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Elementary education student attitudes to teaching mathematics¹

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Abstract

This research study compares the attitudes toward teaching mathematics of elementary education students using the 22-item Likert-type Mathematics Teaching Attitude Questionnaire (Nisbet, 1991). Data were collected from 153 freshman students majoring in elementary education (133 women and 20 men) whose ages ranged between 18 and 37 years ($M=19.5$ yr., $SD=2.1$) and from 144 senior elementary education student teachers (128 women, 16 men) whose ages ranged between 21 and 52 years ($M=22.8$ yr., $SD=4.6$). The freshman students majoring in elementary education were in the first or second semester of their undergraduate degree program and were planning to join the elementary teacher education program; whereas, the senior elementary education student teachers were in the final semester of their elementary teacher education program. Analyses of the responses to the questionnaire by the freshman students majoring in elementary education and the senior elementary education student teachers were carried out to assess and compare their attitudes to teaching mathematics. The senior elementary education student teachers scored significantly differently from the freshman students majoring in elementary education on two of the four scales of the Mathematics Teaching Attitude Questionnaire reflecting overall lower Anxiety, and higher Confidence and Enjoyment.

The National Council of Teachers of Mathematics (NCTM), a professional organization in the United States, stated that mathematics instruction should be based on the comprehension of core concepts rather than as sets of rules and procedures (NCTM, 2000). Several researchers (Morris, 2001; Chick, 2002; Amarto & Watson, 2003) reported that pre-service teachers may not always have the conceptual understanding of the mathematics content they will be expected to teach. However, not only is subject knowledge important in teaching and learning of mathematics, but it has also been argued that teacher attitudes are important determinants of student attitudes and performance in mathematics (Aiken, 1970). Attitudes – not only toward the subject of mathematics, but also toward the teaching of mathematics – have a powerful bearing on the atmosphere within the mathematics classroom (Ernest, 1989; van der Sandt, 2007). Therefore, in teacher preparation programs, it is necessary to recognize the value of mathematics instruction, and to identify the attitudes preservice elementary teachers have toward teaching in general and particularly the teaching of mathematics. Battista (1986) found that the quality of mathematics instruction of elementary students depends on the preparation of pre-service elementary teachers of mathematics. Southwell, White, Way, and Perry (2005) studied the links between pre-service elementary student teachers' attitudes to mathematics and teaching of mathematics to their mathematics achievement. Their study indicated an overall trend of positive attitudes towards mathematics and teaching of mathematics. Their study further indicated links between mathematical achievement and attitudes towards teaching mathematics that have significant implications for teacher education. So, improving prospective elementary teachers' attitudes toward teaching of mathematics in the teacher education program at universities seem crucial because attitudes of pre-service teachers toward teaching mathematics are effective on their professional lives (Capri & Celikkaleli, 2008).

Definitions of attitude usually include the idea that attitudes manifest themselves as responses to objects, tasks, or situations. For instance, the term "attitudes" is described

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as being a complex mental state involving beliefs, feelings, values, and dispositions to act in certain ways (Princeton University WordNet, 2010). In (Aiken, 2000; McLeod, 1992) attitudes are defined as positive or negative emotional dispositions. According to Leder (1992), attitudes are learned and predispose one toward action, which may be either favorable or unfavorable with respect to a given object. Such a definition indicates that attitudes encompass an emotional reaction to an object, beliefs about the object, and behavior toward an object (Rajecki, 1982).

Attitudes relate to learning are connected to Bandura's (1977) social cognitive learning theory as one of the personal factors that affect learning, and cannot be easily separated from learning itself. Attitudes affect learning and are themselves, in a cyclical process, affected by the process of learning. Farrant (1994) described learning as a process of acquiring and retaining attitudes, knowledge, understanding, skills, and capabilities. Understanding prospective teachers' mathematical attitudes is therefore critical to teacher educators.

Research (e.g., Thompson, 1992; Tan, 2011; Turner, Warzon, & Christensen, 2011) suggests that teachers' attitudes about the nature of mathematics provide a strong indicator of their future teaching practices. Relich, Way, and Martin (1994) stated that attitudes of pre-service teachers toward the teaching of mathematics need to be considered because of their probable influence on students. It was also determined that attitudes are considered significant in determining not only how teachers teach, but also how their students learn (Wagner, Lee, & Ozgun-Koca, 1999). However, according to White, Way, Perry, and Southwell (2006), while attitudes are important, they are not sufficient to predict pre-service mathematics teacher success in teaching. In 1991, Nisbet stated that graduating students who obtain a teaching position take with them into classroom achievements and attitudes in the three distinct fields – subject knowledge, pedagogical knowledge, and mathematics teaching. Moreover, in the classroom, e.g., teachers with high mathematics anxiety may unintentionally communicate these negative feelings to their students (Wood, 1988).

Several studies measuring students' attitudes were completed between 2003 and 2013. In an assessment study of attitudes toward mathematics teaching of first and final year Scottish elementary student teachers, MacNab and Payne (2003) found that final year students were more confident about their teaching but less positive about mathematics. In 2004, Oral found no differences between student teachers' attitudes in their freshman and in their senior years. In Standslause, Maito, and Ochiel (2013), teachers had positive attitudes toward the teaching of mathematics. Barrantes and Blanco (2006) noted that the ideas that elementary student teachers have about learning to teach mathematics appear and

develop during their education, and, as a result, the researchers suggested that paying more attention to initial teacher education is considered necessary to ensure future changes of current curriculum. In a subsequent study (Tok, 2011), pre-service elementary freshman and senior student teachers' attitudes toward teaching were examined. The results showed that attitudes were positive; however, students' attitudes decreased significantly, when the scores from their senior years were compared to those from their freshman years. In contrast, Kogce, Aydin, and Yildiz (2010) compared the attitudes of elementary freshman and senior mathematics teaching students, and senior students had more positive attitudes than freshman students.

Nisbet (1991) stated that to teach mathematics well, one needed a positive attitude toward the subject. It was also suggested that course designers and professors should incorporate topics and learning strategies that boost positive attitudes. This is consistent with teaching in a general sense because one of the objectives of a teacher education program is to develop a positive or favorable attitude toward teaching (Jain, 2007). Hill (2000) suggested that pre-service elementary teachers need adequate and meaningful teaching practice if they are to modify existing attitudes in favor of new views and dispositions of mathematics teaching and learning. Barrantes and Blanco (2006) stated that initial teacher education is necessary for future changes.

Since limited research exists regarding the attitudes of elementary education students to teaching mathematics, the present study attempted to bridge that gap in the existing research. In examining the issue, attitudes toward teaching mathematics among elementary education students should be an important affective consequence of any feasible and successful education program. Measuring such attitudes with a reliable and valid instrument would allow educators to gauge more precisely the extent of the success of their education programs in this area of concern. In one of the few studies on the attitudes of elementary education students on teaching mathematics, an instrument to monitor the attitudes of student teachers was developed and assessed for reliability and validity using a sample of Australian students (Nisbet, 1991). This research measures the attitudes of elementary education students to teaching mathematics using the 22-item Likert-type Mathematics Teaching Attitude Questionnaire (Nisbet, 1991).

The present study differs from previous studies in that attitudes of elementary education students toward teaching mathematics were the primary focus. Attitudes of pre-service teachers have an important effect on students and influence classroom practices, and thus it is crucial that these attitudes be examined as they progress from their initial year to their final year of study when they practice teaching. The purpose of the present study was to compare the attitudes of freshman and

senior elementary education students' toward teaching mathematics. In this study, favorable attitudes to teaching mathematics are defined as positive feelings toward the teaching of mathematics with respect to one's ability to deal with mathematical concepts (Relich, Way, & Martin, 1994).

Hypothesis. There will be a significant difference between freshman and senior education majors on their attitudes toward teaching mathematics as a subject, with seniors showing more favorable attitudes than freshman students.

Method

Participants

The present quantitative study was conducted with two independent groups of students ($N=297$) drawn from undergraduate classes at a private Midwestern university in the United States, with an enrollment of approximately 5,000 students. The participants of the first group were 153 freshman students majoring in elementary education planning to join the elementary teacher education program and were enrolled in mathematics for elementary school teachers, a preparatory course focusing mainly on mathematics content for teaching elementary mathematics. This group is referred to here as "freshman students majoring in elementary education." There were 133 women and 20 men with a mean age of 19.5 yr. ($SD=2.1$, range=18–37, $Mdn=19$). Participants of the second group were 144 senior student teachers majoring in elementary education completing their student teaching requirement and were in their final semester of their elementary teacher education program. This group is referred to here as "senior elementary education student teachers." There were 128 women and 16 men, with a mean age of 22.8 yr. ($SD=4.6$, range=21–52, $Mdn=22$).

The freshman students majoring in elementary education were interested in the elementary teacher education program and had not yet been admitted into the teacher education program as they were under evaluation, and so had not practiced teaching at this time. They were enrolled in Mathematics for Elementary School Teachers course, which is the first of two required undergraduate mathematics courses for students majoring in elementary education. The content of the course was typical of many first mathematics courses for students majoring in elementary education. The course focused on problem-solving techniques, sets and set operations; whole numbers, integers, rational numbers, real numbers, operations that can be performed on the aforementioned sets; functions; number systems; estimation; and number theory. The class met for two hours two times each week for 14 consecutive weeks. Typically, these students had completed at least two years of high school mathematics.

On the other hand, the senior elementary education student teachers were in their final semester of the elementary teacher education program and were working toward K-6 licensure in elementary education from the State of the attended university. At the time of data collection, they were enrolled in the Supervised Teaching course, which is the last required course students complete in the elementary teacher education program. The course focused on planning and implementing instruction under the guidance of a cooperating classroom teacher and the direction and observation of a university supervisor. It provided practical experience with the activities, curriculum, and methods appropriate for the grade level identified in the licensure parameters. The undergraduate elementary teacher education program provided two 10-week, full time classroom experiences, one in the lower elementary grades and the other in the upper elementary grades. Overall, the elementary teacher education program's vision indicated that the elementary curriculum was designed to foster the knowledge, attitudes, and skills appropriate for professional practice among prospective teachers and graduate students.

Procedure

The data were collected in the final week of a 20-week Supervised Teaching course in the spring semester after the student teachers had completed most of their student teaching. All participants in this group had completed at least the two elementary mathematics content courses (Mathematics for Elementary School Teachers), four credit hours in mathematics methods, mathematics field experience tutoring second grade classes, teaching small groups of kindergarteners, and providing differentiated instruction to whole Grade 5 and 6 classrooms. They completed these courses when they were students majoring in elementary education before they were admitted into the elementary teacher education program.

Measure

Nisbet's (1991) Mathematics Teaching Attitude Questionnaire was used to assess the attitudes of the freshmen majoring in elementary education and senior elementary education student teachers to teaching mathematics. Data were collected in this study over a period of four consecutive years. It is noted in Nisbet (1991) that the items of the questionnaire were derived from Fennema-Sherman's (1976) scales, which were designed for the measurement of attitudes toward mathematics in their study of attitudes in high school students. The items for the questionnaire scales were created by taking statements from the Fennema-Sherman scales developed in U.S. and modifying them to suit the notion of teaching mathematics rather than mathematics as such. The instrument used by Nisbet (1991) consisted of the Fenne-

ma-Sherman (1976) "Mathematics Attitude Scales" plus parallel scales constructed by Nisbet to cover "Attitudes to Teaching Mathematics." The final instrument consisted of 22 items divided into four scales measuring elementary education students' attitudes to teaching mathematics in the following areas: Anxiety, Confidence and Enjoyment, Desire for Recognition, and Pressure to Conform. Response options gave three levels of agreement and three levels of disagreement with an option for a neutral or undecided response. Some items were worded positively and some negatively to diminish the threat of a "response set" on the part of students. Students indicated their responses on a seven point Likert-type scale from 7: Agree strongly to 1: Disagree strongly. For example, in the mathematics teaching anxiety scale, Item 1 read, "Generally I feel secure about the idea of teaching mathematics," and Item 9 read, "Teaching mathematics at practice teaching makes me feel nervous." The negative items (positive items for the anxiety scale) were reverse-scored. The elementary education students completed the Mathematics Teaching Attitude Questionnaire in their freshman and senior years. Possible scores ranged from 8 to 56 for both the Mathematics Teaching Anxiety, and Confidence and Enjoyment scales, and 3 to 21 for both the Desire for Recognition, and Pressure to Conform scales. The higher the score, the more positive the attitude toward teaching mathematics is. In the case of the Mathematics Teaching Anxiety scale, the higher the score, the higher the mathematics teaching anxiety. Scale reliabilities of an Australian sample for each of the four scales were .80 for the Mathematics Teaching Anxiety scale, .89 for the Confidence and Enjoyment scale, .71 for the Desire for Recognition scale, and .74 for the Pressure to Conform scale. The validity analysis using Principal Components Factor Analysis produced four factors of Mathematics Teaching Anxiety, Confidence and Enjoyment, Desire for Recognition, and Pressure to Conform (Nisbet, 1991).

Analysis

All participants in the current study were volunteers and their responses were anonymous. Students were informed both verbally and in writing that their involvement in the study was totally voluntary and would not impact their grade in the course during which it was ad-

ministered. Composite scores on the four attitude scales in teaching mathematics (Mathematics Teaching Anxiety, Confidence and Enjoyment, Desire for Recognition, and Pressure to Conform) were calculated and analyzed. The mean score of the freshman students majoring in elementary education in this study was compared to the mean score of the senior elementary education student teachers. A majority of the participants (88%) were women in both groups; therefore, no effort was made to differentiate results by sex. Data were analyzed by SPSS (20.0) for Windows. Internal consistency reliability estimate (Cronbach's α) was computed for the Mathematics Teaching Attitude Questionnaire. The level of statistical significance was set at 5%, and the independent *t* test was then carried out to find differences in attitudes toward teaching mathematics. To measure the magnitude of the differences in attitudes toward teaching mathematics, Cohen's *d* was used as the measure of effect sizes of differences in attitudes toward teaching mathematics. Effect size interpretation are usually based on Cohen's (1992) conventions which states that a *d* value of 0.20 is small, 0.50 is medium and 0.80 is a large effect.

Results

Cronbach's α reliability scores for the freshman students majoring in elementary education were .92, .90, .83, and .68, for the scales Anxiety, Confidence and Enjoyment, Desire for Recognition, and Pressure to Conform, respectively. Cronbach's α reliabilities for the senior elementary education student teachers were .94, .94, .82, and .64, for Anxiety, Confidence and Enjoyment, Desire for Recognition, and Pressure to Conform, respectively. These were similar to the values reported originally by Nisbet, with the exception of the Pressure to Conform scale, for both groups. Table 1 presents the means and standard deviations for the four scales of the Mathematics Teaching Attitude Questionnaire by group; Table 1 also reports group comparisons on attitudes about teaching mathematics. The results of the independent *t* test indicated an overall significant difference on two of the four scales of the Mathematics Teaching Attitude Questionnaire. The greatest difference in scores was on the Confidence and Enjoyment scale in favor of the senior student teachers. It is not only important to report differences in

TABLE 1
Summary Data For the Total and Scales Scores

Scale	Freshman Students (<i>n</i> =153)		Senior Students (<i>n</i> =144)		<i>t</i>	Cohen's <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Mathematic Teaching Anxiety	28.8	10.8	23.2	12.2	4.22*	0.49
Confidence and Enjoyment	34.3	8.1	43.0	10.0	8.29*	0.96
Desire for Recognition	18.5	2.6	19.0	2.3	1.71	0.20
Pressure to Conform	16.1	3.2	16.5	3.5	1.05	0.12

**p*<.001 (two tailed).

attitudes toward teaching mathematics but also to find out how large these differences are. As shown in Table 1, the magnitude of the differences in attitudes toward teaching mathematics (*d*) appear to be large for Confidence and Enjoyment (0.96), medium for Anxiety (0.59), and small for Desire for Recognition (0.20) and Pressure to Conform (0.12), according to Cohen's (1992) general categorization of effect sizes.

Discussion

The main purpose of this study was to assess and compare responses to the Mathematics Teaching Attitude Questionnaire by a group of freshman students majoring in elementary education and a group of senior elementary education student teachers. Elementary education students in this study enter and leave the elementary education program with some feelings of fear and anxiety about teaching mathematics. However, an examination of the mean responses on the mathematics teaching anxiety scale indicates that senior elementary education student teachers in their final semester of elementary teacher education program are significantly less anxious about teaching mathematics than the freshman students majoring in elementary education in first year of undergraduate education. Mathematics teaching anxiety decreases as the students progress through the elementary teacher education program of study. Contrary to this, research in Turkey showed a significant positive change in pre-service elementary education teachers' attitudes toward the teaching profession between their freshman and senior years as a result of training in favor of the freshman students (Tok, 2011). Anxiety regarding teaching of mathematics may include a feeling of worry, nervousness, lack of confidence, impatience, and fear of failure; anxiety is also a major component of attitudes to teaching mathematics (Nisbet, 1991).

Mathematics teaching anxiety is also tied to poor academic performance of students and/or lack of confidence about their ability to teach mathematics to children (Hembree, 1990; Brown, Westenskow, & Moyer-Packenham, 2011). Nontraditional approaches to teaching to reduce mathematics-teaching anxiety include establishing an online discussion of anxiety toward teaching mathematics among elementary teacher candidates (Liu, 2008). Research shows that the reform-based mathematics strategies learned in undergraduate methods courses can straightforwardly revert to traditional, lecture-based teaching styles through the first few years of in-service teaching (Ebby, 2000). Hence, ensuring that early mathematics teaching experiences do not result in mathematics teaching anxiety is crucial to the future of mathematics teaching. A possible reason for the significant difference in mathematics teaching anxiety found between freshmen and seniors in this study could be that the senior student teachers are in their final semester, are currently involved

in practicum experiences, and have already completed the methods courses required for their degrees.

Nisbet (1991) argued that anxiety and confidence in teaching mathematics are independent factors. But, Relich, Way, and Martin (1994) disagreed based on their study of Australian undergraduate pre-service students. They indicated that anxiety is highly correlated with attitude and, hence, is an element of attitudinal profiles. Other research revealed a relationship between mathematics anxiety and confidence in learning mathematics, so they are often considered to be the same concept (Freislich & Bowen-James, 2003).

Mean responses from both groups indicate that scores on the Confidence and Enjoyment scale were significantly higher for senior elementary education student teachers. One reason could be related to the enthusiasm of these senior elementary education student teachers for using what they learned from mathematics and mathematics methods courses in their field or practical experiences. Another reason may be that the freshmen majoring in elementary education who did not enjoy the thought of teaching mathematics, or felt insufficiently competent to do so, dropped out before they started their student teaching. A third explanation to this could be that these students' field experiences encouraged them and gave them confidence. According to Wagner, Lee, and Ozgun-Koca (1999), most student teachers develop or limit their self-confidence based on their success or failure during their student teaching experience. The mean score may indicate even over-confidence among the senior elementary education student teachers.

Since the freshmen students majoring in elementary education were still in the first year of their undergraduate degree program, there is a potential for an increase in confidence and enjoyment toward their teaching mathematics as they progress through the program. It is suggested that mathematics education course designers and professors offer chances for their students to have experiences that enhance their confidence and provide enjoyment in the context of teaching mathematics to elementary children (Nisbet, 1991). In Szydlik, Szydlik, and Benson (2003), the confidence students gained in believing they could construct mathematics learning sessions is particularly important for prospective teachers, who will be expected, as indicated by National Council of Teachers of Mathematics (NCTM, 2000), to help their future students make, refine, and explore mathematical conjectures based on evidence and make arguments to support those claims.

Senior elementary education student teachers were not significantly different from the freshman students majoring in education in terms of scores on the Desire for Recognition and Pressure to Conform scales. The Desire for Recognition scale may measure that fundamental human need, recognition, along with a motivation to be

prosperous at one's chosen career, as described by Nisbet (1991). The mean scores indicate that all the participants "agreed generally" with the pride in being recognized as a good teacher of mathematics. The mean scores on the Pressure to Conform scale indicate that all participants "agreed a little" with pressure to conform or reluctance to be seen. Neither Desire for Recognition nor Pressure to Conform is addressed in the elementary education sequence of courses of the institution from which the sample was drawn. Consequently, the stability of scores over time is to be expected, because both groups are learning from the formal curriculum with limited experiential learning. Another possibility is that the experiences of these participants are comparable to their recollections of their own schooling, and some of their attitudes are carried out through their teacher education program (Grootenboer, 2006). Views about Desire for Recognition and Pressure to Conform established through their own schooling are carried out, demonstrating that the gains are not strong enough, in the context of personal experiences, to overcome their prior views.

The Mathematics Teaching Attitude Questionnaire appears to be an internally consistent measure of elementary education student attitudes to teaching mathematics. The low reliability of the Pressure to Conform scale for both samples may reflect the fact that this scale was not addressed in the content and pedagogy of the elementary education program, so the range of scores was limited. For the freshman students majoring in elementary education data, the Cronbach's α was .68, and for the senior elementary education student teachers, the alpha was .64. Senior elementary education student teachers may have felt the pressure to conform less than their counterparts among the freshman students. Overall, the reliability of the instrument was judged sufficient because the alpha value was above .60 (Nunnally & Bernstein, 1994) which is the minimum requirement.

Overall, the elementary education students' attitudes toward teaching mathematics is healthy in this study. According to White, Way, Perry, and Southwell (2006), positive attitudes are necessary, but not sufficient. Even if pre-service teachers have positive attitudes, they need to also know the mathematics content. Pre-service mathematics education courses, then, must deal with content and attitudes as well as pedagogical content knowledge. A subsequent longitudinal study of the freshman students would provide a clearer understanding of these issues. It is also recommended that investigation of this scale in non-Western cultures is necessary to assess its general suitability. Comparative studies with large numbers of education students across locations are recommended as well.

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