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RECIPROCAL RELATIONSHIPS BETWEEN MATHEMATICS ANXIETY AND ATTITUDE TOWARDS MATHEMATICS IN ELEMENTARY STUDENTS

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Abstract: This current study examined the reciprocal relationship between anxiety and attitude towards mathematics in elementary students. Two instruments (attitudes towards mathematics inventory short form [ATMI-Short Form] and the Revised Fennema-Sherman Mathematics Anxiety Scale [Revised-FSMAS]) were administered to 310 fourth grade elementary students. Results of this study revealed that elementary students had higher level of attitude towards mathematics in comparison to their mathematics anxiety level. Findings of the study revealed that mathematics attitudes were linked to their mathematics anxiety. Although the magnitude of the correlations between mathematics anxiety and attitude towards mathematics were not very strong, the significant relationship between these two components should be acknowledged.

Key words: Mathematics, anxiety, attitude, elementary, student.

1. Introduction

Mathematics can be a rich context through facilitating connections to real life examples. However, for those of us who are not mathematically inclined, encouraging these connections may be overwhelming. Although students begin schools with positive attitude towards mathematics, mathematical experiences gained in schools plays a detrimental role in students' anxiety and attitude towards mathematics (Philippou & Christou, 1998; Reyes, 1984). Therefore, it is essential to measure the level of students' anxiety and attitude towards mathematics to predict the role of these constructs on their mathematics achievement.

Attitude has been defined and redefined as a construct by several research studies in mathematics education (Di Martino & Zan, 2010; Haladyna, Shaughnessy, & Shaughnessy, 1983; Hannula, 2002; Hart, 1989). Attitude defined as "learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person" (Aiken, 1970, p. 551). In the same way, Neale (1969) referred to attitude towards mathematics as "liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics useful or useless" (p. 632). Ma and Kishor (1997) extended this definition by adding students' affective responses to the easy/difficult as well as the importance/unimportance of mathematics" (s. 27). Researches also defined attitude as a positive or negative emotional tendency towards mathematics (Haladyna et al., 1983; Zan & Di Martino, 2007). For this current study, attitude was defined as an aggregated measure of one's feelings and emotions towards mathematics that consists of value, self-confidence, enjoyment and motivation (Tapia & Marsh, 2004, 2005). Value of mathematics refers to one's beliefs on the usefulness, importance and worth of mathematics. Enjoyment defined as to the degree students like doing mathematics. Motivation refers to one's interest in mathematics and intentions to pursue studying mathematics (Tapia & Marsh, 2004). In other words, students' positive attitudes improve their willingness to learn, while their negative attitudes may cause resistance (Duda & Garrett, 2008; Eshun, 2004). Research studies have shown that strong relationships exist between these domains (value, self-confidence, enjoyment, motivation) and mathematics achievement (Antonnen, 1969; Atkinson & Raynor, 1974;

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Bouchey & Harter, 2005; Foire, 1999; Minato & Yanase, 1984; Samuelsson & Granstrom, 2007). Over the last four decades, students' attitudes toward mathematics have been examined (e.g., Neale, 1969; Aiken, 1976; Ma & Kishor, 1997; Alkhateeb & Mji, 2005; Hemmings & Kay, 2010). The study of Mayes, Chase and Walker (2008) revealed that negative attitudes towards mathematics often lead to poor engagement and low performance of students. Some evidence indicated that students' positive attitudes toward mathematics have positive influence on students' achievement (House, 1995; Evans, 2007). According to the meta-analytic study of Ma and Kishor (1997), the relationship between attitude towards mathematics and achievement in mathematics seemed to be stronger from the lover elementary grades (1 to 4) to the upper elementary grade (5 to 6). However, this finding showed that the effect size was small for the relationship between two variables. In the same way, results of studies showed that relationship between attitude towards mathematics and achievement in mathematics were not very strong (Aiken, 1970; Ma & Kishor, 1997). In addition, students' confidence, anxiety in mathematics as well as usefulness and enjoyment of mathematics has been seen as important implications of students' attitude towards mathematics (Fennema & Sherman, 1976; Tapia & Marsh, 2004). According to Mohammadpour (2012), students' attitude towards mathematics can also be affected by whether or not they find mathematics enjoyable, valuable and essential to be successful in school and future career goals. In the same way, students' views on usefulness and significance of mathematics are related to their mathematics performance (Kiwanuka et.al, 2017). Hemmings et al. (2011) found prior achievement and attitudes towards mathematics to be highly predictive of student performance. The study of Mata, Monterio and Peixoto (2012) highlighted the effect of mathematics achievement and grade level on positive attitude towards mathematics.

Mathematics anxiety is defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p.551). Anxiety is defined as one of the most common factors preventing students to continue on mathematics related educational tracks (Ashcraft, 2002). In the case of mathematics anxiety, negative attitudes could take many forms from a simple dislike of mathematics to fear (or anxiety) of dealing with any mathematics tasks (Chipman, Krantz & Silver; 1992).

These two constructs, anxiety and attitude towards mathematics have profound implications for children's learning, achievement, and academic performance in school (Bekdemir, 2010; Ho, Senturk, Lam, Zimmer, Hong, Okamoto, Chiu, Nakazawa, Wang, 2000; Ma, 1999; Ma & Kishor, 1997; Pekrun, 2006; Schenkel, 2009). Instructional approaches that are used for teaching hold a key role in children's aspirations to pursuing future career choices related to mathematics. Traditional teaching practices such as expectations on correct answers (Harper & Daane, 1998), fear of making mistakes (Dutton, 1951), and rote calculations and memorizations (Hilton, 1980) have been defined as contributing factors to students' anxiety and attitude towards mathematics in elementary classrooms (Hilton, 1980). Student with high level of mathematics anxiety feel stress and worry about completing simple mathematical tasks and struggle with low mathematics performance (Bekdemir, 2010; Hembree, 1990; Wigfield & Meece, 1988). Children's anxiety and attitude towards mathematics seems to be a critical variable affecting their performance and mathematics achievement (Bekdemir, 2010; Ho et al., 2000; Ma, 1999; Ma & Kishor, 1997; Schenkel, 2009). Bramlett and Herron (2009) suggested that students' enjoyment while working on mathematics problems tends to enhance their positive attitude toward mathematics that leads to better performance and high achievement. In addition, negative attitude towards mathematics is often associated with value, enjoyment and motivation of mathematics as well as students' confidence (Fennema & Sherman, 1976; Tapia & Marsh, 2004). These negative relations between these components often lead to poor engagement and low achievement of students (Mayes, Chase, & Walker, 2008). Results of the research studies reported a negative correlation between mathematics anxiety and low performance in mathematics, and negative attitudes towards mathematics (Fennema, 1977; Fennema & Shermon, 1977; Richardson & Suinn, 1972; Tobias & Weissbrod, 1980). Considering the numbers of studies conducted with students to examine their attitudes towards mathematics and mathematics anxiety individually (e.g., Cargnelutti, Tomasetto & Passolunghi, 2016; Gierl & Bisanz, 1995; Ma, 1999; Wigfield & Meece, 1988), further research is needed to examine the reciprocal relationship between anxiety and attitude

towards mathematics in elementary students.

It does appear that mathematics anxiety might be linked to elementary students' attitude towards mathematics. Therefore, the present study aims to answer the following research questions:

1. What is level of elementary students' mathematics anxiety and attitude towards mathematics?
2. Is there a significant difference in mathematics anxiety and attitude towards mathematics scores of elementary students regarding gender?
3. Is there a significant difference in mathematics anxiety and attitude towards mathematics scores of elementary students regarding mathematics achievement?
4. What is the relationship between elementary students' mathematics anxiety and attitude towards mathematics?

2. Method

2.1. Participants

Data were collected from 310 fourth grade students enrolled in three elementary public schools located in northwest part of Turkey. The sample consists of 147 females and 163 males.

In this study, two instruments, attitudes towards mathematics inventory short form (ATMI-Short Form) and the Revised Fennema-Sherman Mathematics Anxiety Scale (Revised-FSMAS) were administered to elementary students.

2.2. Instruments

2. 2.1 *Attitude Towards Mathematics Inventory Short Form (ATMI-Short Form)*

Attitude Towards Mathematics Inventory Short Form (ATMI-Short Form) was developed by Lim and Chapman (2013a) and adapted to Turkish by (Haciomeroglu, 2017). In this current study, ATMI-Short Form was utilized to measure elementary students' attitudes towards mathematics. The inventory included 17 items on a four-point Likert scale anchored at points with the statements: strongly disagree, disagree, undecided, agree, and strongly agree. Higher scores reflect positive attitudes towards mathematics. The reliability coefficient of the value (V), self-confidence (SC), and enjoyment and motivation (EM) subscales, 0.91, 0.86, and 0.82 respectively. The internal reliability of the ATMI-Short Form was 0.84.

2. 2.2 *Revised Fennema-Sherman Mathematics Anxiety Scale (Revised-FSMAS)*

Revised-FSMAS was developed by Lim and Chapman (2013b) and adapted to Turkish by Haciomeroglu & Kutluca (2016). In this present study, the Revised-FSMAS was utilized to measure students' anxiety toward mathematics in particular. Elementary students were asked to indicate the extent to which they felt anxiety on a five point Likert scale anchored at points with the statements: almost always, often, sometimes, seldom and never. Revised-FSMAS consists of 8 items in a five-point Likert-type of scale. The reliability coefficient of the four subscales, ease and anxiety were 0.79 and 0.71 respectively. The internal reliability of the overall instrument was calculated as 0.70. High score on Revised-RSMAS means high level of mathematics anxiety.

2.3 Prior Achiement in Mathematics

For the elementary students' achievement, mathematics grade on the record card at the end of the school year was gathered. In Turkish Schools, students receive grades ranging from 1 through 5. Grading scale can be seen in Table 1.

Table 1. *Grading scale*

Description	Grade	Grade Point
Excellent	5	85-100
Good	4	70-84
Fair	3	55-69
Pass	2	45-54
Failure	1	0-44

2.4 Procedure

In this study, data were collected with two instruments. ATMI-Short Form and the Revised-FSMAS were administered to elementary students. Students who agreed to be part of this study were given these instruments to complete during their regular class hours. It took approximately 20-25 minutes for students to complete the instruments.

2.5 Data Analysis

Descriptive and inferential statistics were used for the analysis of mathematics anxiety and attitude towards mathematics scores of elementary students. An independent t-test was used to examine the difference between anxiety and attitude towards mathematics scores of the elementary students regarding gender. Elementary students' mathematics anxiety scores were used to assign them into three groups: low, moderate and high. The classifications of the groups were determined using quartiles. Low and high anxiety groups include students whose scores were in the lower 25% and in the upper 25% of the distribution. Students' scores fell between 25% and 50% were considered the moderate group. In addition, the Pearson product correlation coefficients for the sub-scales of ATMI Short Form and Revised-FSMAS were calculated to explain the possible relationships between these variables. One-way ANOVA and Tukey HSD (Honestly Significant Differences) tests were used to compare the mean ATMI Short Form scores of the different mathematics anxiety groups.

3. Results

Elementary students responses on the ATMI Short Form and Revised-FSMAS were analyzed by using descriptive and inferential statistics. Descriptive analysis of ATMI Short Form revealed that overall students held positive attitudes towards mathematics (M=3.18; SD=0.79). In addition, students' score on value (V) (M=3.70; SD=1.30) and enjoyment and motivation (EM) (M=3.25; SD=1.04) presents positive attitudes of students for these subscales. However, students' attitudes regarding self-confidence (SC) (M=2.55; SD=1.15) seemed to lower then their attitudes regarding value (V), and enjoyment and motivation (EM) subscales. These findings suggest that students seemed to value and enjoy working on mathematics. Their self-confidence was somewhat low in comparison to both value, enjoyment and motivation they feel regarding mathematics. However, results of the analysis on Revised-FSMAS showed that student generally held a low level of mathematics anxiety in general (M=2.48; SD=0.82). This finding suggested that the students' low scores on ease (M=2.31; SD=1.03) and anxiety (M=2.77; SD=1.21) subscales indicated that they generally feel less anxious when dealing with mathematics. Results revealedthat not only elementary students felt less anxious about mathematics but also they seemed to enjoy working on mathematics problems.

An independent sample t test was conducted to determine the differences between students' ATMI Sort Form subscale scores (i.e., value, self-confidence, enjoyment and motivation) regarding gender. Results of the study revealed that there were no significant differences between students' value ($t=4.316$, $p>.05$), self-confidence ($t=1.742$, $p>.05$), enjoyment and motivation ($t=3.451$, $p>.05$) regarding gender. These findings suggested that there was no significant difference between female

and male students attitudes towards mathematics. An additional t-test was conducted to examine the difference between students Revised FSMAS subscale scores (i.e., ease and anxiety) regarding gender. It was found that there was no significant difference between female and male students' scores on both ease (t=0.251, p>.05) and anxiety subscales (t=1.886, p>.05).

Results of the one-way ANOVA showed that there was a statistically significant difference between ease scores of the Revised-FSMAS and mathematics achievement scores of the elementary students at F (4, 305) = 12.314, p = .00 respectively. According to Cohen (1988), the effect size, calculated using eta squared, was large (h^2 =.13). According to the Tukey's HSD tests, the mean differences in ease scores between the 1-5, 2-5, 3-5, and 4-5 mathematics achievement scores were found to be statistically significant. Additionally, there was no significant difference between anxiety scores of the Revised-FSMAS and achievement scores of the students at F (4, 305) = 1.164, p = .32, p> .05, respectively. In the same way, there was no significant difference between attitude scores of the ATMI Short form subscales, value [F (4, 305) = 1.164, p = .32, p> .05], self-confidence [F (4, 305) = 1.164, p = .32, p> .05], and enjoyment and motivation [F (4, 305) = 1.164, p = .32, p> .05]) regarding mathematics achievement.

The relationship between attitude towards mathematics (as measured by ATMI Short Form) and mathematics anxiety (as measured by Revised-FSMAS) among elementary students was investigated using Pearson product correlation coefficient. The bivariate correlations between value and ease, and value and anxiety were significant at r =-.17, p<.01 and r = -.23, p<.01 respectively. There was a medium, negative correlation between self-confidence and ease (r = -.45, p< .01). The relationship between enjoyment and motivation and ease (r =-.24, p< .01) and motivation and anxiety (r =-.26, p<.01) were found significant. Results of the analysis demonstrated that elementary students with higher level of attitude towards mathematics had lower level of mathematics anxiety.

Table 2. *Correlations between anxiety and attitude towards mathematics*

	Subscales	1	2	3	4	5
1	ATMI value				-.17 (**)	-.23 (**)
2	ATMI self confidence				-.45 (**)	-
3	ATMI enjoyment and motivation				-.24 (**)	-.26 (**)
4	Revised-FSMAS Ease					
5	Revised-FSMAS Anxiety					
N=310, **p<.01						

A one-way between groups analysis of variance was conducted to explore the impact of mathematics anxiety on levels of attitude towards mathematics, as measured by the Revised-FSMAS. Elementary students scores on ease and anxiety subscales of Revised-FSMAS were divided into three groups: low, moderate and high (See Table 2).

Table 3. Low, moderate and high groups of Revised-FSMAS sub-scales

		Low			**Moderate**			**High**		
Revised Fennema Sherman		N	M	SD	N	M	SD	N	M	SD

	Ease	81	3.83	1.36	147	3.74	1.27	82	3.73	1.22
	Anxiety	74	3.48	1.42	173	3.57	1.30	63	4.33	.96

Results of the analysis showed that there was a statistically significant difference at the p<.05 level in Short ATMI sub-scale scores (i.e., value, self confidence, and enjoyment and motivation) for the three groups (low, moderate and high) of Revised-FSMAS sub-scales (i.e., ease and anxiety) (See Table 3).

There was a significant difference between value (V) score and three groups of ease (low, moderate and high) at F (2, 307) = 5.777, p = .03 respectively. According to Cohen (1988), the effect size, calculated using eta squared, was (h^2 =.03) small. According to the Tukey's HSD tests, the mean differences in value (V) score between the low and high ease anxiety groups and between moderate and high ease anxiety groups were found to be statistically significant. In the same way, there was a significant difference between self-confidence (SC) score and three groups of ease (low, moderate and high) at F (2, 307) = 8.555, p = .00 respectively. Eta square was calculated as h^2 =.16 respectively. This finding shows that effect size was large (Cohen, 1988). Tukey's HSD test revealed that there was a significant difference between low and moderate and low and high mathematics ease groups. In addition, there was a significant difference between moderate and high groups. Similarly, there was a statistically significant difference at the p < .05 level in enjoyment and motivation (EM) score for the three groups of ease anxiety: F (2, 307) = 8.555, p = .00 respectively. The effect size, calculated using eta squared, was small (h^2 = .05). The mean differences in enjoyment and motivation (EM) score between low and high and moderate and high ease anxiety groups.

Additionally, there was a significant difference between value (V) score and three groups of anxiety (low, moderate and high) at F (2, 307) = 9.664, p =.00 respectively. According to Cohen (1988), the effect size, calculated using eta squared, was medium (h^2 =.05). According to the Tukey's HSD tests, the mean differences in value (V) score between low and high and moderate and high mathematics anxiety groups were found to be statistically significant. In the same way, there was a significant difference between self-confidence (SC) score and three groups of anxiety scores (low, moderate and high) at F (2, 307) = 5.344, p =.005 respectively. Eta square was calculated as h^2 =.03. The effect size was small. Tukey's HSD test revealed that there was a significant difference between moderate and high mathematics anxiety groups. Similarly, there was a statistically significant difference in enjoyment and motivation (EM) score for the three groups of anxiety scores (low, moderate and high): F (2, 307) = 15.787, p = .000. The actual difference in mean scores between the groups was moderate. The effect size, calculated using eta squared, was moderate (h^2 = .09). There was a significant difference between low and high and moderate and high anxiety groups.

4. Discussion and Conclusion

The main goal of the current study was to investigate the reciprocal relationships between anxiety and attitude towards mathematics of elementary students. On the basis of the previous research, it was hypothesized that students' attitudes towards mathematics would be reciprocally associated with their math anxiety. Results of this current study revealed significant but small effect size of this reciprocal relationships between anxiety and attitude towards mathematics. The findings revealed that higher levels of attitude towards mathematics predicted subsequent lower levels of anxiety. In the same way, results of the previous studies revealed that students who had strong attitude towards mathematics were more likely to feel less anxious about mathematics (Briley, 2012; Swars et al., 2007; Swars et al., 2009). This finding suggested that both anxiety and attitude could be effective components for the elementary students' learning of mathematics. It can be said that students with low anxiety tend to have more confidence to learn mathematics. In addition, this current study showed the significant relationships between anxiety and attitude towards mathematics. However, the magnitude of the

correlations between these components were not very strong. Still, these two constructs play an important role in students' learning of mathematics. Along with research studies (Köğce et al., 2009; Ma & Kishor, 1997; Mohamed & Waheed, 2011), this study concluded that gender does not affect students' anxiety and attitudes towards mathematics. However, there was a significant difference between students' ease scores and mathematics achievement scores of the students. It seems students' low level of anxiety regarding ease made a significant difference between lower and higher mathematics achievement scores of the students. It can be said that students with high mathematics achievement seemed to have low level of anxiety.

Anxiety and attitude towards mathematics are important predictors of motivation and educational outcomes related to achievement. As a result, this study suggests that longitudinal research studies should be conducted with elementary students to examine the development of their attitudes towards mathematics and its relations to anxiety. This way, learning needs of the students can be better understood.

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