

PRESERVICE TEACHERS' MATH TEACHING ANXIETY IN AN ONLINE LABORATORY SCHOOL

OBJECTIVES AND PERSPECTIVES

Math anxiety, “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems” (Richardson & Suinn, 1972, p. 551), is an important construct that might cause students to avoid taking mathematics courses, and to follow career paths that do not involve mathematics (Ma, 1999). Some negative outcomes of math anxiety include low academic performance (Ashcraft, 2002), reduced working memory functioning (Ashcraft & Moore, 2009), and low perceptions of one’s own abilities (Hembree, 1990). Past research has reported that one main reason for students’ math anxiety stems from their early negative experiences with teachers in classrooms (e.g., Bekdemir, 2010; Bryant, 2009). In particular, teachers’ math anxiety has an effect on students’ math anxiety with the use of some pedagogical practices such as overreliance on rote memorization rather than encouraging conceptual understanding (e.g., Vinson, 2001).

In addition to math anxiety, math teaching anxiety can be defined as “pre- and in-service teachers’ feelings of tension and anxiety that occurs during teaching mathematical concepts, theories, and formulas or during problem solving.” (Peker, 2009, p. 336). Thus, math anxiety and math teaching anxiety are related, but two distinct constructs (e.g., Hadley & Dorward, 2011). Teachers can have math teaching anxiety because they think that they are not capable of teaching mathematics to their students. However, they can be very confident about their mathematical knowledge. In a study with 692 in-service elementary teachers, Hadley and Dorward (2011) found that students in classrooms where their teachers had lower levels of math teaching anxiety were more successful in mathematics than those students whose teachers had higher levels of math teaching anxiety.

Regarding the negative long-term impacts of math teaching anxiety, it is important to identify math teaching anxiety levels of preservice teachers so that it will be possible to provide interventions for how to decrease math teaching anxiety before they teach in real classrooms. In order to provide preservice teachers with "teaching" experience during the pandemic period, an Online Laboratory School (OLS) was founded within a university in Turkey where teacher educators and experienced teachers collaborate as supervisors for

guiding preservice teachers' practices and preservice teachers work with real middle school students in simultaneous and interactive teaching. Therefore, the purpose of this study was to examine math teaching anxiety levels of preservice middle school teachers (PMSTs), to explore the relationships between math teaching anxiety and several variables such as grade levels, and to understand how PMSTs' math teaching anxiety levels change during eight-weeks of the OLS. The following research questions were addressed:

- 1- What are the math teaching anxiety levels of PMSTs?
- 2- Are there significant relationships among math teaching anxiety and several variables such as the number of methods courses completed so far?
- 3- Is there a significant relationship between PMSTs' math teaching anxiety levels before and after eight-weeks of the OLS?

METHODS

Participants and Context

The sample consists of 43 PMSTs (20 first year, 13 third year, and 10 fourth year) for the pre-survey data before the eight-weeks of the OLS and 27 PMSTs (7 first year, 11 third year, and 9 fourth year) who completed both pre-survey and post-survey during Fall 2020. The OLS has provided free mathematics courses to many students and internship opportunities for PMSTs since Spring 2020 (Authors, 2020). Third and fourth year PMSTs planned and taught middle school mathematics lessons under the guidance of supervisors for eight weeks, while first year PMSTs conducted observations. We used Blackboard Collaborate as a platform. A general meeting was held each week for all PMSTs and supervisors to discuss the implemented lessons in each class. All of the meetings and classroom sessions were video-recorded.

Instruments

The Anxiety about Teaching Mathematics scale was developed by Hadley and Dorward (2011) by adapting from Mathematics Anxiety Rating Scale-Revised (MARS-R; Hopko, 2003) scale based on teaching situations. The scale has 12 items with five response categories for each item including "not at all," "a little," "a moderate amount", "a lot" and "very much." The scale has some validity evidence based on expert reviews and the coefficient alpha was .90. In this study, we adapted this scale to online teaching situations and added two more items. Thus, the new scale, the Math Teaching Anxiety (MTA) scale, has 14 items with the same five response categories and the coefficient alpha in the present study is .93. While a minimum possible score of 14 indicates no math teaching anxiety, a maximum possible score

of 70 indicates high math teaching anxiety. PMSTs completed the MTA scale during approximately 20 minutes of a class period. The MTA scale items are presented in Table 1. We also administered a demographic information questionnaire to obtain information about various characteristics such as the number of methods courses completed.

Data Analysis

We administered the MTA scale to 43 PMSTs before the eight-weeks of the OLS during Fall 2020 and answered the first two research questions using this pre-survey data. For the first research question asking PMSTs' math teaching anxiety levels, we examined descriptive statistics. For the second research question asking the relationships among several variables such as grade levels, we compared correlations among the variables. To answer the third research question, we administered the same MTA scale to 27 PMSTs after the OLS and compared those 27 PMSTs' math teaching anxiety before and after the eight-weeks of the OLS by applying paired sample t-tests. Moreover, we compared PMSTs' math teaching anxiety across grade levels using independent sample t-tests.

RESULTS

Math Teaching Anxiety based on Pre-survey Data

For the first research question asking PMSTs' math teaching anxiety levels, the mean math teaching anxiety score was 30.91 with standard deviation of 10.25. While the minimum score was 14, the maximum score was 54. Thus, it can be said that on average, PMSTs had math teaching anxiety from "a little" to "a moderate amount" degree before the OLS. In Hadley and Dorward's (2011) study with 692 in-service elementary teachers, the mean score for the 12 item survey was 21.55 with standard deviation of 7.41, indicating that the PMSTs in the present study had higher math teaching anxiety than those teachers. The MTA scale items are presented in Table 1 with item mean and standard deviation.

Table 1 here

Based on Table 1, most of the MTA scale items (11 of the 14 items) had item means over 2.00, indicating higher anxiety responses than the teachers in Hadley and Dorward's (2011) study, which had only four of 12 items with item means over 2.00. The highest anxiety response was 2.79 for the item "I become anxious when my supervisor or mentor teacher evaluates my performance during a math lesson I am teaching." This indicates that PMSTs

experienced highest math teaching anxiety when their university supervisors or mentor teachers observed and evaluated their teaching.

Relationships among Several Variables based on Pre-survey Data

To answer the second research question, Table 2 presents the relationships among several variables including the number of whole class teaching hours, the number of online class teaching hours, the number of mathematics courses completed, the number of methods courses completed, the number of general education courses completed, and GPA. Based on Table 2, math teaching anxiety was only significantly correlated with the number of methods courses completed ($r = -.34, p < .05$). This indicates that PMSTs who had completed more methods courses during their teacher preparation program had significantly less math teaching anxiety. However, there was no significant relationship between math teaching anxiety and the number of mathematics courses (e.g., analytical geometry), or the number of general education courses (e.g., classroom management) completed so far. Similarly, PMSTs' internship experience based on the number of whole class or online teaching hours was not significantly related to their math teaching anxiety.

Table 2 Here

Math Teaching Anxiety during Eight-weeks of the OLS

For the third research question asking whether there was a significant relationship between PMSTs' math teaching anxiety during eight-weeks of the OLS, we applied paired sample t-tests for 27 PMSTs who completed both pre-survey and post-survey. We found that first year, third year, and fourth year PMSTs' math teaching anxiety did not significantly change during the OLS. This indicates that the OLS did not contribute to a decrease in math teaching anxiety (see Table 3 for means and standard deviations across grade levels).

Table 3 Here

Finally, we compared PMSTs' math teaching anxiety across grade levels for both pre-survey and post-survey data using independent sample t-tests (see Table 3 for mean scores). We found that third year PMSTs had significantly higher math teaching anxiety than first year PMSTs based on both pre-survey ($p = .01$) and on post-survey ($p = .01$). Moreover, no significant difference existed between first and fourth year PMSTs' math teaching anxiety based on both pre-survey ($p = .30$) and post-survey ($p = .15$). Similarly, there was no

significant difference between third and fourth year PMSTs' math teaching anxiety based on both pre-survey ($p = .11$) and post-survey ($p = .46$).

DISCUSSION

The purpose of this study was to examine PMSTs' math teaching anxiety, to explore the relationships between math teaching anxiety and several variables, and to understand how PMSTs' math teaching anxiety changed during eight-weeks of the OLS. The results revealed that on average, PMSTs had math teaching anxiety from "a little" to "a moderate amount" degree before the OLS and their math teaching anxiety did not significantly change during the OLS. In particular, PMSTs experienced highest math teaching anxiety when their university supervisors or mentor teachers observed and evaluated their teaching. This result reveals an urgent need to find alternative ways to evaluate PMSTs' performance in our teacher preparation program as well as preservice teachers' performance in other teacher preparation programs. Regarding the relationships between math teaching anxiety and several variables, math teaching anxiety was only significantly correlated with the number of methods courses completed so far. This indicates that math methods courses rather than providing PMSTs teaching experience opportunities at the OLS contributed to a decrease in math teaching anxiety. Similar to previous studies reporting that math methods courses were helpful for decreasing math anxiety levels of elementary preservice teachers (e.g., Gresham, 2007; McGlynn-Stewart, 2010; Tooke, & Lindstrom, 1998), we found that math methods courses were also helpful for decreasing math teaching anxiety levels of PMSTs.

Finally, we found that third year PMSTs had significantly higher math teaching anxiety than first year PMSTs both before and after the OLS. Although taking more math methods courses contribute to less math teaching anxiety, being responsible for teaching in the OLS seems to cause more math teaching anxiety. This may be expected as it was the first semester that third year PMSTs were required to plan and experience online teaching. Future studies should continue to examine PMSTs' math teaching anxiety with larger samples in the same university and with different universities.

SIGNIFICANCE OF THIS STUDY

Past research has shown that math methods courses were helpful for decreasing math anxiety levels of elementary preservice teachers (e.g., Gresham, 2007; Vinson, 2001). In terms of decreasing preservice teachers' math teaching anxiety levels, peer tutoring among preservice teachers (Henderson & Rodrigues, 2008), methods courses focusing on students' learning and

use of different models and representations for teaching (Tooke & Lindstrom, 1998) as well as methods courses that incorporated field placement and collaborative lesson planning (McGlynn-Stewart, 2010) were found as effective practices. However, to our knowledge, no studies have examined whether internship experience, specifically whole class teaching or online class teaching experience, is related to PMSTs' math teaching anxiety. Therefore, the present study explores whether internship experience as well as math methods courses have an effect on decreasing PMSTs' math teaching anxiety levels.

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Table 1. The MTA scale items

Items	Content	Mean	SD
Item 1	I become anxious when looking through the pages in MEB or similar mathematics books.	1.84	.90
Item 2	I become anxious when teaching students how to use and interpret tables, graphs, and charts.	2.00	.85
Item 3	I become anxious when preparing students for a math exam that will take place in their schools.	2.09	.97
Item 4	I become anxious when working out math equations online in front of a class of students.	2.28	1.08
Item 5	I become anxious when preparing a presentation about a lesson plan for Online Lab School.	2.56	1.10
Item 6	I become anxious when preparing to teach students a new math concept that will be challenging to them in the Online Lab School.	2.56	1.16
Item 7	I become anxious when a parent may be present during my online teaching.	1.93	.99
Item 8	I become anxious when talking to a student who is eager to use a different way to solve a math problem than the way taught in the Online Lab School.	1.79	.86
Item 9	I become anxious when writing a lesson plan for online teaching of a new math concept.	2.67	.99
Item 10	I become anxious when waiting whether my students will be able to respond to my questions.	2.02	.96
Item 11	I become anxious when my supervisor or mentor teacher evaluates my performance during a math lesson I am teaching.	2.79	1.15
Item 12	I become anxious when going online and thinking about teaching a math lesson.	2.16	1.05
Item 13	I become anxious when investigating online tools (or applications) to support my teaching of mathematics.	2.14	1.04
Item 14	I become anxious when I assess my students' learning during online teaching.	2.07	1.06

Note: SD indicates standard deviation.

Table 2. Correlations among several variables based on pre-survey data (N=43).

	MTA	Whole Class Hours	Online Class Hours	# of Math Classes	# of Methods Classes	# of Edu Classes	GPA
MTA	1	-.15	-.05	-.02	-.34*	-.18	.04
Whole Class Hours		1	.30	.10	.35*	.24	-.07
Online Class Hours			1	.06	.20	.15	.19
# of Math Classes				1	.59**	.73**	.57**
# of Methods Classes					1	.66**	.42**
# of Edu Classes						1	.65**
GPA							1

Note: MTA = Math Teaching Anxiety; # = number; * $p < 0.05$, ** $p < 0.01$

Table 3. Paired sample t-tests across grade levels based on pre-survey and post-survey

	MTA Pre-survey	MTA Post-survey
First year PSTs		
<i>Mean</i>	23.86	25.29 ($p = .62$)
<i>SD</i>	3.58	5.59
<i>N</i>	7	7
Third year PSTs		
<i>Mean</i>	35.18	37.18 ($p = .38$)
<i>SD</i>	8.81	9.61
<i>N</i>	11	11
Fourth year PSTs		
<i>Mean</i>	28.11	33.33 ($p = .09$)
<i>SD</i>	9.98	12.94
<i>N</i>	9	9
All PSTs		
<i>Mean</i>	29.89	32.82 ($p = .053$)
<i>SD</i>	9.28	10.85
<i>N</i>	27	27

Note: PST=preservice teachers; SD=standard deviation; MTA = Math Teaching Anxiety; * $p < 0.05$.