likert scale of five response categories: strongly agree, agree, uncertain, disagree, and strongly disagree. The 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 instrument was previously shown to be reliable and valid by Enochs et al. (2000) for the assessment of mathematics teaching self-efficacy and outcome expectancy with pre-service elementary teachers in the United States.

Three researchers worked together to translate the English version of the MTEBI into the T-MTEBI. One researcher was a native English speaker and two researchers were native Thai speakers. All three researchers speak 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. These translations were then crossed check 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 in order to preserve the meaning of each item to the greatest extent possible.

For some items, 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, 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 the contrapositive of this statement. 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 on this item 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 does not focus on use of manipulatives and instead asked for a rating on the pre-service teachers’ ability to find “a good method” to explain why math works. Similarly, item 18 uses the English word “principal” in conjunction with willingness or pre-service 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 pre-service teachers. 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.

Participants

For the purpose of examining the validity of the translated Thai MTEBI (T-MTEBI) instrument, a sample of pre-service mathematics teachers were chosen 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 sample size was 262 pre-service mathematics teachers (66 Male and 196 Female). The mathematics teacher preparation program spanned a 5-year period. Participants ranged from first year students to fourth year students (40 first year, 116 second year, 60 third year, and 46 fourth year). The study used aggregated data for the purpose of the T-MTEBI instrument validation. The participants were given the Thai MTEBI one month after the start of the academic year.

ANALYSIS

Similar to the MTEBI, the T-MTEBI asked participants to respond to 21 statements about teaching efficacy using a five point Likert scale. A value of 1 was awarded for Strongly Disagrees up to a 5 for Strongly Agrees 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. The mean of the scores for the eight items, 1, 4, 7, 9, 10, 12, 13, and 14, was computed as the Mathematics Teaching Outcome Expectancy (MTOE) score. Similarly, the scores for the remaining 13 items were averaged to find the Personal Mathematics Teaching Efficacy (PMTE) score. Note that all of the items worded negatively measure PMTE: 3, 6, 8, 15, 17, 18, 19, and 21.

A total of $n = 262$ participants completed the translated MTEBI. Basic summary statistics for the MTOE and PMTE scores were computed using Minitab and are given in Table 1. Notice that the scores are very positive in both measures with means of 4.04 for MTOE and 3.71 for PMTE. Median scores are 4.00 for MTOE and 3.69 for PMTE. The Anderson-Darling test for normality indicates that the distributions of these scores are approximated well by normal distributions.

Table 1: Summary Statistics

	MTOE		PMTE	
Mean	4.04	[4.00, 4.08]	3.71	[3.66, 3.77]
Standard Deviation	0.35	[0.32, 0.38]	0.41	[0.38, 0.45]
Minimum	2.88		2.62	
Q_1	3.75		3.46	
Median	4.00	[4.00, 4.04]	3.69	[3.62, 3.77]
Q_3	4.25		4.00	
Maximum	5.00		4.85	
Anderson-Darling Normality Test *p*-value	.005		.040	

95% confidence intervals are given in Table 1. Q_1 and Q_3 were computed using the Minitab method. SAS and Minitab were used to perform a confirmatory factor analysis to test the validity of the instrument used with this population. Results of this 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 Enoch et al. (2000). Cronbach's alpha values for the T-MTEBI were .64 for MTOE and .78 for PTME. These are both lower than the corresponding measures in the original study but the alpha for PMTE is still good and the alpha for MTOE is marginally acceptable. Item-total score correlations were computed for each item. Notice that the Item-total correlations were higher than in the original study for MTOE (mean of .54 vs. .47) but slightly lower for the PMTE (mean of .51 vs. .56). Other computed measures of total fit include Bentler Comparative Fit Index (CFI) of .628 and Akaike Information Criterion (AIC) of 235. The Chi-Squared/degrees of freedom ratio is 3.24. Each of these total fit measures is a bit short of the desired levels and of the levels reported in the original study; therefore a closer examination of the individual questions is in order.

When we examine the individual item-total correlations in the MTOE items we do not notice any unusually different items. However, when we examine the item-total correlations in the PMTE items we found that the items fall into two groups. Questions in group 1: 2, 5, 11, 16, and 20 have item-total correlations from .28 to .34 whereas the item-total correlations on the other PMTE items, called group 2: 3, 6, 8, 15, 17, 18, 19, and 21, are from .56 to .68. Though the item-total correlations were very low for items in group one, when the correlations between these items and the mean of the subgroup of items were computed the correlations were much higher (from .53 to .71). Further examination reveals that the items in group 1 have consistently higher means and lower standard deviations than the items in group 2. This difference in the scores from the two groups definitely lowers the goodness of fit measures reported above. This difference leads to an examination of the questions to see what could account for the difference in participant responses.

When we examine the content of the questions we found no evidence of translation difficulty but we did find a particularly striking commonality of difference between the questions in group 1 and group 2. All of the questions in group 1 are positively worded and all of the questions in group 2 are negatively worded. So with this population of pre-service teachers there is a significant difference between wording the questions positively or negatively. This difference in mean PMTE score is significant with a *t*-test *p*-value of 0 to over 30 decimal places. We compared these item-total correlations for the T-MTEBI with the validation study for the MTEBI (Enoch et al., 2000) and found that this result was not observed with the American students.

Table 2: Confirmatory Factor Analysis

Item	Wording	Median	Mean	T-MTEBI Standard Deviation	T-MTEBI Item-Total Correlations	T-MTEBI Item-Subgroup Correlations	English MTEBI Item-Total Correlations
Mathematics Teaching Outcome Expectancy (MTOE)							
1	P	4.0	4.20	0.53	.44		0.49
4	P	4.0	4.19	0.63	.61		0.49
7	P	3.0	3.26	0.93	.54		0.42
9	P	4.0	4.22	0.62	.52		0.42
10	P	4.0	4.23	0.64	.59		0.48
12	P	4.0	3.96	0.64	.64		0.45
13	P	4.0	4.05	0.62	.48		0.53
14	P	4.0	4.19	0.51	.48		0.49
mean		4.0	4.04	0.35	.54		0.47
Personal Mathematics Teaching Efficacy (PMTE)							
2	P	4.0	4.24	0.49	.28	.53	.36
5	P	4.0	3.91	0.58	.33	.71	.54
11	P	4.0	4.01	0.69	.25	.64	.59
16	P	4.0	3.79	0.68	.34	.69	.62
20	P	4.0	4.42	0.60	.32	.59	.47
3	N	4.0	3.54	0.81	.65	.68	.62
6	N	4.0	3.58	0.90	.56	.58	.56
8	N	4.0	3.65	0.77	.68	.68	.55
15	N	3.5	3.35	0.92	.62	.68	.50
17	N	3.0	3.13	0.85	.59	.67	.62
18	N	4.0	3.60	0.94	.65	.70	.58
19	N	4.0	3.60	0.92	.64	.70	.65
21	N	3.0	3.37	0.90	.67	.71	.61
Mean		3.7	3.71	0.41	.50	.66	.56

DISCUSSION

There is something different in this population, which causes the participants to respond with higher measures of PMTE on the positively worded questions. This could be some factor in the translation of the items or the culture of the participants. Regardless of the reason of this bias, this indicates that rather than measuring different aspects of personal efficacy these two groups of questions appear to differ due to their positive or negative orientation. Therefore, we suggest rewording some of the questions so that there are an equal number of positively and negatively worded questions in both the PMTE and MTOE questions. While this adjustment will likely lower the goodness of fit measures it will correct for the positive/negative wording bias.

Further research should be done on the social cultural aspects and teaching efficacy in Thailand and how these interact. For ourselves, building upon this research study we

look to work with others to better understand how teaching efficacy might be measured and interpreted within the framework of differing cultures.

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