Mathematics Education Trends and Research 2014 (2014) 1-17

Available online at www.ispacs.com/metr

Volume 2014, Year 2014 Article ID metr-00052, 17 Pages

doi:10.5899/2014/metr-00052

Research Article

South Korean Elementary Teachers' Mathematics Teaching Efficacy Beliefs: Implications for Educational Policy and Research

Rina Kim[1*], Hang Gyun Sihn[2], Rebecca Mitchell[1]

(1) Department of Curriculum and Instruction, Boston College, MA, U.S.
(2) Department of Mathematics Education, Seoul National University of Education, Seoul, South Korea

Abstract

It is known that teacher efficacy is associated with mathematical instructional quality and student confidence (Gresham, 2009). To think more about ways to promote teacher efficacy, we examined South Korean elementary teachers' mathematics teaching efficacy beliefs and what factors increase their efficacy beliefs. A translated and adapted version of the mathematics teaching efficacy belief instrument was used to gather information on teachers' mathematics teaching efficacy beliefs and their background information (n=283). Based on statistical analyses (ANOVA and the multiple regression model), we found that South Korean mathematics teaching efficacy beliefs differ by educational level in mathematics education, certification level, and range of teaching experience. For example, teacher efficacy beliefs increase with experience, on average, with the highest occurring in teachers with between eleven and fifteen years of experience, then decline after fifteen years, possibly because of a reduction in certification and professional development participation after that time. The findings imply that elementary teachers' mathematics teaching efficacy beliefs might be increased with teachers' professional development programs focusing on mathematics education.

Keywords: Efficacy, mathematics teaching, South Korea, elementary mathematics, professional development.

1 Introduction

Recent studies propose that teachers are one of the major factors related to students' achievement in mathematics [1]. Among diverse characteristics of teachers, which may affect students' outcome, recent studies focus on teachers' beliefs [2]. Beliefs are closely associated with one's behavior based on the theory of social learning [3]. In particular, people develop specific beliefs regarding their abilities to deal with modifications, and it is called self-efficacy [3]. Self-efficacy indicates people's beliefs in their own ability to perform desired behaviors [4]. In accordance with the concept that beliefs provide the foundation for

* Corresponding Author. Email address: rina@bc.edu

people's behaviors, diverse studies have addressed the effect of teachers' efficacy on their mathematics interaction [5]. Many studies indicate that students' development of mathematical proficiency is related to teachers' efficacy in teaching mathematics. For example, Enochs, Smith, and Huinker (2000) proposed that highly efficacious teachers have a positive effect on student learning because efficacy affects the teachers' persistence on a task, willingness to take risks, and use of innovations in their teaching [6]. Gresham (2009) also demonstrated that teachers' efficacy is associated with the quality of mathematics instruction along with their students' confidence in solving mathematics problems [2]. In the same vein, Esterly (2003) found that teachers who have lower efficacy tend to use teacher-directed strategies in their mathematics classrooms, and this has resulted in lower student performance and decreased student participation [7]. Improving teachers' efficacy in teaching mathematics may enhance students' confidence levels as well as their achievement in mathematics. Therefore, studies on the factors that may contribute to the improvement of teachers' efficacy required for effective mathematics instruction are necessary to inform policy makers, teacher preparation programs, and professional development providers. In particular, it is important to investigate the factors that might affect elementary teachers' efficacy in teaching mathematics because elementary students' attitudes toward mathematics and their academic achievement are more easily affected by their teachers than the students at secondary level [1, 8]. However, there are few discussions regarding factors that might help improve elementary teachers' efficacy beliefs in teaching mathematics because teachers' efficacy beliefs have been defined as context specific [9]. Such vague approaches may prevent us from understanding how to improve teachers' efficacy beliefs in teaching mathematics [10]. Toward that end, this study seeks to identify factors that may affect South Korean elementary teachers' efficacy beliefs in teaching mathematics. International data are significant resources for researchers in the social science [11]. In addition, studies focusing on elementary teachers in South Korea are expected to obtain consistent results from data analyses because the distribution of elementary teachers and their quality are controlled by the South Korean Government. The emphasis of this study concerns factors that may contribute to elementary teachers' efficacy in teaching mathematics in South Korea. Specifically, the purpose of this study is to investigate the following research questions:

- How does South Korean elementary teachers' efficacy in teaching mathematics correspond to gender, the number of years of teaching experience, and certification level attained?
- Which of the above factors contribute most to South Korean elementary teachers' efficacy in teaching mathematics?

2 Elementary Teachers' Mathematics Teaching Efficacy Beliefs

Efficacy beliefs are an active and learned system of beliefs held in context [2]. Specifically, teachers' mathematics teaching efficacy belief is an adaptive dynamic contract [12] because teachers' efficacy beliefs are believed to mediate relationships between knowledge and behaviors interacting within an appropriate context [13]. Therefore, elementary teachers' efficacy beliefs in teaching mathematics might be defined as a teacher's individual beliefs in his or her competence to perform specific mathematics teaching tasks at a specified level of quality in a context of school. In particular, teachers' efficacy should be distinguished from self-efficacy because teachers' efficacy is expected to affect students' academic performance [13]. While teacher self-efficacy beliefs focus on successfully performing specific teaching tasks in a teacher's current teaching condition, including specific surroundings such as a school or a classroom, teacher efficacy is focused on successfully affecting student performance [13]. For example, teachers who possess self-efficacy beliefs in their mathematics instruction may have different teacher efficacy when they are required to teach the same mathematical topics to students in an advanced classroom as opposed to students in a regular classroom. The introduction of this specialized teacher efficacy improves upon Bandura's (1981) self-efficacy, specifically in the field of mathematics education, and is referred to as mathematics teaching efficacy belief [4]. This is a super ordinate concept that includes

both a teacher's self-efficacy and teacher efficacy. Teachers who believe that effective teaching can affect student learning (teacher efficacy) and who have confidence in their own teaching abilities (self-efficacy) may provide a greater academic focus in the classroom and offer diverse feedback according to the students' academic backgrounds more than do teachers who have low mathematics teaching efficacy belief [14]. Using the framework of mathematics teaching efficacy belief, studies have established the relationship between teachers' mathematics teaching efficacy belief and the quality of mathematics instruction [15, 16]. Further studies should investigate factors (e.g., years in teaching or type of degree and advanced certification obtained) that might contribute to the development of this type of teacher efficacy and inform teacher preparation and to those who provide professional development programs.

3 Educational Context in South Korea

The findings in this study should be discussed in the context of the educational setting in South Korea because international studies need appropriate interpretations according to the specific surroundings [17]. Therefore, this section will focus on South Korea's educational context as it relates to interpreting and understanding data acquired from the survey.

3.1. Elementary School System in South Korea

The Ministry of Education manages the education system, which results in a unique system of education in South Korea. The Ministry of Education also controls the quality and the distribution of elementary teachers. For example, to teach in both public and private elementary schools in South Korea, pre-service teachers must have a second-level elementary teacher certification. Elementary teacher candidates obtain the second-level elementary teacher certification by attaining a bachelor's degree from the 13 specialized 5-year universities designated by the Ministry of Education. In South Korea, there are only 13 universities that offer a pre-service education program for those interested in becoming elementary school teachers. In addition, elementary teachers who work in a public school must change their school every 6 years under the law. The Ministry of Education takes charge of the distribution of elementary teachers. According to the Ministry of Education in South Korea [18], there are 5,895 elementary schools in South Korea. Among them, only 76 schools (1.3%) are private. The Ministry of Education has a major role in developing and managing the national curriculum for both public and private elementary schools. Moreover, the Ministry of Education developed an efficient system in which to convey the content of the national curriculum to elementary students. The Ministry of Education determines the content and organization of the national curriculum. Based on the national curriculum, the Ministry of Education develops the textbooks and provides them to all elementary students in South Korea free. Additionally, the Ministry of Education provides free highly detailed guidebooks to all elementary teachers, which contain short lesson plans, teaching methods, teaching materials, and an assessment approach for each lesson. Elementary teachers must teach according to the national curriculum because the Ministry of Education hires teachers and regulates their teaching by law. In addition, the educational law specifies school days and hours for each subject. Every time the Ministry of Education amends the national curriculum, the Ministry provides new textbooks to students and guidebooks to teachers. The teachers should understand the new national curriculum and the ways of teaching it through teacher education programs, which are also provided by the Ministry of Education.

3.2. Professional Development Programs for Elementary Teachers in South Korea

To attain both a bachelor's degree and second-level elementary teacher certification, all the pre-service teachers must complete the same required courses for 120 credits and an extra 20 credits for advanced subject matter education [19]. For advanced subject matter education, pre-service teachers may choose one subject among 12 subjects in elementary education in South Korea as their specialty. For example, if pre-

service teachers want to study mathematics education, they may take courses related to mathematics education for their advanced subject matter education. Among the required 120 credits for all pre-service teachers, there are five credits related to mathematics education: two credits for mathematics content and three credits for elementary mathematics curriculum. To work in a public elementary school, pre-service teachers must pass the national teacher recruitment examination provided by one of states in which they apply. After passing the exam, teachers are located at an elementary school by each state's office of education under the direction of the Ministry of Education. After 3–5 years of teaching experience in both private and public elementary schools in South Korea, all in-service teachers are required to obtain the first-level elementary teacher certification with at least 90 hours of the professional development program provided by the Ministry of Education [20]. With the first-level elementary teacher certification, the teacher is qualified to become a head teacher in an elementary school. Among the 90 hours for the professional development program, in-service teachers usually take at least 4 hours of lectures on mathematics education, including study on the mathematics curriculum and teaching strategies in mathematics education. The 13 specialized universities also provide master's-level courses focusing on elementary education from 1995. For example, Seoul National University of Education offers 25 majors related to elementary education for the master's-level courses, including elementary mathematics education. Among the 13 universities, only two offer doctoral courses aiming on elementary education: Seoul National University of Education and GyeongIn in University of Education. The two South Korean universities started to administer doctoral courses in 2013.

4 Methods

Conducting a survey helped to develop a broader perspective about elementary teachers' knowledge for teaching mathematics. Survey method is useful when the purpose of the study is to quantitatively describe specific aspects of a given population [22]. If a survey obtains data based on a representative sample, the data can be generalizable to a population [23]. Therefore, this research surveyed randomly selected 283 South Korean elementary teachers in order to insure validity and generalizability.

4.1. Participants

The target population of this study is South Korean elementary school teachers. This study chose participants who work in Seoul because of its geographical accessibility. There are 181,435 elementary teachers in South Korea, and among them, 29,762 elementary teachers work in Seoul [21]. From this number, 500 elementary teachers were randomly selected for this research. Among them, 283 elementary teachers participated in the survey, and the response rate was 56.6%. Although 283 South Korean elementary teachers participated in this survey, the participants had the right to skip questions they did want to answer. Therefore, the total number of participants may differ among items. The demographic information of the participants is as shown in Table 1.

Table 1**:** Demographic information of the participants

		Gender		Total Number
		Male (n)	Female (n)	
Teaching Experience	**0-5 years**	10	60	70
	6-10 years	15	66	81
	11-15 years	10	35	45
	16-20 years	5	10	15
	21 years -more	5	35	40
	Total	45	206	251
Teacher Certification	**1st level**	35	141	176
	2nd level	10	60	70
	Total	36	160	196
Degree relates to elementary education (including elementary mathematics education)	**Bachelor**	25	170	196
	Master	15	36	51
	Doctoral	.	.	.
	Total	40	206	246
Degree relates to elementary mathematics education**	**Bachelor***	10	40	50
	Master	5	20	25
	Doctoral	.	.	.
	None	10	60	70
	Total	25	120	145

*****Bachelor relates to elementary mathematics education representing teachers who had to take mathematics education courses for their 20 credits of advanced subject matter courses when they were pre-service teachers.

******Teachers were requested to identify their highest attainment in elementary mathematics education. For example, if a teacher had a master's degree as well as bachelor's degree in mathematics education, he or she only indicated the master's degree for this item.

4.2. Data Sources

For the survey, two instruments were used: the Qualtrics online survey system and the mathematics teaching efficacy belief instrument (MTEBI) [4]. The Qualtrics online survey system collects information on teachers' number of years teaching, the highest educational degree obtained, and gender. MTEBI measures South Korean elementary teachers' teaching efficacy in teaching mathematics. This survey consists of two categories. The first category focuses on personal mathematics teaching efficacy (PMTE), which includes 13 items. The second part regarding the mathematics teaching outcome expectancy (MTOE) comprises 10 items. The reliability of the first part is 0.88, and the second part has 0.75 (n = 324) [4].

4.3. Procedures

The survey instrument was translated and adapted into Korean by the authors of this study, and principal component analysis was conducted to ensure the validity and reliability of these measures. The two authors of this study are native speakers of Korean also fluent in English and have had more than 10 years of teaching experience in South Korea. To maintain validity, the instrument used in this study was translated into Korean using a double translation process. Three specialists validated the translation of the instrument: a professor of mathematics education at Seoul National University of Education and two elementary teachers with 15 years of teaching experience each. All specialists are fluent in both English and Korean. These experts verified that the translations were accurate and that any changes regarding wording and cultural fit were in line with common presentations in South Korea. To ensure the reliability

of the instrument, we conducted a pilot survey with 50 South Korean elementary teachers in October 2013. We randomly selected 50 elementary teachers who had a variety teaching experience and a certification level to participate in the pilot survey. From the principal component analysis, we obtained the reliability of the instrument, and the reliabilities of both PMTE and MTOE were 0.85. In December 2013, we administered a survey on South Korean elementary teachers' anxiety for teaching mathematics to a sample of 500 elementary teachers. Institutional Review Board approval was obtained to conduct research with human subjects from Boston College. Working with the alumni of Seoul National University of Education, the participants for the survey were recruited via e-mail. Participation was voluntary. A total score for all participants was generated based on their responses. Participants' data were analyzed to examine the characteristics of the teachers in this study. Analyses of variance (ANOVA) were conducted to investigate whether the teachers were different in terms of their efficacy in teaching mathematics based on other background information from them. We also generated a multiple regression on the teachers' background information. Technically, the computer statistical tool SPSS was used to analyze the data.

5 Results

5.1. Descriptive Statistics

The majority of the teachers in this study were female (82%); the percentage of female participants is acceptable to represent the population in this study when it considers teachers' gender proportion in South Korea. Most of the participants had a first-level elementary teacher certification (80%). When it considers that elementary teachers are required to achieve the first elementary teacher certification after 3 to 5 years of teaching, the proportion of teachers who have the first-level certification is acceptable for the survey. Most of teachers in this survey had a bachelor's degree in elementary education (79%). Among the respondents, almost half the teachers did not have an academic degree related to elementary mathematics education (48%). Table 2 summarizes the results from the survey. All results were reported at $\alpha = 0.05$. The mean of South Korean elementary teachers' mathematics teaching efficacy belief (MTEB) was 2.88 (SD = 0.33). This score corresponded to the average score of the participant's responses to the 21 items in the survey instrument.

Table 2: Results of analysis of variance of MTEB scores

Variable	N	Percentage	MTEB mean (SD)	P-value
Gender				
Male	45	18	3 (0.32)	0.62
Female	191	82	2.86 (0.32)	
Teaching experience				
0–5 years	55	23	2.64 (0.21)	
6–10 years	81	33	2.99 (0.33)	0.000*
11–15 years	50	20	3.03 (0.38)	
16–20 years	15	6	2.93 (0.46)	
> 21 years	40	18	2.88 (0.32)	
Certification				
Level 2	55	20	2.64 (0.21)	0.000*
Level 1	181	80	2.95 (0.32)	
Degree relates to elementary				
Education				0.000*
Bachelor's	185	78	2.84 (0.15)	
Master's	51	22	2.87 (0.34)	
Degree relates to mathematics				
Education				
None	65	52	2.78 (0.18)	0.000*
Bachelor's	45	31	2.84 (0.42)	
Master's	25	17	3.46 (0.30)	
***** Significant at 0.01 level.				

5.2. Anlaysis of Variance

There were significant differences among groups of teachers' mean of MTEB scores based on their years of teaching experience (P 0< 0.001), levels of certification (P < 0.001), obtained degree relates to elementary education (P <0 .001), and obtained degree relating to mathematics education (P< 0.001). A one-way ANOVA was used to test for differences in mean MTEB of scores among five groups of teachers that had teaching experience of 0–5 years, 6–10 years, 11–15 years, 16–20 years, and more than 21 years. Teaching experience differed significantly across the five groups (F = 16.15, P = 0.000). Post hoc tests using the Bonferroni correction revealed that the 0–5 teaching experience range group had a statistically significantly lower mean of MTEB scores than did the 6–10 year range group (P = 0.000), 11–15 years range group (P =0.000), and 16–20 year range group (P = 0.007). In addition, the more than 21 years range group had statistically significantly lower mean MTEB scores than did both the 6–10 year range group (P = 0.011) and 11–15 year range group (P = 0.003), and the more than 21 years range group was not statistically significant different from the other groups at P < 0.05. Means of MTEB scores according to degrees related to mathematics education were also significantly different across the three groups. In particular, the group of bachelor's degrees related to mathematics education had a statistically significantly higher mean of MTEB scores than did the group of non-degree (P=0.00). The groups of master's degree-holding participants related to mathematics education also had a statistically significantly higher mean of MTEB scores than did both the group of bachelor's degree-holding participants related to mathematics education (P = 0.00) and the groups of non-degree holders (P= 0.00).

5.3. Multivariate Regression Model

To identify which of the variables were significant predictors of South Korean elementary teachers' MTEB scores, a multiple linear regression model was applied. A backward elimination selection process was used to eliminate variables that did not significantly predict the MTEB scores. In the resulting regression mole,

MTEB scores were regressed on the degree in elementary mathematics education and levels of certification. These three predictors accounted for approximately 45.6% of the variance in MTEB scores (R^2 = 0.469), which was significant at the P = 0.000 level. The degree in mathematics education (β = 0.462, P = 0.000) was the most influential predictor, followed by levels of certification (β = 0.433, P= 0.003). An increase in levels of academic degree in mathematics education predicted an increase of 0.46 standard deviation points in the MTEB score. The first-level teacher certification predicted a decrease of 0.43 standard deviation points in the teachers' MTEB score compared with the second-level teacher certification. The results are summarized in Table 3.

Table 3: A multiple regression model for MTEB

Predictor Variables	Unstandardized beta
Intercept	1.9 (0.000)
Certification level	0.46 (0.000)
Academic degree in mathematics education	0.43 (0.000)
Note: Numbers in parentheses are P-value.	

6 Discussion

There were significant differences among groups of teachers in this study based on their years of teaching experience. The greatest difference was between those who had taught from 11 to 15 years and those who had taught from 0 to 5 years (P = 0.000). The relationship between years of teaching experience and teachers' MTEB score was not linear. The scatter plots in Figure 1 show that a quadratic curve is a better fit (R^2 = 0.203) than is a linear one (R^2 = 0.01). However, the total number of teachers that had taught 16 to 20 years (N = 6) was relatively small compared with the other groups. The small sample size in the group might have influenced the interpretation of the relationship. Eliminating the group from the analysis resulted in a more quadric relationship (R^2 = 0.21) between the number of years of teaching experience and the mean MTEB scores as shown in the scatter plots (see Figure 2). South Korean elementary teachers' MTEB scores increase up to 15 years of teaching and then decreases afterward.

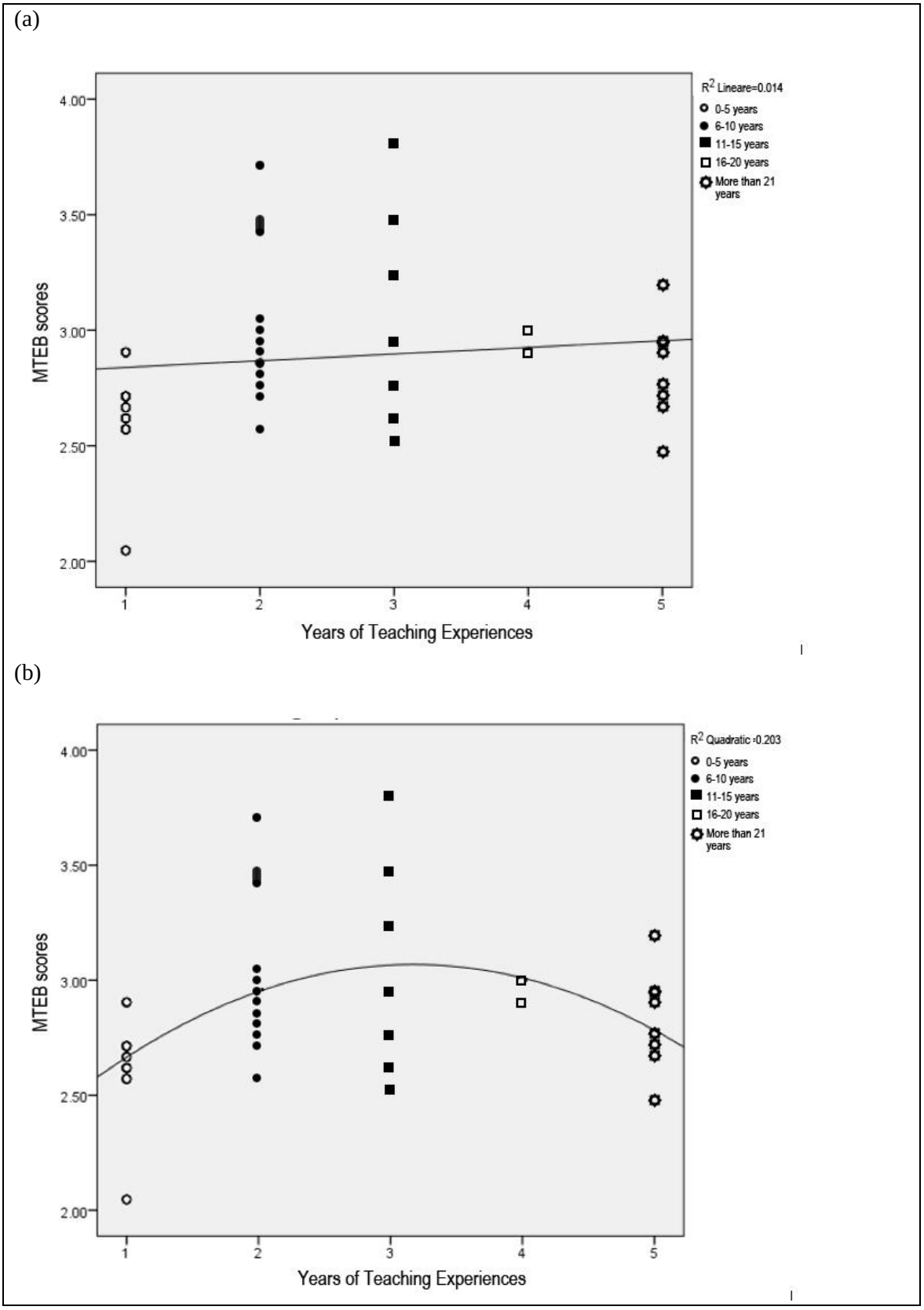

Figure 1: Scatter plots of number of years of teaching experience and mathematics teaching efficacy beliefs using (a) linear fitting and (b) quadratic fitting

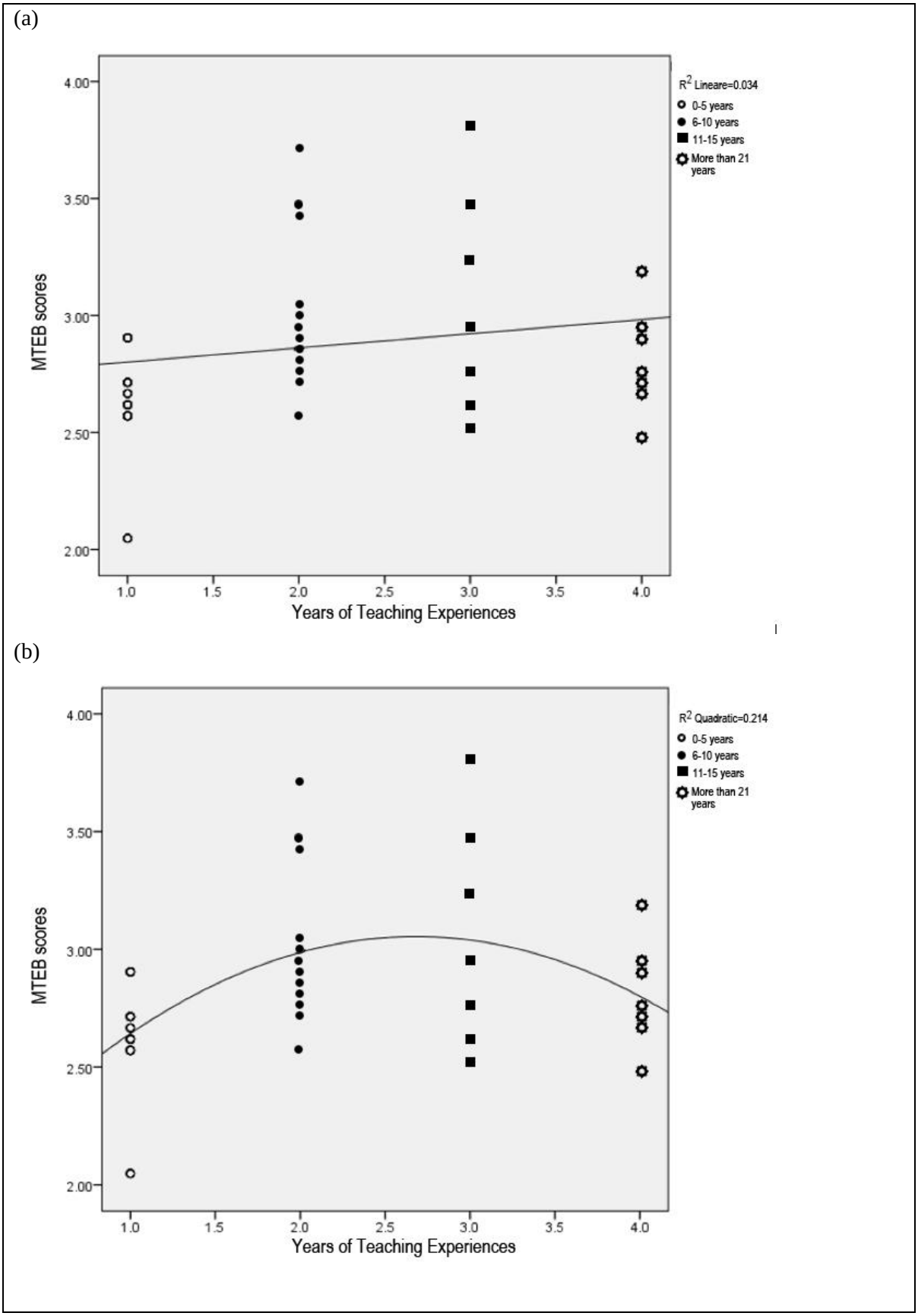

Figure 2: Scatter plots of number of years of teaching experience and mathematics teaching efficacy beliefs using (a) linear fitting and (b) quadratic fitting

The finding contradicts Hoy and Spero's [24] argument that once "efficacy beliefs are established, they appear to be somewhat resistant to change". A plausible reason for why there is a quadratic relationship between MTEB scores and the teachers' years of teaching experience is the connections between teachers' professional development and their mathematics teaching efficacy beliefs. Recent studies propose that elementary teachers' participation in a professional development program improves their mathematics teaching efficacy beliefs [25]. Thus, there is a limited demand on South Korean elementary teachers to continue learning content [26] and a lack of opportunities to participate in diverse teacher professional development programs throughout their careers [27] that may cause the decline in the MTEB scores of the teachers who have more than 15 years of teaching experience. In particular, elementary teachers are officially required to study mathematics education twice in their entire careers as elementary teachers in South Korea. First, the teachers should earn five credits from courses on mathematics education from their pre-service program to achieve the second-level elementary teacher certification. Second, after 3 to 5 years of teaching experience, teachers are required to achieve four-to-five credits about mathematics education from their in-service program to achieve the first-level elementary teacher certification. After the teachers acquire the first-level elementary teacher certification, they do not need to participate in any in-service teacher education programs for mathematics education unless they wish to. This may lead to experienced elementary teachers' low participation in professional development programs [27] and a decrease in mathematics teaching efficacy beliefs. In addition, the group of teachers that has teaching experience from 0 to 5 years tend to participate in in-service teacher education programs significantly more than those who have more teaching experience do [26]. The findings of this study demonstrate that there is a need for further investigation on developing in-service teacher education programs for experienced teachers who both may not find their proper program and may not be willing to participate in the program regardless. It is a notable aspect that novice elementary teachers' mean MTEB scores are statistically significantly lower than that of experienced elementary teachers. There are two possible assumptions for this finding. First, teaching experience may affect the development of mathematics teaching efficacy beliefs to some degree, although it might not have a permanent effect on throughout teaching careers. Second, current pre-service teacher education programs in South Korea might not be as effective as in-service teacher education programs are in terms of improving the teachers' mathematics teaching efficacy beliefs. Although this study did not examine the effects of pre-service elementary teacher education program on their efficacy beliefs, the findings of this study suggest that the pre-service preparation programs providers should reconsider the effectiveness of the programs and find ways to improve teachers' mathematics teaching efficacy beliefs. A similar finding emerged from the analysis of the relationship between teachers' certification level and their MTEB scores. There was a significant difference between the mean MTEB scores between teachers who had the first-level elementary teacher certification and those who had the second level ($p = .000$). Teachers who had the first-level elementary teacher certification had significantly higher MTEB scores compared with teachers who had the second-level certification. That is, there was a positive correlation between teachers' certification levels and their MTEB scores ($R^2 = 0.16$). As discussed above, previous studies identify that teacher-training courses in mathematics education have been effective in lessening teachers' anxiety for teaching mathematics by improving their knowledge for teaching mathematics [6]. The findings of this study illustrate that the teacher professional development program also affects improvement of teachers' mathematics teaching efficacy beliefs. However, we also acknowledge that there is a need for more investigation on the effects of the professional development program for the first-level certification because the program did not only focus on mathematics education. There was a significant difference between teachers' educational backgrounds and their mean MTEB scores ($P=0.000$). Teachers who had master's degrees in elementary education had higher MTEB scores than teachers with a bachelor's degree in elementary education. In addition, teachers who had graduated with a bachelor's degree in mathematics education had higher MTEB scores than teachers with a bachelor's degree in general elementary education. Also, teachers who had a master's degree in mathematics

education had higher MTEB scores for teaching mathematics than did both those with a bachelor's degree in mathematics education and those who did not. The scatter plot in Figure 3 shows that there is a positive correlation between teachers' degree levels and their MTEB scores ($R^2 = 0.31$).

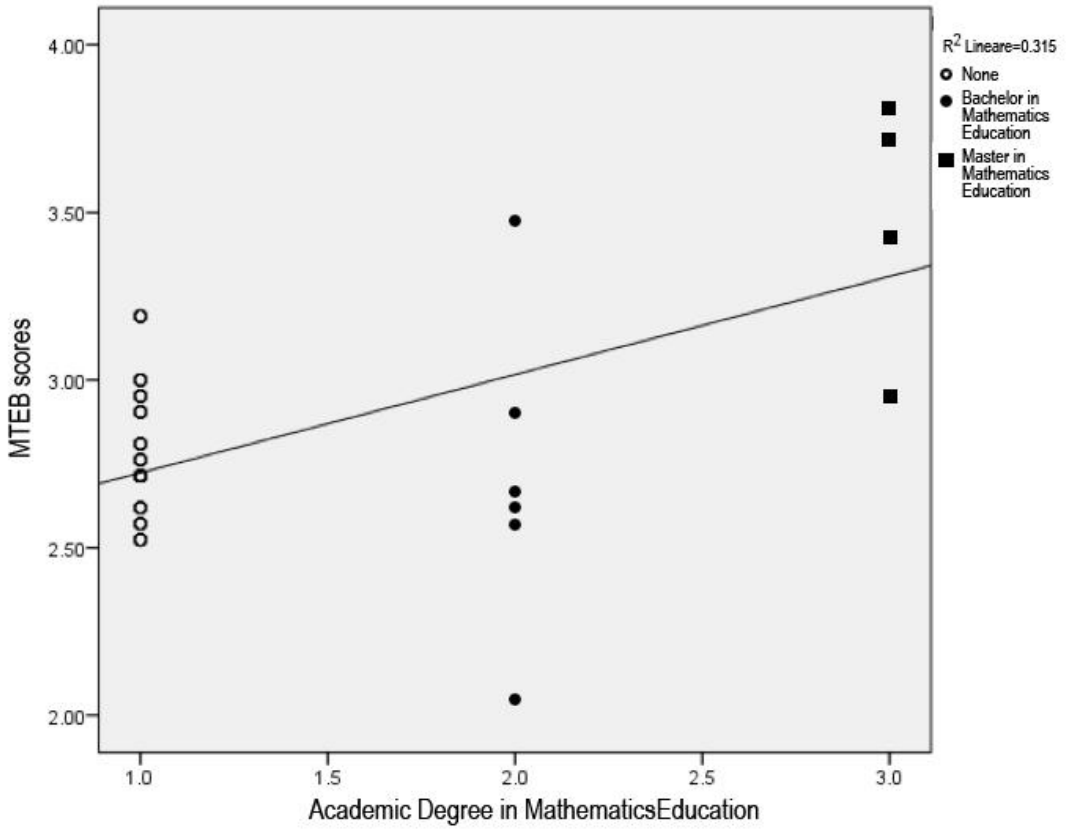

Figure 3: A scatter plot of elementary teachers' academic degree and mathematics teaching efficacy beliefs

The finding illustrates that teachers' MTEB scores increased as teachers attained higher academic degree in mathematics education. Recent studies confirm that there is a positive moderate relationship between teachers' knowledge and their mathematics teaching efficacy beliefs [28, 29]. Although there is a need for further investigation on the aspects of academic degrees, which may affect teachers' mathematics teaching efficacy beliefs (e.g., content knowledge, teaching methods, or resources), the fact that teachers who obtain higher educational attainment in elementary mathematics education have higher efficacy beliefs in mathematics education demonstrates the significance of elementary teachers' professional development. Not only do teachers with higher academic degrees in mathematics education have better knowledge for teaching mathematics than do those who do not [30, 31], but also they have higher mathematics teaching efficacy beliefs. There were no statistically significant differences in the mean MTEB scores between female and male teachers, although the mean for male teachers was higher than the mean for female teachers was. This conclusion is consistent with recent studies' results that there is no significant difference in teaching efficacy between male and female teachers [32, 33]. This indirectly proves the effects of the teacher professional development program in improving elementary teachers' teaching efficacy; teacher education programs affect improving teachers' teaching efficacy more than teachers' innate nature does, such as gender.

7 Conclusion

From the multiple regression model, we identified two significant factors that contribute to South Korean elementary teachers' mathematics teaching efficacy beliefs: certification level and academic degree

in elementary mathematics education. Teachers with higher education attainment had better mathematics teaching efficacy beliefs, which confirms existing studies [34, 35]. Extensive teacher education programs improve teachers' mathematics teaching efficacy beliefs [36]. These results support the current policy regarding the minimum requirement for elementary teachers to complete at least 4 years of specialized university in South Korea. However, further research needs to be conducted to determine whether this trend continues for degrees beyond the master's. Will the positive relationship between teachers' efficacy beliefs and degrees in elementary mathematics education continue or not? Are there any significant differences in terms of student achievement between those students whose teachers who hold a master's degree in mathematics education compared with those with a bachelor's degree? These questions are important for policy makers and teacher professional development programs when deciding minimum requirements for elementary teachers regarding their participation in pre-service professional development programs. A second finding from this study is that teachers with the first-level elementary teacher certification had higher mathematics teaching efficacy beliefs than did those who had the second level. Professional development programs increase teachers' mathematics teaching efficacy beliefs [25]. This may show the importance of in-service teacher educational programs in mathematics education. However, when one considers that the South Korean elementary teachers participated in the professional development program for attaining the first-level certification when they had 3 to 5 years of teaching experience and their mathematics teaching efficacy beliefs decreased again after about 16 years of teaching experience, policy makers should consider providing another professional development program in elementary mathematics education for those whose have more than 16 years of teaching experience. In addition, further studies are warranted to explore the effectiveness of these possibilities to improve elementary teachers' mathematics teaching efficacy beliefs and ultimately students' academic achievement in mathematics. A third finding in this study is the relationship between teachers' mathematics teaching efficacy beliefs and their teaching experience, which is quadratic rather than linear. In particular, teachers with teaching experience of 5 to 15 years composed the group with the highest mathematics teaching efficacy beliefs among all teacher groups. Several plausible reasons for this finding include the periods during which the teachers attained first-level certifications and positive influences of a few years of teaching experience on increasing mathematics teaching efficacy beliefs. However, the point is that novice elementary teachers who have 0 to 5 years of teaching experience have the lowest mathematics teaching efficacy beliefs. This finding implies that current pre-service teacher education program in mathematics should consider developing more effective programs that help pre-service elementary teachers increase their mathematics teaching efficacy beliefs. The regression model identified higher teachers' certification levels and the academic degree in mathematics education as predictors of higher mathematics teaching efficacy beliefs. In addition, the results of data analysis demonstrated that teachers' gender, educational attainment in general elementary education, and teaching experience were not significant factors that affect South Korean elementary teachers' mathematics teaching efficacy beliefs. This may imply that elementary teachers' mathematics teaching efficacy beliefs might decrease with teacher education programs that focus on elementary mathematics education. However, more studies are needed to examine the effects of teachers' education in mathematics, including these two variables that may have an impact on elementary teachers' mathematics teaching efficacy beliefs.

Teachers' quality and its impact on students' mathematical achievement have become global concerns [37]. As we know more about teachers' characteristics as they may affect students' outcomes, we may find ways to support students' mathematical learning effectively. Based on the assumption that elementary teachers' mathematics teaching efficacy beliefs affect the quality of their mathematics instruction, we focused on the factors related to mathematics teaching efficacy beliefs in this study. Although this study primarily concentrates on mathematics educational fields, findings from this study are expected to be relevant to other subject areas as well. Policy makers should consider the importance of both pre-service and in-service teacher professional development programs. Professional development programs also provide

diverse programs based on various demands from elementary teachers who have different educational backgrounds and teaching experience. If we investigate teachers' professional development, both teachers and students will benefit.

References

[1] H. C. Hill, M. L. Blunk, Y. Charalambos, J. M. Lewis, G. C. Phelps, L. Sleep, D. L. Ball, Mathematical knowledge for teaching and the mathematical quality of instruction: An exploratory study, Cognition and Instruction, 26 (4) (2008) 430-511.
http://dx.doi.org/10.1080/07370000802177235

[2] G. Gresham, An examination of mathematics teacher efficacy and mathematics anxiety in elementary pre-service teachers, Journal of Classroom Interaction, 44 (2) (2009) 22-38.
http://eric.ed.gov/?id=EJ899352

[3] A. Bandura, Self-referent thought: A developmental analysis of self-efficacy, In J. H. Flavell & Ross (Eds.), Social cognitive development frontiers and possible futures (pp. 200-239). Cambridge, MA: Cambridge University Press (1981).

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

[5] L. G. Enochs, P. L. Smith, D. Huinker, Establishing factorial validity of mathematics teaching efficacy belief instrument, School Science and Mathematics, 100 (4) (2000) 194-202.
http://dx.doi.org/10.1111/j.1949-8594.2000.tb17256.x

[6] D. Knoblauch, A. Hoy, Maybe I can teach those kids. The influence of contextual factors on student teachers' efficacy beliefs, Teaching and Teacher Education, 24 (1) (2008) 166-179.
http://dx.doi.org/10.1016/j.tate.2007.05.005

[7] E. J. Esterly, A multi-method exploration of the mathematics teaching efficacy and epistemological beliefs of elementary preservice and novice teachers, Doctoral dissertation, Ohio State University, Ohio, (2003).
https://etd.ohiolink.edu/ap/0?0:APPLICATION_PROCESS%3DDOWNLOAD_ETD_SUB_DOC_ACCNUM:::F1501_ID:osu1070405222%2Cattachment

[8] S. Konstantopoulos, Teacher effects in early grades: Evidence from a randomized study, Teachers College Record, 113 (7) (2011) 1541-1565.

[9] A. W. Hoy, Changes in teacher efficacy during the early years of teaching, Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA, (2000).

[10] D. W. Chan, General, collective, and domain-specific teacher self-efficacy among Chinese prospective and in-service teachers in Hong Kong, Teaching and Teacher Education, 24 (2008) 1057-1069.
http://dx.doi.org/10.1016/j.tate.2007.11.010

[11] J. W. Osborn, Best practices in using large, complex samples: The importance of using appropriate weight and design effect compensation, Practical Assessment, Research & Evaluation, 16 (2011) 1-7.

[12] S. Turner, P. Cruz, A. Papakonstantinou, The impact of professional development program on teachers' self-efficacy, Poster presented at the 82nd Annual Meeting of the National Council of Teachers of Mathematics, Philadelphia: PA (2004).

[13] A. M. Dellinger, J. J. Bobbet, D. F. Olivier, C. D. Ellet, Measuring teachers' self-efficacy beliefs: Development and use of the TEBS- Self, Teaching and Teacher Education, 24 (2008) 751-766.
http://dx.doi.org/10.1016/j.tate.2007.02.010

[14] S. Gibson, M. H. Dembo, Teacher efficacy: Aconstruct validation, Journal of Educational Psychology, 76 (1984) 503-511.
http://dx.doi.org/10.1037/0022-0663.76.4.569

[15] S. L. Swars, Examining perceptions of mathematics teaching effectiveness among elementary preservice teachers with differing levels of mathematics teacher efficacy, Journal of Instructional Psychology, 32 (2) (2005) 139-149.

[16] Y. C. Charalambous, G. N. Phillippou, L. Kyriakides, Tracing the development of pre-service teachers' efficacy beliefs in teaching mathematics during the fieldwork, Educ Stud Math, 67 (2008) 125-142.
http://dx.doi.org/10.1007/s10649-007-9084-2

[17] S. Anderson, M. K. Peterson, S. W. Toops, J. A. K. Hey, International studies: An interdisciplinary approach to global issues, Boulder, CO: Westview Press (2008).

[18] Ministry of Education, Announcement No. 2012-10.
http://www.moe.go.kr

[19] Seoul National University of Education, Bulletin.
http://www.snue.ac.kr

[20] R. B. Yoo, Differences in teacher efficacy based on qualification training experience for the elementary 1st class regular teacher Master's thesis, Seoul National University of Education, (2012).
http://www.riss.kr/search/detail/DetailView.do?p_mat_type=be54d9b8bc7cdb09&control_no=e00c9a9ad773679bffe0bdc3ef48d419&outLink=N

[21] Ministry of Education, Statistical analysis of education in South Korea, (2012).
http://cesi.kedi.re.kr

[22] K. L. Kraemer, Introduction. Paper presented at the Information System Research Challenge: Survey Research Methods, (1991).

[23] K. Kelly, B. Clark, V. Brown, V. J. Sitzia, Good practice in the conduct and reporting of survey research, International Journal for Quality in Health Care, 15 (2003) 261-266.
http://dx.doi.org/10.1093/intqhc/mzg031

[24] A. W. Hoy, R. B. Spero, Changes in teacher efficacy during the early years of teaching: A comparison of four measures, Teaching and Teacher Education, 21 (2005) 343-356.
http://dx.doi.org/10.1016/j.tate.2005.01.007

[25] S. L. Swars, S. Z. Smith, M. E. Smith, L. C. Hart, A longitudinal study of effects of a developmental teacher preparation program on elementary prospective teachers' mathematics beliefs, J Math Teacher Educ, 12 (2009) 47-66.
http://dx.doi.org/10.1007/s10857-008-9092-x

[26] M. K. Goo, A study on the cognition and current status concerning elementary teachers' self-supervision for the improvement of teaching, Master's thesis, Busan National University of Education, (2013).
http://www.riss.kr/search/detail/DetailView.do?p_mat_type=be54d9b8bc7cdb09&control_no=ab109f64ee785ce0ffe0bdc3ef48d419&outLink=N

[27] T. R. Kim, Analysis of South Korean elementary teachers' demands for professional development programs according to their teaching experiences, Master's thesis, Busan National University of Education, (2008).
http://dlps.nanet.go.kr/SearchDetailView.do?cn=KDMT1200801676&sysid=nhn

[28] K. J. Newton, J. Leonard, B. R. Evans, J. A. Eastburn, Pre-service elementary teachers' mathematics content knowledge and teacher efficacy, School Science and Mathematics, 112 (2012) (5) 289-299.

[29] B. R. Evans, Content knowledge, attitudes, and self-efficacy in the mathematics New York City teaching fellows (NYCTF) program, School Science and Mathematics, 111 (5) (2011) 225-235.
http://dx.doi.org/10.1111/j.1949-8594.2011.00081.x

[30] D. Ng, Indonesian primary teachers' mathematical knowledge for teaching geometry: implications for educational policy and teacher preparation programs, Asia-Pacific Journal of Teacher Education. 39 (2) (2011) 151-164.
http://dx.doi.org/10.1080/1359866X.2011.560648

[31] B. Gimbert, L. Bol, D. Wallace, The influence of teacher preparation on student achievement and the application of National Standards by teachers of mathematics in urban secondary schools, Education and Urban Society, 40 (1) (2007) 91-117.
http://eus.sagepub.com/cgi/content/abstract/40/1/91

[32] C. Perry, I. Ball, Emotional intelligence and teaching: further validation evidence, Issues in Educational Research, 15 (2) (2005) 175-192.

[33] M. C. Tejeda-Delgado, Teacher efficacy, tolerance, gender, and years of experience and special education referrals, International Journal of Special Education, 24 (1) (2009) 112-119.

[34] M. V. Dinther, F. Dochy, M. Segers, Factors affecting students' self-efficacy in higher education, Educational Research Review, 6 (2) (2011) 95-108.
http://dx.doi.org/10.1016/j.edurev.2010.10.003

[35] M. E. Smith, S. L. Swars, S. Z. Smith, L. C. Hart, R. Haardorfer, Effects of an additional mathematics content courses on elementary teachers' mathematical beliefs and knowledge for teaching, Action in Teacher Education, 34 (4) (2012) 336-348.
http://dx.doi.org/10.1080/01626620.2012.712745

[36] J. Ross, C. Bruce, Professional development effect on teacher efficacy: Results of randomized field trial, The Journal of Educational Research, 101 (1) (2008) 50-62.
http://dx.doi.org/10.3200/JOER.101.1.50-60

[37] K. Park, Mathematics teacher education in Korea, In Koon, F., Leung, S., & Li, Y. (Eds.), Reforms and issues in school mathematics in East Asia: Sharing and understanding mathematics education policies and practices (pp. 181-196). Chesapeake, VA: AACE (2010).