

The Effects Of Previous Mathematics Courses On Current Mathematics Anxiety Levels

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ÖZET

Geçmiş matematik derslerinin öğrencilerin halihazırdaki matematik kaygı düzeylerini nasıl etkilediğini belirlemek amacıyla, istatistiğe giriş dersini almakta olan 246 üniversite öğrencisi üzerinde bu çalışma gerçekleştirilmiştir. Öğrenciler orta öğretim II kademe, lise ve üniversitede aldıkları matematik derslerini belirtmişler ve ayrıca bir matematik kaygı ölçeğini cevaplamışlardır. Öğrencilerin belli dersleri alıp almadığı ile kaygı düzeyleri baz alındığında, anlamlı grup farklılıkları bulunmuştur. Ortaokul cebir ve geometri; lise ileri cebir; üniversite matematiğe giriş, cebir, trigonometri, ve kalkulus dersleri anlamlı etkiye sahip olmuşlardır. Çoğunlukla, bu dersleri alan öğrencilerin daha düşük matematik kaygısı yaşadıkları bulunmuştur.

Anahtar Kelimeler: Matematik kaygısı, üniversite öğrencileri, geçmiş matematik dersleri.

ABSTRACT

The effects of previously completed mathematics courses on students' current mathematics anxiety levels were investigated on 246 college students who were enrolled in introductory statistics courses. Participants reported the courses that they have completed at junior/senior high school and college levels and responded to a mathematics anxiety scale. Independent t-tests compared groups on current mathematics anxiety levels. Significant group differences were found based on the presence or absence of a particular course. Junior-high school level beginning algebra and geometry; senior-high school level advanced algebra, trigonometry, mathematics review for calculus, beginning calculus, and advanced calculus; college level general mathematics, beginning algebra, trigonometry, beginning calculus, and advance calculus courses had significant effects. The effect, in most cases, was that students who completed these courses were found to be experiencing lower mathematics anxiety.

Keywords: Mathematics anxiety, college students, previous mathematics courses.

1. INTRODUCTION

Mathematics anxiety is "feelings of tension and anxiety that interfere with the manipulation of numbers and solving mathematical problems in a wide variety of ordinary life and academic situations" [19]. Interest in mathematics anxiety began with individual observations of mathematics teachers in the early 1950s. Since

1970s, extensive research has revealed that mathematics anxiety is an interaction of many factors, including mathematics itself, educational and curriculum related issues, parental attitudes, values, expectations about mathematics, and previous mathematics experiences.

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Harris and Harris [10] suggested three factors that affect mathematics anxiety: student-related, teacher-related, and teaching-related. Similarly, Shodahl and Diers [22] reviewed the literature (1971-1984) and concluded that some of the sources of mathematics anxiety were inadequate preparation, attitudes of the mathematics teachers and their teaching methods, inadequate mathematics textbooks, and students' level of thinking. Berebitsky's review [3] of over 30-year mathematics anxiety research (1954-1985) identified parental attitudes, mathematics teachers, and the nature of mathematics as contributors to mathematics anxiety. The sources of mathematics anxiety can also be investigated in terms of three factors: dispositional, situational, and environmental [4].

The psychological and emotional characteristics of individuals are considered as dispositional antecedents. Hembree [11] suggested that intellectual ability is not a significant factor in mathematics anxiety. Faust [7] found that mathematics anxiety did not "involve differences in the amount of knowledge stored in memory, nor in the process of retrieving that knowledge" (p. 8). Ling [14] suggested that difficulty with mathematics was mostly independent of abilities and more relevant to attitudes. Attitudes toward the field of mathematics have been intensively investigated as dispositional antecedents of mathematics anxiety [12]. Mulenga [16] used meta-analysis techniques to investigate the relations between attitudes toward mathematics and mathematics anxiety. Analyses, including 14 studies conducted between 1980 and 1989, showed that the correlation coefficient between mathematics anxiety and attitudes toward mathematics was $r = -.50$, and that relations between attitudes toward mathematics and mathematics achievement was $r = -.30$.

By using path analysis techniques, Olson [17] developed a theoretical model of mathematics anxiety that included several variables such as attitudes toward mathematics, field independence, general anxiety, locus of control, gender, sex-orientation, number of mathematics courses taken, spatial ability, logical reasoning ability, and mathematics achievement. The model's Adjusted Goodness-of-Fit index was .92, which suggested that the model fit well. A separate discriminant analysis showed that field independence, trait anxiety, mathematics achievement, mathematics attitude, facilitating anxiety, and debilitating

anxiety discriminated the high mathematics-anxious group from the low mathematics-anxious group ($\chi^2 = 62.98$, $p < .01$) about 76% of the time.

The influence of mathematics teachers is an important situational factor of mathematics anxiety. Lazarus [13] pointed out that "particularly in elementary schools, and sometimes in high schools as well, a significant fraction of mathematics teachers may themselves be subject to mathphobia" (p. 21). Hence, many researchers hypothesized that mathematics anxiety is transferred from mathematics teachers to their students [e.g., 3, 5, 22]. Other teacher-related situational antecedents are an authoritarian teaching style [9] and teacher attitudes [10, 22]. In addition, the nature of mathematics (i.e., mathematical notation and terminology) has been found as an important contributor of mathematics anxiety [3, 23].

Rounds and Hendel [20] asserted that mathematics anxiety is prevalent among all students who do not have a strong mathematics background. Not surprisingly, students majoring in non quantitative fields show greater mathematics anxiety than do students majoring in quantitative fields [7]. Benson [2], Hembree [11], Scitutto [21], and Zeidner [24] found that prior mathematics involvement was the strongest predictor of mathematics anxiety. Faust [7] found that social science students exhibited higher mathematics anxiety than physical science students.

In sum, the current mathematics anxiety literature indicates that number of previous mathematics courses and the presence or absence of a particular course might be important determinants of mathematics anxiety. However, limited number of studies investigated the effects of specific mathematics courses completed on the levels of mathematics anxiety. In the present study, previous mathematics experiences were measured as different mathematics courses completed at junior high school, senior high school, and college levels. The purpose of the study was to investigate whether current mathematics anxiety levels were affected by those previously completed mathematics courses.

2. METHOD

2.1. Participants

Participants of the present study were enrolled in introductory statistics courses, at the time of administration, at different states universities in the states of Texas and Kansas. Of the total 246 voluntary students, there were 183 (74.4%) women and 63 (25.6%) were men. Participants' age ranged from 18 to 57 years with a mean of 27.15 years ($SD = 8.84$). In terms of college status, 2 (0.8%) were freshmen, 20 (8.2%) were sophomores, 74 (30.2%) were juniors, 94 (38.4%) were seniors, and 55 (22.4%) were graduate students. One student did not indicate her college status. A variety of study majors were represented in the present study; however, the majority of the students (71.1 %) were in social sciences, followed by students majoring in business (9.3%) and science (6.5%).

2.2. Instruments

In addition to a demographic information sheet, a list that included commonly offered mathematics courses at junior/senior high schools and colleges was distributed to the participants. Students were asked to indicate the mathematics courses that they have completed at each level. List included General Mathematics, Business Mathematics, Beginning Algebra, Geometry, Advanced Algebra, Trigonometry, Mathematics Review for Calculus, Probability, Beginning Calculus, and Advanced Calculus. These courses were also rated and rank ordered by three mathematics professors according to their complexity, from *lower level or simplest* (1) to *upper level or most complex* (10). Then the average of three rating was found as: General Mathematics (1), Beginning Algebra (2), Business Mathematics (3), Geometry (4), Advanced Algebra (5), Trigonometry (5), Mathematics Review for Calculus (5), Beginning Calculus (8), Probability (8), and Advanced Calculus (10).

Also completed was the Revised Mathematics Anxiety Rating Scale (RMARS) [1]. The RMARS is a 25-item, 5-point, Likert-type self-report that measures anxiety related to mathematics under three categories: Mathematics course anxiety, mathematics test anxiety, and numerical anxiety. Higher scores on the instrument indicate higher levels of mathematics anxiety. Construct validity of the instrument was established using a sample of 517 undergraduate students, of whom 62 participants were also retested for reliability

purposes. A principal component analysis using squared multiple correlations as the initial communality estimates and a varimax rotation of the 69-item version of the Mathematics Anxiety Rating Scale (MARS) [19] revealed three factors: Mathematics Test Anxiety (15 items), Numerical Anxiety (5 items), and Mathematics Course Anxiety (5 items). These factors accounted for 31% of the total variance. The RMARS was highly related to MARS ($r = .93$, $p < .01$). It was also compared with the Mathematics Anxiety Scale [8] and negative relations were found, which meant that students who had favorable attitudes toward mathematics experienced lower mathematics anxiety. Moore, Alexander, Redfield, and Martray [15] found high-to-moderate correlations between the RMARS and the Mathematics Anxiety Scale [8]. Alexander and Martray [1] found that students who completed an algebra ($F = 18.07$, $p < .001$) and a geometry ($F = 25.60$, $p < .001$) course in high school received significantly lower RMARS scores compared to students who did not complete these courses. Moore et al. [15] also found that the RMARS was significantly correlated with the American College Testing (ACT) mathematics scores and mathematics course grades. Coefficient alpha reliabilities of the RMARS were found to be .96 for Mathematics Test Anxiety, .86 for Numerical Anxiety, and .84 for Mathematics Course Anxiety.

2.3. Procedures

Students signed a release form granting permission to use their responses for research purposes. They also provided demographic data about themselves (i.e., gender, age, and college status). In order to ensure confidentiality, participants were asked to write no identifying information on the packets. Survey packets were distributed during the class hours and returned at the next class meetings. Upon completion, the survey packets and consent forms were collected and the participants were debriefed. Debriefing included a statement of appreciation for participation and a brief description of the study. Data were screened for the accuracy and, then, for the assumptions of parametric statistics. Normality, homogeneity of variance, and linearity assumptions were tested at univariate, bivariate, and multivariate level.

3. RESULTS

Students' mathematics anxiety scores ranged from 25 to 109 with a mean of 64.16 ($SD = 18.27$). Current mathematics anxiety levels were

age, gender, college status, and major and no significant differences were found. Gender differences in mathematics anxiety were investigated. Even though women showed slightly higher ($M = 64.39$, $SD = 18.86$) mathematics anxiety than men ($M = 63.57$, $SD = 16.57$), the difference was not statistically significant ($t = .30$, $p < .77$). Students' mathematics anxiety levels were also compared based on their college status (i.e., freshmen, sophomore, junior, and etc.) and no significant differences were found ($F_{(4,241)} = 1.07$, $p < .37$). No significant differences ($F_{(3,242)} = 1.06$, $p < .37$) in mathematics anxiety were found among business ($M = 67.96$, $SD = 15.48$), social science ($M = 64.30$, $SD = 18.58$), and science majors ($M = 58.74$, $SD = 16.08$).

General mathematics, beginning algebra, and geometry were the most commonly completed courses in junior high schools. Two hundred seventeen students (88.2%) completed a general mathematics, 150 (61.0%) a beginning algebra, and 45 (18.3%) a geometry course. The most commonly completed senior high school mathematics courses were geometry (69.5%), advanced algebra (56.5%), beginning algebra (52.4%), and general mathematics (44.3%). About half of the students were enrolled in a beginning and an advanced algebra course in their college years. The least commonly enrolled mathematics courses at college level were trigonometry (13.8%), advanced calculus (7.7%), geometry (6.9%), and mathematics review for calculus (6.5%).

Independent *t*-tests investigated whether taking or not taking a certain mathematics course made a significant difference on the current mathematics anxiety levels (Table 1). [Insert Table 1 about here]

Students who completed a specified mathematics course were experiencing significantly lower mathematics anxiety than those who did not complete those courses. However, students who took college level general mathematics or beginning algebra courses were experiencing significantly higher mathematics anxiety than students who did not enroll in those courses.

4. DISCUSSION

In the present study, the effects of previously completed mathematics courses on students' current mathematics anxiety levels were investigated. An important reminder is that the participants of the present study were students enrolled in introductory statistics

compared on different demographic variables such as age, gender, college status, and major and no significant differences were found. These findings are in line with several other recent studies [6, 18]. These findings cast suspicion on the common belief that women experience higher mathematics anxiety compared to men. Similarly, contrary to other researchers [e.g., 7, 24], the present study failed to confirm that social science majoring students experience higher mathematics anxiety levels compared to other majors. Results support Hembree [11], Sciutto [21], and Zeidner [24] that the previous mathematics experience (measured as number of previous mathematics courses completed) significantly affect students' present mathematics anxiety levels.

Students' previous mathematics experiences included courses completed in junior high school, senior high school, and college. Independent *t*-tests compared the two groups of students on current mathematics anxiety levels and significant group differences were found. At junior high school level, students who completed beginning algebra and geometry courses were experiencing significantly lower mathematics anxiety than those who did not complete these courses. Senior high school advanced algebra, trigonometry, mathematics review for calculus, and beginning and advanced calculus courses affected students' current anxiety levels significantly. Again, students who completed these high school mathematics courses were experiencing lower anxiety.

At college level, there was a difference in terms of the effect of previous mathematics courses. Students who completed advance level courses such as trigonometry, math review for calculus, beginning calculus, and advance calculus were experiencing significantly lower mathematics anxiety than others who did not complete these courses. On the other hand, lower level college mathematics courses had a negative effect on anxiety. Students who completed college level general mathematics and beginning algebra were found to experience significantly higher mathematics anxiety than those who did not take these courses in college.

The results of the present study suggest that upper level (i.e., complex) mathematics courses are not common at junior high school level. Lower level (simple) high school mathematics do not have significant effect on the students' current mathematics anxiety levels; however, upper level courses do have such effects. A general-type of mathematics course does not reduce or increase students' current mathematics anxiety levels. However, students who have completed

Table 1
Means, Standard Deviations^a, and Significant^b Group Differences in Mathematics Anxiety Scores Depending on Mathematics Courses Completed at Junior/Senior High School or College

Courses	Mathematics Courses at										
	Junior High School				Senior High School				College		
	Not taken	t	Taken	t	Not taken	t	Taken	t	Not taken	t	
General Mathematics									62.4 (18.0)	69.3 (18.2)	-2.62**
Beginning Algebra	68.9 (17.3)	61.2 (18.3)	3.29*		62.0 (18.3)				62.0 (18.3)	66.8 (17.9)	-2.10***
Geometry	65.2 (18.2)	59.6 (18.2)	1.88***								
Advanced Algebra				68.4 (19.1)	60.9 (16.9)	3.24*					
Trigonometry				69.0 (17.8)	56.9 (16.6)	5.35*			65.7 (18.1)	54.6 (16.5)	3.35*
Math Review for Calculus				65.4 (18.2)	58.1 (17.6)	2.37*			64.8 (18.3)	54.4 (15.0)	2.23***
Beginning Calculus				66.2 (18.1)	59.1 (16.6)	2.78*			65.8 (18.4)	57.1 (16.3)	2.95**
Advanced Calculus				65.0 (18.2)	54.8 (16.0)	2.49*			65.0 (18.1)	53.8 (17.0)	2.59**

* $p < .001$ ** $p < .01$ *** $p < .05$ ^a Within parentheses are standard deviations ^b Non-significant differences are not reported

more specific mathematics courses in senior high school and college display significantly lower mathematics anxiety levels. It may be said that those students who do not have strong negative feelings toward mathematics (i.e., anxiety) are more likely to attend these courses. It might also be argued that because of these previous experiences those students feel lower anxious in mathematics.

An interesting finding in the present study was that students who were enrolled in a general mathematics or a beginning algebra course at college level were currently experiencing significantly higher mathematics anxiety compared to students who have not completed these courses. One could argue that these general-type mathematics courses are usually required rather than voluntarily taken, which might be factor that induces anxiety. Also, these type general college mathematics classes are usually crowded and fast-pace courses, which does not provide a pleasant learning environment especially for students who already have difficulties in mathematics.

In sum, previous mathematics courses seem to have a significant effect (positive or negative) on students' current anxiety levels. This information should be useful for mathematics instructors at all levels. Instructors can take a look at their students' specific mathematics courses and expect that students with more previous mathematics experience face lower mathematics anxiety. However, more studies are needed to investigate the effects of even earlier mathematics courses such as elementary school or pre-school. Finally the biggest limitation of the present study is that the current anxiety levels were measured by only a self-report instrument. Mathematics anxiety can also be measured by other means (i.e., physical measures or teacher ratings) and be investigated.

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