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# South Korean elementary teachers' anxiety for teaching mathematics

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**Abstract:** The researcher examined South Korean elementary teachers' anxiety for teaching mathematics and what factors increase their anxiety levels. A translated and adapted version of the McAnallen Anxiety in Mathematics Teaching Survey was used to gather information on teachers' anxiety for teaching mathematics and their background information. Based on statistical analyses (ANOVA and multiple regression model), I demonstrate in this study that South Korean teachers' anxiety for teaching mathematics differs by educational level in mathematics education, certification level, and range of teaching experiences. In addition, the results of the data analysis demonstrated that teachers' gender, educational attainment in general elementary education, and teaching experiences were not significant factors that affect South Korean elementary teachers' anxiety for teaching mathematics. The findings of this study imply that elementary teachers' anxiety for teaching mathematics might be decreased with teacher education programs in mathematics education. Implications include more studies are needed to examine the effects that teacher education programs in mathematics education.

**Keywords:** Anxiety for Teaching Mathematics, Educational Policy, Elementary Teacher, Teacher Education Program

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## 1. Introduction

As recent studies reveal that there is a positive correlation between teachers' anxiety levels for teaching mathematics and their students' levels of mathematics anxiety, the concerns about teachers' anxiety for teaching mathematics rapidly increasing [1, 2]. Students' mathematics anxiety refers to their fears and mental disorders when they are required to solve mathematics problems; their anxiety has negative impacts on their mathematics achievement scores [3]. Teachers' anxiety for teaching mathematics indicates the stress and nervousness they experience when they teach mathematical concepts, theorems, formulas, or problem solving during a math lesson [4]. Teachers who have high levels of anxiety for teaching mathematics may not want to teach mathematics or to focus on mathematics instruction [5]. Thus, teachers' anxiety for teaching mathematics is one of the significant factors that may decrease the quality of mathematics instruction [6]. Teacher's anxiety for teaching mathematics causes students' mathematics anxiety because teachers who have high levels of anxiety for teaching mathematics tend to have an insufficient knowledge of mathematics content and provide unpleasant mathematics experiences for their students [7]. For example, teachers who

have anxiety for teaching mathematics may not provide engaging mathematics activities and not employing meaningful teaching methods [27].

Therefore, it is important for policy makers as well as researchers to determine the factors that might be correlated with teachers' anxiety for teaching mathematics to improve the quality of mathematics instruction as well as prevent students' mathematics anxiety [8]. Studies on these factors required for effective teaching are thus deemed necessary to inform policy makers, teacher preparation programs, and professional development providers. In particular, I focus on elementary teachers because elementary students' attitudes toward mathematics and their academic achievement are more easily affected by their teachers than are secondary-level students [9, 10]. This study's emphasis concerns factors that may contribute to elementary teachers' anxiety for teaching mathematics in South Korea. Specifically, the purpose of this study was to investigate the following research questions:

- How does South Korean elementary teachers' anxiety for teaching mathematics corresponds to gender, the number of years of teaching experience, and

certification level attained?

- Which of the above factors contributes most to South Korean elementary teachers' anxiety for teaching mathematics?

## 2. Teachers' Anxiety for Teaching Mathematics

Analyses of teachers' attitudes toward mathematics reveal that teachers' perceptions regarding mathematics instruction may affect students' desires to learn mathematics as well as their use of mathematics in their daily lives [11]. Gresham (2007) argued that teachers' negative attitudes toward mathematics instruction might have diminished their efforts to improve the quality of their mathematics instruction and thus have contributed to their students' failures on academic achievement tests [12]. As noted previously, teachers' negative perceptions of mathematics and mathematics instruction are known to contribute to teachers' anxiety for teaching mathematics [13]. In particular, Cruikshank and Sheffield (1992) specified the characteristics of teachers who have anxiety for teaching mathematics as follows [14]:

- Do not express that they like mathematics
- Do not enjoy solving mathematics problems
- Do not show how to apply mathematics concepts in everyday situations
- Do not include students' mathematics interests in their mathematics instructions
- Do not establish efficient lesson objectives for their mathematics instruction
- Do not provide interesting mathematics activities to their students during the lesson
- Do not use effective teaching methods during the lesson

Based on these characteristics, the framework established by the McAnallen Anxiety in Mathematics Teaching Survey provides a useful lens for understanding elementary teachers' anxiety for teaching mathematics [15]; teachers' anxiety for teaching mathematics is a superordinate concept that may comprise teachers' mathematics anxiety. Also, teachers' anxiety for teaching mathematics may connect to their quality of mathematics instruction. With this assumption, the framework consists of four factors: the four following factors: Personal mathematics self-efficacy, Personal mathematics anxiety, Mathematics teaching self-efficacy, and Mathematics teaching anxiety [15].

Using this framework, I investigated the relationship between teachers' characteristics and their anxiety for teaching mathematics and discovered that there are not many discussions about factors that correlate with elementary teachers' anxiety for teaching mathematics [1]. Thus, further studies are necessary to investigate the factors that may contribute to understanding elementary teachers' anxiety for teaching mathematics and inform teacher preparation as well as teacher professional development programs.

## 3. Elementary Teacher Professional Development Programs in South Korea

The findings in an international study should be discussed in the context of the educational setting in its specific surroundings [16]. Thus, I focus on South Korean teacher professional development programs for elementary teacher licensing.

### 3.1. Second-Level Elementary Teachers' License

According to the Ministry of Education in South Korea (2012), there are 5,895 elementary schools in South Korea. Among them, only 76 schools (1.3%) are private schools [17]. To teach in both public and private elementary schools in South Korea, preservice teachers should have a second-level elementary teacher's license. Elementary teacher candidates obtain the license by attaining bachelor's degrees from 13 specialized 4-year universities designated by the South Korean government. According to the curriculum of Seoul National University of Education (2012), one of the 13 approved universities; elementary teacher candidates should earn 140 credits to attain the license. The curriculum is organized as is shown in Table 1 [18].

**Table 1.** Organization of Curriculum in Seoul National University of Education

Required Courses	Required Credits
Pedagogy	18
Preservice Teacher Practicum	4
Liberal Arts	40
Subject Matter Education and Extracurricular Activities	50
Practical Techniques in Subject Matter Education	8
Undergraduate Subject of Study	P/F*
Community Service	P/F*
Advanced Subject Matter Education	20

\*P/F = pass or fail. Although there are no credits for the course, preservice teachers should pass these courses to graduate from the university [18, P.136]

All preservice teachers complete the same required courses for 120 credits and 20 elective credits for advanced subject matter education [18]. For the advanced subject matter education, preservice teachers may choose one subject among 12 in elementary education as their specialty. For example, if preservice teachers want to study more about mathematics education, they may take courses related to mathematics education for their advanced subject matter education.

Five credits among the required 120 credits are related to mathematics education: two credits for mathematics

content and three credits for elementary mathematics curriculum. After earning 140 credits, preservice teachers obtain both bachelor's degrees in elementary education and second-level elementary teachers' licenses.

### 3.2. First-Level Elementary Teachers' License

To work in a public elementary school, preservice teachers are required to pass the national teacher recruitment examination provided by the state in which they apply. After passing the exam, teachers are located at an elementary school by the office of education of each state. Elementary teachers who work in a public school should change their school every five years by the law.

After three to five teaching experiences in both private and public elementary schools, all in-service teachers are required to obtain first-level elementary teachers' licenses with at least 90 hours of credits in a professional development program [19]. With first-level elementary teachers' licenses, teachers are qualified to become head teachers in elementary schools. Although specific courses in the professional development program might differ according to the local offices of education, the Ministry of Education provides the guidelines for the professional development programs for first-level teachers' licenses, as shown in Table 2.

**Table 2.** Guidelines for Professional Development Program [20, p.5]

Area	Detail Subject Area	Contents	Ratio of Allocation
Basic grounding	Visions for the future	<ul style="list-style-type: none"> <li>• Leadership</li> <li>• Creativity</li> <li>• Educational change</li> <li>• Educational policy</li> </ul>	5–15%
	Common qualifications	<ul style="list-style-type: none"> <li>• Government management philosophy</li> <li>• Human rights</li> <li>• Public service ethics</li> </ul>	5–10%
	Local education	<ul style="list-style-type: none"> <li>• Local office of education may choose the course based on its requirements</li> </ul>	0–5%
	Total: 10–20%		
Teaching capacity	Professional development	<ul style="list-style-type: none"> <li>• Self-improvement</li> <li>• Self-monitoring</li> <li>• Self-esteem</li> <li>• Improvement of classroom teaching</li> <li>• Strategies for classroom management</li> <li>• Educational laws/office management/understanding of school accounting system</li> </ul>	10–15%
	Classroom management	<ul style="list-style-type: none"> <li>• Democratic atmosphere in a classroom</li> <li>• Rapport between teachers and students</li> </ul>	10–15%
	Local education	<ul style="list-style-type: none"> <li>• Local office of education may choose the course based on its requirements</li> </ul>	0–10%
	Total: 20–30%		
Specialized teaching area	Teaching ability	<ul style="list-style-type: none"> <li>• Understanding of subject matter</li> <li>• Developing own teaching strategies</li> <li>• How to motivate students</li> <li>• Innovation in education</li> <li>• Developing creativity tasks</li> <li>• Career guidance for students</li> <li>• Mutual confidence</li> </ul>	20–30%
	Education of humanism	<ul style="list-style-type: none"> <li>• Justice</li> <li>• Responsibility</li> <li>• Understanding of students</li> <li>• Collaboration</li> <li>• Communication</li> <li>• Positive thinking</li> </ul>	20–30%
	Local education	<ul style="list-style-type: none"> <li>• Local office of education may choose the course based on its requirements</li> </ul>	5–10%
	Total: 50–70%		

Among the 90 hours for the professional development program, in-service teachers usually take at least 4 hours of lectures on mathematics education, including understanding the mathematics curriculum and teaching strategies in mathematics education from the teaching ability area.

## 4. Methods

### 4.1. Participants

The target population of the study is South Korean elementary teachers. Seoul was chosen because of its

geographic accessibility. There are 181,435 elementary teachers in South Korea, and among them, 29,762 elementary teachers work in Seoul [17]. From this number, 400 elementary teachers were randomly selected for this research. Among them, 214 elementary teachers participated in the survey, and the response rate was 53.5%. Although 214 South Korean elementary teachers participated in this survey, the participants could skip questions that they were not willing to answer. Therefore, the total number of participants may differ among items. The demographic information of the participants is shown

in Table 3.

Table 3 summarizes the demographic information of the pilot sample. Respondents were predominantly female (82.7%), but this dominance might not be problematic in this study because 76.2% of the 181,435 elementary teachers in South Korea in 2012 were female [28]. The majority of respondents (86.6%) had been teaching between 0 and 15 years. In addition, more than half (67.9%) had earned the Elementary School Teacher's License Level 1.

**Table 3.** Demographic Information of Participants

		Gender		Total Number
		Male (n)	Female (n)	
Teaching experience	0–5 years	8	48	56
	6–10 years	12	52	64
	11–15 years	8	28	36
	16–20 years	4	8	12
	21 years or more	4	28	12
	Total	36	164	200
Teacher certification	First level	28	112	140
	Second level	8	48	56
	Total	36	160	196
Degree relates to Elementary education (including elementary mathematics education)	Bachelor's	20	136	156
	Master's	12	28	40
	Doctoral**	—	—	—
	Total	32	164	196
Degree relates to Elementary mathematics education***	Bachelor's*	8	32	49
	Master's	4	16	20
	Doctoral	—	—	—
	None	8	48	56
	Total	20	96	116

\* Bachelor's relates to elementary mathematics education teachers who had to take mathematics education courses for their 20 credits of advanced subject matter courses when they were preservice teachers.

\*\* Universities in South Korea started to provide doctoral courses focusing on elementary education beginning in 2013.

\*\*\* Teachers were asked to identify their highest attainment in elementary mathematics education. For example, if teachers had a master's degree and a bachelor's degree in mathematics education, they checked only the master's degree for this item.

## 4.2. Data Sources

Conducting a survey helped to develop a broader perspective about elementary teachers' knowledge for teaching mathematics because the survey method is useful when the purpose of the study is to quantitatively describe specific aspects of a given population [21]. If the survey obtained data based on a representative sample, the data can be generalizable to a population [22]. Therefore, 214 randomly selected South Korean elementary teachers were surveyed to ensure validity and generalize findings.

For the survey, two instruments were used: the Qualtrics Online Survey System and the McAnallen Anxiety in Mathematics Teaching Survey (MAMTS) [15]. The Qualtrics Online Survey System collects information on teachers' number of years of teaching experience, the highest educational degree obtained, and gender. MAMTS measures South Korean elementary teachers' anxiety for teaching mathematics. This survey consists of two parts. The first part, which focuses on elementary teachers' mathematics teaching self-efficacy and an anxiety factor, includes 15 items. The second part, which measures

personal mathematics self-efficacy and anxiety, comprises 10 items. The reliability of the first part is .923 and that of the second part is .952 [15].

## 4.3. Procedures

I translated and adapted the survey instrument into Korean and conducted a principal component analysis to ensure measurement validity and reliability. I am a native speaker of Korean, I am fluent in English, and I have 10 years of teaching experience in South Korea. To maintain validity, the instrument I used in this study was translated into Korean using a double translation process and then adjusted for cultural differences. For example, McAnallen (2012) used the mathematics concept of fractions as one of the difficult topics to teach at the elementary level [15]. However, South Korean elementary teachers may not perceive this concept in the same way that U.S. teachers do. Thus, I changed the phrase "Having to work with fractions" to "Having to work with higher level of mathematics concepts at elementary level." Three specialists validated the translation of the instrument: a professor of mathematics education at Seoul National University of

Education and two elementary teachers who each have 15 years of teaching experiences. 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, I conducted a pilot survey with 50 South Korean elementary teachers in October 2013. The randomly selected elementary teachers who participated in the pilot survey had various teaching experiences and certification levels. From the principal component analysis, I obtained the reliability of the instrument; the reliability of elementary teachers' mathematics teaching self-efficacy and their personal mathematics self-efficacy was .861.

On December 2013, I administered the survey measuring South Korean elementary teachers' anxiety for teaching mathematics to a sample of 400 elementary teachers. I obtained institutional review board approval from Seoul National University of Education. Working with the alumni of Seoul National University of Education, I recruited the participants for the survey via e-mail. Participation was on a voluntary basis.

A total score for each participant was generated based on his or her responses. Participants' data were analyzed to examine the characteristics of the teachers in this study. Analyses of variance (ANOVAs) were conducted to

investigate whether the teachers varied in terms of their anxiety for teaching mathematics based on their other background information. I also generated a multiple regression on the teachers' background information. Technically, the computer statistical tool SPSS (SPSS Statistics 20) was used to analyze the data.

## 5. Results

### 5.1. Descriptive Statistics

The majority of the teachers in this study were female teachers (82%). The percentage of female participants is acceptable to represent the population in this study, when teachers' gender proportion in South Korea is considered; 76.2% of the 181,435 elementary teachers in South Korea in 2012 were female [28]. Most of the teachers had the first-level elementary teacher's license (67%), and half of them did not have an academic degree related to mathematics education (48%). Table 4 summarizes the results from the survey. All results were reported at  $\alpha = 0.05$ . The mean of South Korean elementary teachers' anxiety for teaching mathematics was 2.225 ( $SD = 0.397$ ). This score corresponds to the average score of the participants' responses to the 25 items in the survey instrument.

**Table 4.** Results of Analysis of Variance of Anxiety for Teaching Mathematics

Variable	N	Percentage	Anxiety mean (SD)	p value
Gender				
Male	36	18	2.12 (0.39)	0.111
Female	160	82	2.24 (0.39)	
Teaching experiences				
0–5 years	56	28	2.34 (0.32)	.001*
6–10 years	64	32	2.10 (0.42)	
11–15 years	40	20	2.10 (0.47)	
16–20 years	8	4	2.36 (0.42)	
>21 years	32	26	2.37 (0.27)	
Certification				
License level 1	140	67	2.17 (0.41)	0.04*
License level 2	56	33	2.34 (0.32)	
Degree relates to Elementary education				
Bachelor's	156	75	2.22 (0.39)	0.78
Master's	40	25	2.32 (0.25)	
Degree relates to Mathematics education				
Bachelor's	40	35	2.12 (0.44)	0.00**
Master's	20	17	1.58 (0.39)	
None	52	48	2.43 (0.26)	

\*Significant at 0.05 level. \*\*Significant at 0.01 level.

### 5.2. Analysis of Variance

There were significant differences between groups of teachers' anxiety for teaching mathematics based on teaching experiences ( $p < .05$ ), certification level ( $p < .05$ ), and obtained degree as it relates to mathematics education ( $p < .001$ ).

A one-way ANOVA was used to test for differences in anxiety for teaching mathematics among five groups of teachers who have teaching experiences of 0–5 years, 6–10

years, 11–15 years, 16–20 years, and more than 21 years. Teaching experiences differed significantly across the five groups ( $F = 5.19$ ,  $p = 0.01$ ). Post hoc tests, using the Bonferroni correction, revealed that the group with 0–5 years of teaching experiences has statistically significant higher anxiety for teaching mathematics than both the groups with 6–10 ( $p = 0.93$ ) and 11–15 ( $p = 0.33$ ) years of teaching experiences. In addition, the group with more than 21 years of teaching experiences had statistically

significant higher anxiety for teaching mathematics than did both the groups with 6–10 ( $p = 0.17$ ) and 11–15 ( $p = 0.42$ ) years of teaching experiences.

Means of anxiety for teaching mathematics according to degrees related to mathematics education were significantly different across three groups. In particular, the group of bachelor's degrees related to mathematics education had statistically significant lower anxiety for teaching mathematics than did the group of nondegreed teachers ( $p = 0.00$ ). The group of master's degrees related to mathematics education had statistically significant lower anxiety for teaching mathematics than did both the groups of bachelor's degrees related to mathematics education ( $p = 0.00$ ) and nondegreed teachers ( $p = 0.00$ ).

### 5.3. Multivariate Regression Model

To identify the most significant predictors of South Korean elementary teachers' anxiety for teaching mathematics, I applied a multiple linear regression model. In particular, I used a backward elimination selection process to eliminate variables that did not significantly predict the anxiety for teaching mathematics scores. From the analysis of data, anxiety for teaching mathematics scores was regressed on teachers' academic degrees in mathematics education and the level of teacher certification. These three predictors accounted for approximately 29.8% of the variance in anxiety for teaching mathematics scores ( $R^2 = .298$ ), which was significant at the  $p = .000$  level. Teacher certification level ( $\beta = .327$ ,  $p = .000$ ) was the most influential predictor, followed by teachers' academic degree in mathematics education ( $\beta = .136$ ,  $p = .000$ ). The

first-level teacher's license predicts a decrease of .32 standard deviation point in the teachers' anxiety for teaching mathematics score compared to the second-level teacher's license. An increase in the level of academic degree in mathematics education predicts a decrease of 1.36 standard deviation points in the anxiety for teaching mathematics score. The results are summarized in Table 5.

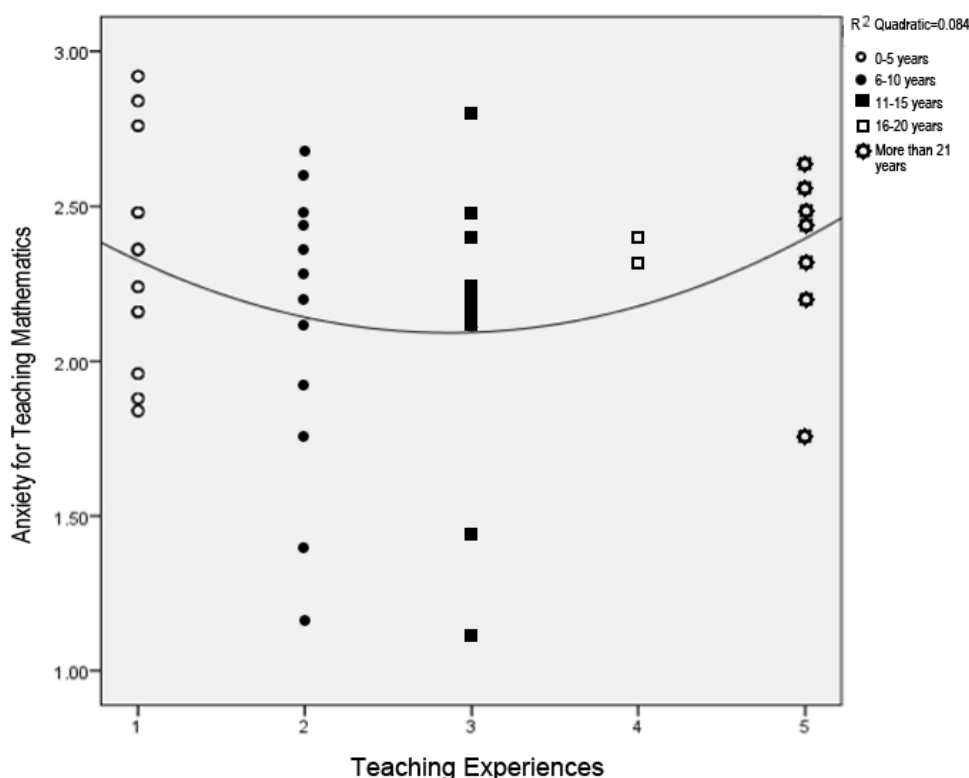
**Table 5.** A Multiple Regression Model for Anxiety for Teaching Mathematics

Predictor variables	Unstandardized beta
Intercept	.768 (.031)
Certification level	.327 (.000)
Academic degree in mathematics education	.136 (.000)

Note: Numbers in parentheses are  $p$ -values.

## 6. Discussion

There was a statistically significant difference between teachers' degrees related to mathematics education ( $p < .001$ ). Teachers who had graduated with a bachelor's degree in mathematics education had lower anxiety for teaching mathematics than did teachers with a bachelor's degree in general elementary education. Also, teachers who had master's degrees in mathematics education had lower anxiety for teaching mathematics than did both those who have bachelor's degrees in mathematics education and those who do not. The scatterplot in Fig 1 shows that there is a negative correlation between teachers' degree levels and their anxiety for teaching mathematics ( $R^2 = 0.414$ ).



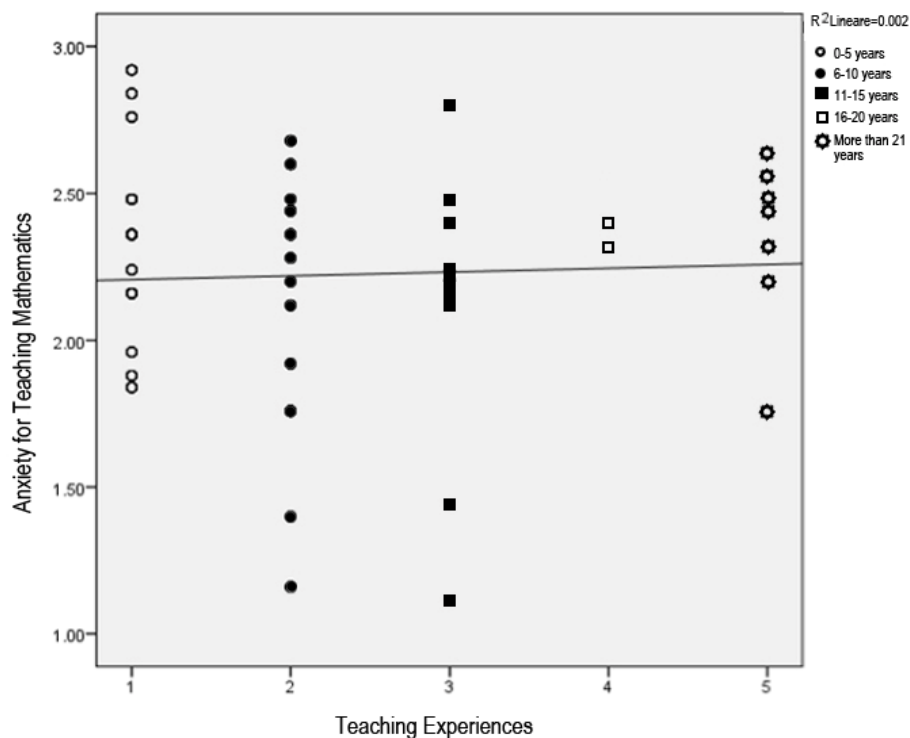
**Figure 1.** A scatterplot of elementary teachers' academic degree and anxiety for teaching mathematics.

A plausible reason for why teachers' anxiety for teaching mathematics would decrease as they attained higher academic degrees in mathematics education includes their development of knowledge for teaching mathematics. The teachers with higher academic degrees in mathematics education had better knowledge for teaching mathematics than those who do not [23, 24]. This assumption that teachers' knowledge may affect the teachers' level of anxiety for teaching mathematics corresponds with Levine's (1996) results that insufficient knowledge of mathematics may increase elementary teachers' anxiety for teaching mathematics [7]. Bursal and Paznokas (2006) argued that teachers' anxiety for teaching mathematics was significantly reduced as their mathematical knowledge increased [3].

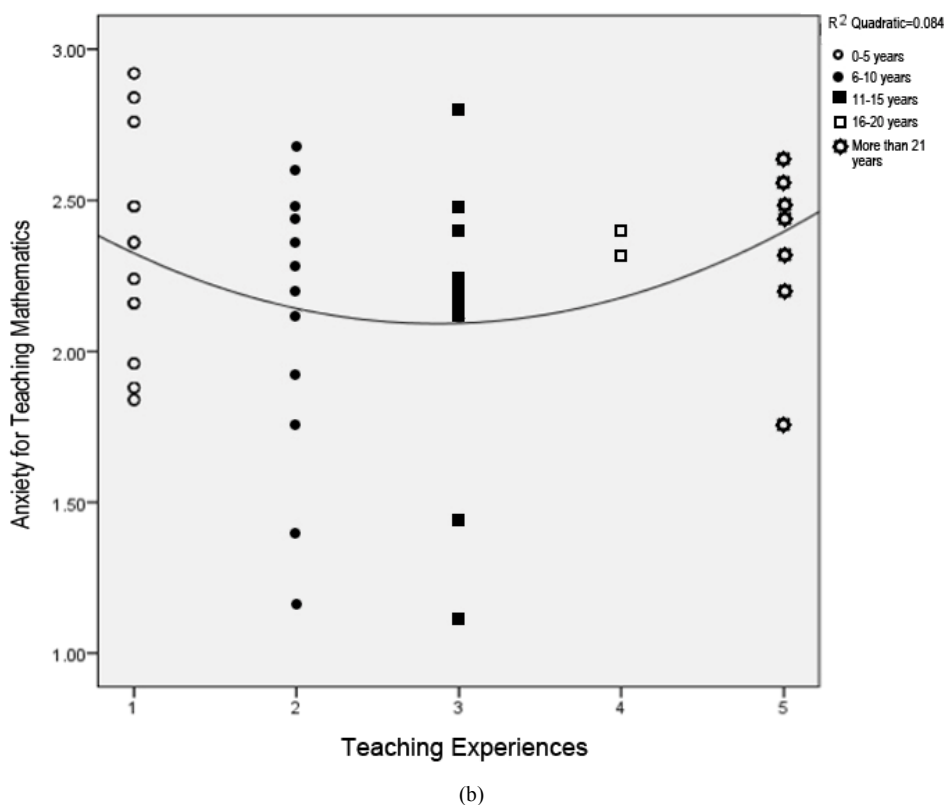
A similar finding emerged from the analysis of the relationship between teachers' certification level and their anxiety for teaching mathematics. There was a significant difference between the mean anxiety for teaching mathematics between teachers who had the first-level elementary teacher's certification and those who had the second level ( $p < .05$ ). Teachers who had the first-level elementary teacher's certification had lower anxiety for teaching mathematics compared to teachers who had the second-level certification. That is, there is a negative correlation between teachers' certification levels and their

anxiety for teaching mathematics ( $R^2 = 0.034$ ). Previous studies identified that teacher-training courses in mathematics education have been effective in lessening teachers' anxiety for teaching mathematics by improving their knowledge for teaching mathematics [1]. Although I did not examine the relationship between the amount of South Korean elementary teachers' knowledge for teaching mathematics and their level of anxiety for teaching mathematics, the statistical findings of this study suggest that teachers with higher educational attainment had less anxiety for teaching mathematics. However, I also acknowledge that there needs to be more investigation done on the effects of the professional development program for the first-level license because the program did not focus only on mathematics education (e.g., leadership, self-esteem).

There were statistically significant differences between groups of teachers in this study based on their years of teaching experiences. The greatest difference was between those who had taught from 0–5 years and those who had taught from 6–10 years ( $p < .01$ ). The relationship between years of teaching experience and teachers' anxiety for teaching mathematics was not linear. The scatterplots in Fig 2 demonstrate that a quadratic curve fits the relationship ( $R^2 = 0.084$ ) better than a linear one ( $R^2 = 0.002$ ).



(a)



**Figure 2.** Scatterplots of number of years of teaching experience and anxiety for teaching mathematics using (a) linear fitting and (b) quadratic fitting.

A probable explanation for this finding might be grounded in current research on elementary teachers' knowledge for teaching mathematics. Ng (2010) found from a survey of 167 elementary teachers in Indonesia that there is a quadratic relationship between elementary teachers' knowledge for teaching geometry and their teaching experiences; Indonesian elementary teachers' knowledge for teaching geometry had increased according to their teaching experiences until 15 years of teaching, at which point it started to decrease [24]. Ng (2010) proposed that the lack of demand on Indonesian teachers to continue learning mathematics content throughout their careers and the limited opportunities for professional development might have caused the decline of teachers' knowledge for teaching mathematics after 15 years of teaching experiences [24].

In South Korea, elementary teachers are officially required to study mathematics education twice in their entire careers as elementary teachers. First, the teachers should earn five credits from the courses about mathematics education from their preservice programs to achieve the second-level elementary teacher's license. Second, after 3 to 5 years of teaching experiences, the teachers are required to achieve four to five credits about mathematics education from their in-service programs to achieve the first-level elementary teacher's license. After the teachers acquire the first-level elementary teacher's license, they do not need to participate in any in-service teacher education programs for mathematics education unless they do so voluntarily.

From the previous findings, I assume that teachers' knowledge in mathematics education may affect their

anxiety for teaching mathematics. In the same vein, the fact that South Korean elementary teachers are not required to take any in-service teacher education programs after they have acquired the first-level elementary teacher's license may affect their knowledge in mathematics education as well as their anxiety for teaching mathematics. As shown in Fig 2, the anxiety of teaching mathematics increased significantly after the teachers' teaching experiences of 5 to 15 years.

Another possible assumption for this finding is that the in-service teacher education program for the first-level teacher's license might be effective in reducing teachers' anxiety for teaching mathematics. When I consider that South Korean elementary teachers are required to take the in-service teacher education program for the first-level teacher's license after three to five teaching experiences and the finding from my data analysis that teachers who have first-level licenses have lower anxiety for teaching mathematics than those who have second-level licenses, I may assume that the in-service teacher education program for the first-level teacher's license might play a significant role in reducing teachers' anxiety for teaching mathematics. As noted above, previous studies also indicate that teacher education programs in mathematics are effective in decreasing elementary teachers' anxiety for teaching mathematics [e.g., 25, 26]. Although the effect of the in-service teacher education program for the first-level license may not last until the end of a teacher's career, the findings of this study suggest that there needs to be more investigation into the relationship between the in-service



education program and teachers' anxiety for teaching mathematics.

There were no statistically significant differences in the mean anxiety for teaching mathematics scores between female and male teachers, although the mean for female teachers is higher than that for male teachers. This finding contradicts Yazici and Ertekin's (2010) statistically significant finding that female teachers have more anxiety for teaching mathematics than do male teachers [13]. Yazici and Ertekin (2010) suggested that one of the possible reasons for this difference might be the fact that male preservice teachers tend to learn more mathematics than do female preservice teachers after they graduate from high school [13]. South Korean preservice elementary teachers should take the required mathematics education courses regardless of their gender. This may imply that similar levels of knowledge in mathematics education might overcome the differences between men and women in terms of their anxiety for teaching mathematics.

## 7. Conclusion

This study identified three significant factors that contribute to South Korean elementary teachers' anxiety for teaching mathematics: educational level in mathematics education, certification level, and range of teaching experiences. Teachers with higher educational attainment in mathematics education had lower anxiety for teaching mathematics, which confirms the results of existing studies [e.g., 3]. In particular, it was a notable finding that teachers who have bachelor's degrees in mathematics education have lower anxiety for teaching mathematics than those who do not, although they took similar courses from one of the specialized universities. If studying mathematics education an extra 20 hours might be helpful to decrease elementary teachers' anxiety for teaching mathematics, we need to consider requiring preservice teachers to take more mathematics education courses in college. However, further research is needed to determine whether this trend continues throughout teachers' careers. Will the negative relationship between teachers' educational attainment and teachers' anxiety for teaching mathematics continue, or will it level off over time? Are there any significant differences in students' mathematics anxiety between those students whose teachers have a high level of educational attainment in mathematics education and those who have teachers who do not have any degree related to mathematics education? Those questions are significant for both preservice and in-service teacher education program developers, as well as for policy makers, when making decisions about minimum requirements for mathematics education courses in professional development programs for teachers.

A second finding from this study is that teachers who had the first-level teacher's license had lower anxiety for teaching mathematics than those who had the second-level teacher's license. Professional development programs reduce teachers' anxiety for teaching mathematics [26].

This may show the importance of in-service teacher's education programs in mathematics education. However, the South Korean elementary teachers' anxiety for teaching mathematics increased again after about sixteen years of teaching experiences, policy makers should consider providing another professional development program in elementary mathematics education for those teachers who have more than 16 years of teaching experience. In addition, further studies are warranted to explore the effectiveness of these possibilities in reducing elementary teachers' anxiety for teaching mathematics and ultimately students' academic achievement in mathematics.

A third finding in this study is that the relationship between teachers' anxiety for teaching mathematics and their teaching experiences is quadratic rather than linear. In particular, teachers who have teaching experiences of 5 to 15 years measure the lowest anxiety for teaching mathematics among all the groups. Several plausible reasons for this finding include the periods that the teachers attained the first-level licenses and the positive influences of a few years of teaching experiences on reducing anxiety for teaching mathematics. However, the point is that novice elementary teachers who have 0 to 5 years of teaching experience have higher anxiety for teaching mathematics than those who have 6 to 16 years of teaching experience. This finding implies that current preservice teacher education programs in mathematics should consider developing more effective programs that help preservice elementary teachers to reduce their anxiety for teaching mathematics.

The regression model identified higher teachers' certification level and the academic degree in mathematics education as predictors of lower anxiety for teaching mathematics. In addition, the results of the data analysis demonstrated that teachers' gender, educational attainment in general elementary education, and teaching experiences were not significant factors that affect South Korean elementary teachers' anxiety for teaching mathematics. This may imply that elementary teachers' anxiety for teaching mathematics might be decreased with teacher education programs in mathematics education. However, more studies are needed to examine the effects that teacher education programs in mathematics education, including these two variables, may have on elementary teachers' anxiety for teaching mathematics.

Because elementary mathematics education was defined as one of scholarship, countless mathematics educators have produced various theories and methods to improve the quality of mathematics instruction. However, opinions still differ about the way to provide effective teaching of mathematics. The reason is that the objectives of mathematics education are human beings who are infinitely complex. Likewise, elementary teachers' anxiety for teaching mathematics is difficult to define in a single sentence and to provide the right solution to decrease all elementary teachers' anxiety for teaching mathematics at once. Therefore, policy makers should keep investing in

research and teacher education programs to decrease elementary teachers' anxiety for teaching mathematics.

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