# THE RELATIONSHIPS BETWEEN MATH ANXIETY, MATH ATTITUDES, AND SELF-EFFICACY: A STRUCTURAL EQUATION MODEL

Ahmet AKIN[1], Izzet N. KURBANOGLU[2]

[1]Sakarya University, Faculty of Education, Department of Psychological Counseling and Guidance
54300 Hendek/Sakarya, Turkey
E-mail: aakin@sakarya.edu.tr

[2]Sakarya University, Faculty of Education, Department of Science Education
54300 Hendek/Sakarya, Turkey
E-mail: kurbanoglu@sakarya.edu.tr

*Abstract:* The purpose of this study is to examine the relationships between math anxiety, math attitudes, and self-efficacy. Participants were 372 university students who were enrolled in Sakarya University, in Turkey. In this study, the Revised Mathematics Anxiety Rating Scale, the Mathematics Attitudes Scale, and the Self-efficacy Scale were used. Using correlation analysis, math anxiety was found negatively related to positive attitudes and self-efficacy and positively to negative attitudes. On the other hand, positive attitudes were found positively associated with self-efficacy and negatively with negative attitudes. According to the path analysis results, positive attitudes were predicted positively and negative attitudes predicted negatively by self-efficacy. Also, self-efficacy and positive attitudes predicted math anxiety in a negative way and negative attitudes predicted math anxiety in a positive way. Results were discussed in the light of literature.

*Key words:* math anxiety, self-efficacy, math attitudes, path analysis

Research in mathematics education has shown that math anxiety negatively affects the students' success (Thomas, Higbee, 1999), their learning processes (Aiken, 1970, 1976; McLeod, 1988; Sloan, Daane, Geisen, 2002; Vinson, 2001) and is a frequent problem faced by educators (Bursal, Paznokas, 2006; Singh, Granville, Dika, 2002; Zettle, Raines, 2002). Researchers have tackled this structure from different perspectives and have come up with several definitions in their studies. Smith (1997) defines math anxiety as students' restlessness during mathematical operations and their fear thereof, fright of failing exams and experience of physical stress rather than as negative math attitudes or dislike for mathematics. Among prominent researchers in math anxiety, Richardson and Suinn (1972), approaching from a more general perspective, describe math anxiety as "the feeling of tension that hampers the use of numbers and solving mathematical operations in individuals' daily life and in their academic ambits" (p. 551). These definitions indicated that math anxiety is a situation of agitation that the individual encounters during mathematics learning; conceived as a threat to the self-esteem, causing the individual to develop negative attitudes towards mathematics (Bursal, Paznokas, 2006;

Gresham, 2004; Hembree, 1990; Kelly, Tomhave, 1985; Tobias, 1998; Zettle, Raines, 2002).

While in earlier studies (Aiken, 1960) math anxiety was conceptualized as one of the math attitudes, nowadays a majority of the researchers sustain the idea that this structure should be investigated independent of math attitudes. McLeod (1992) asserts that "the term 'attitude' is not sufficient in explaining students' deep emotions and feelings as anxiety, trust, disappointment, and satisfaction during mathematics classes" (p. 576). The debate regarding the dimensions of math anxiety has been carried on for a long time. Some researchers sustain that this structure is multi-dimensional while others argue that math anxiety is a form of test anxiety particular to the field (Brush, 1978). Moreover, some researchers (Ho et al., 2000; Kazelskis et al., 2000) consider test anxiety one of the factors that contribute to math anxiety.

As an unreasonable fear towards mathematical operations and mathematics classes, math anxiety hinders students' mathematics learning, thinking positive about mathematics, and feeling calm. This fear causes low self-esteem, disappointment, and academic failure (Tobias, 1998; Gresham, 2004). Several symptoms, such as panic, thinking of failure, tension, annoyance, doubt, fear, despair, shame, feeling of failure, palm sweating, nausea, tension in stomach, difficulty in breathing, inadequacy in listening to the teacher, inability to concentrate, discomfort using words related to mathematics, and negative internal speaking could be listed as indicators of math anxiety (Austin, Wadlington, 1992; Bursal, Paznokas, 2006; Dutton, Dutton, 1991; Hembree, 1990). Moreover, it was found that math anxiety negatively affects students' level of mathematics use, their willingness to develop advanced mathematics knowledge and skills, and choosing an occupation related to mathematics in the future (d'Ailly, Bergering, 1992; Dutton, Dutton, 1991; Richardson, 1980; Segeler, 1986). Ashcraft, Kirk and Hopko (1998) state that math anxiety is harmful to working memory which is an important predictor in mathematics achievement.

Studies demonstrate that math anxiety is related to a series of variables such as working memory (Ashcraft, Kirk, 2001), age (Gierl, Bisanz, 1995), sex (Bradley, Wygant, 1998), self-efficacy (Pajares, Graham, 1999), math attitudes (Betz, 1978), test anxiety (Kazelskis et al., 2000), and general anxiety (Zettle, Raines, 2000). While some studies investigating gender differences in terms of math anxiety (Betz, 1978; Dew, Galassi, Galassi, 1984; Wigfield, Meece, 1988) show that the girls experience math anxiety more than the boys, other studies (Zettle, Houghton, 1998), however, assert that there is no significant difference between female and male students in the levels of math anxiety.

Research studies indicated that math anxiety is closely related to a broad spectrum of cognitive, psychological, and behavioral problems. Studies about the consequences of math anxiety (Armstrong, 1985; Betz, 1978; Brush, 1978; Burton, 1979; Donady, Tobias, 1977; Hembree, 1990; Hendel, 1980; Ho et al., 2000; Ma, 1999; Preston, 1986; Richardson, Suinn, 1972) found that individuals experiencing this type of anxiety feel impotent in mathematical operations, avoid mathematics classes, feel shame and guilt, will terminate learning mathematics even though they have the ability to do so, develop negative attitudes towards activities and operations related to mathematics, avoid occupations that

necessitate quantitative knowledge and skills, and dislike mathematics even when they become teachers. Moreover, many scholars point out that math anxiety seriously harms the performance of the individual. For instance, studies that tackled adults (Quilter, Harper, 1988), university students (Betz, 1978; Frary, Ling, 1983), and primary and secondary school students (Chiu, Henry, 1990; Lee, 1992; Meece, Wigfield, Eccles, 1990) demonstrate that math anxiety is negatively related to mathematical performance.

Of all these negative consequences of math anxiety, the area that raises most interest and debate on the part of researchers is the negative relationship between math anxiety and success in mathematics. This relationship demonstrates that success in mathematics is low among students with high math anxiety (Ho et al., 2000; Lee, 1992; Satake, Amato, 1995; Tocci, Engelhard, 1991). The meta-analysis study in which Hembree (1990) examines 51 studies in the area of math anxiety found that the relationship between math anxiety and success in mathematics is -.34. In a more recent study, which examines 26 studies in the area of math anxiety, Ma (1999) documented that this relationship in pre-college sample is -.27.

Math anxiety is also closely related to math attitudes. The attitude towards mathematics has been defined as an aggregated measure of "a liking or disliking of mathematics, a tendency to engage in or avoid mathematics activities, a belief that one is good or bad at mathematics and a belief that mathematics is useful or useless" (Neale, 1969, p. 623). The studies in this field (Betz, 1978; Bourquin, 1999; Meece, Wigfield, Eccles, 1990; Pajares, Miller, 1994; Ramirez, Dockweiler, 1987; Richardson, Suinn, 1972; Wigfield, Meece, 1988) demonstrate that there is a negative relationship between math anxiety and positive attitudes towards mathematics. However, research literature has failed to provide consistent findings regarding the relationship between math attitude and math achievement. A number of researchers (Abrego, 1966; Vachon, 1984; Wolf, Blixt, 1981) have demonstrated that the association between math attitude and math achievement is fairly low and they have concluded that attitude-achievement relationship is weak and cannot be regarded to be practically significant. Contrarily, Steinkamp (1982) suggested that the basic variables determining achievement in mathematics are math attitudes.

Another important construct related to math anxiety is self-efficacy. Self-efficacy expectations are a person's beliefs concerning his or her ability to successfully perform a given task or behavior and they are a major determinant of whether a person will attempt a given task. These expectations also indicate how much effort will be expended and how much persistence will be displayed in pursuing the task in the face of obstacles. According to the self-efficacy theory, perceived self-efficacy influences and is in turn influenced by thought patterns, affective arousal and choice behavior as well as task performance (Bandura, 1977, 1986). From the perspective of social learning theory, self-efficacy expectations are proposed to be an even more important factor influencing math attitudes and math anxiety (Bandura, 1977; Hackett, Betz, 1981). Studies (Bandura, 1986; Pajares, 1996; Schunk, 1991) have demonstrated that self-efficacy beliefs predict students' mathematics performances and whether these performances are assessed as criterion - referenced test scores or achievement indexes. Typically, self-efficacy predicts mathematics performances to a greater

degree than does previous math experience (Hackett, 1985; Pajares, Miller, 1995) or self-efficacy for self-regulatory practices (Zimmerman, Bandura, Martinez-Pons, 1992). Pajares and Kranzler (1995) found that the influence of self-efficacy on math performance was as strong as was the influence of general mental ability. Across ability levels, students whose self-efficacy is higher are more accurate in their mathematics computation and show greater persistence on difficult items than do students whose self-efficacy is low (Collins, 1982). Pajares and Graham (1999) and Bourquin (1999) found that self-efficacy is associated negatively with math anxiety.

## THE PRESENT STUDY

Self-efficacy can be regarded as playing a crucial role on math attitudes and math anxiety. Also math anxiety may be influenced by math attitudes. For this reason, the present research aims at examining the relationships between math anxiety, math attitudes, and self-efficacy. Based on the relationship of self-efficacy with math attitudes and math anxiety (Bandura, 1977; Hackett, Betz, 1981) we hypothesized that math anxiety and negative attitudes would be associated negatively and positive attitudes positively with self-efficacy. Also, since studies (Betz, 1978; Bourquin, 1999; Meece, Wigfield, Eccles, 1990; Pajares, Miller, 1994; Ramirez, Dockweiler, 1987; Richardson, Suinn, 1972; Wigfield, Meece, 1988) display a negative relationship between math anxiety and positive attitudes we assumed that math anxiety would be related positively to negative attitudes and negatively to positive ones. This model is represented schematically in Figure 1.

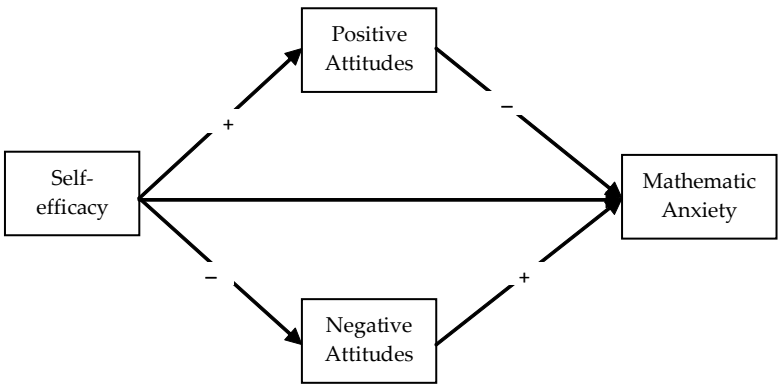


Figure 1. Hypothesized model of the relationship among mathematics anxiety, attitudes towards mathematics, and self-efficacy

## METHOD

### *Participants*

The participants were 372 university students [217 (58%) females, 155 (42%) males] who were enrolled in mid-size state university, in Turkey. Their ages ranged from 18 to 26 years and the mean age of the participants was 20.5 years.

### *Measures*

*The Revised Mathematics Anxiety Rating Scale* (R-MARS; Plake, Parker, 1982). This scale is a 24-item self-report measurement and consists of two subscales; numerical anxiety and mathematics test anxiety. Items are rated on a discrete scale from one to five with descriptions ranging from *not at all* to *very much.* Turkish adaptation of this scale was done by Akın, Kurbanoğlu, Takunyacı (2009). Language validity findings indicated that the correlation between Turkish and English forms was .79. The internal consistency coefficient of the scale was .93 and test-retest reliability coefficient was .91.

*Mathematics Attitudes Scale* (Aşkar, 1986). This scale has 20 items and two subscales; positive attitudes (10 items) and negative attitudes (10 items). Each item was rated on a 5-point Likert scale (1= *unsuitable to me* to 5 = *definitely suitable to me*). The internal consistency reliability coefficient of the scale was .96.

*Self-efficacy Scale.* Self-efficacy was measured by using the Turkish version of the Self-efficacy subscale of the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, McKeachie, 1991). Turkish adaptation of this scale was done by Büyüköztürk, Akgün, Özkahveci, Demirel (2004). The Self-efficacy subscale consists of eight items and each item was rated on a 7-point scale (1 = *not at all true for me* to 7 = *very true for me*). As a result of factor analysis in construct validity, it was found that factor loadings of items were between .52 to .65. In the reliability study, the internal consistency alpha coefficient was calculated as .86.

### *Procedure*

Permission for participation of students was obtained from the appropriate departmental heads and students' participation in the research was voluntary. Completion of the scales was anonymous and confidentiality was guaranteed. The scales were administered to the students in groups in the classrooms. The measures were counterbalanced in the administration. Prior to the administration of the scales, all participants were told about the purpose of the study. In this research, Pearson Correlation Coefficient and Structural Equation Modeling (SEM) was utilized to determine the relationship between math anxiety, math attitudes, and self-efficacy. These analyses were carried out via LISREL 8.54 (Jöreskog, Sorbom, 1996) and SPSS 11.5.

## RESULTS

### *Descriptive Data and Inter-Correlations*

Table 1 shows the means, descriptive statistics, inter-correlations, and internal consistency coefficients of the variables used.

When Table 1 is examined, it is apparent that there are significant correlations between math anxiety, math attitudes, and self-effi-

Table 1. Descriptive statistics, alphas, and inter-correlations of the variables

| Variables | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. Mathematics anxiety | 1.00 | | | |
| 2. Positive attitudes | -.52** | 1.00 | | |
| 3. Negative attitudes | .61** | -.75** | 1.00 | |
| 4. Self-efficacy | -.49** | .55** | -.53** | 1.00 |
| Mean | 52.93 | 36.83 | 22.74 | 40.48 |
| Standard deviation | 16.81 | 8.46 | 8.08 | 9.75 |
| Alpha | .93 | .91 | .87 | .92 |

**p < .01

cacy. Math anxiety related negatively to positive attitudes (r = -.52, p < .01) and self-efficacy (r = -.49, p < .01) and positively to negative attitudes (r = .61, p < .01). On the other hand, positive attitudes were found positively associated with self-efficacy (r = .55, p < .01) and negatively with negative attitudes (r = -.75, p < .01). Furthermore, negative attitudes related negatively to self-efficacy (r = -.53, p < .01).

*Structural Equation Modeling*

To test the hypothesis model [a) Math anxiety and negative attitudes would be associated negatively and positive attitudes positively with self-efficacy; b) Math anxiety would be related positively to negative attitudes and negatively to positive ones], SEM was used. Using SEM, all the param-

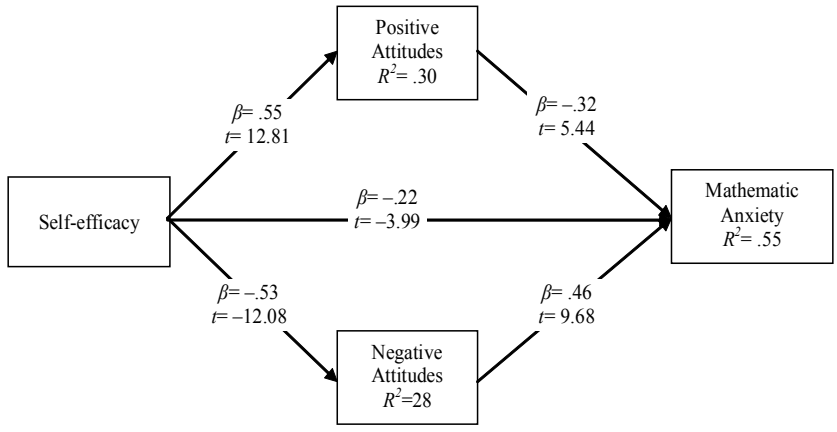


Figure 2. Path analysis between mathematics anxiety, attitudes towards mathematics, and self-efficacy

eters of models can be tested simultaneously in one step. The specifications on the model were for direct paths from self-efficacy to math attitudes and math anxiety and from math attitudes to math anxiety. The results of testing whether self-efficacy has a direct effect on math attitudes and math anxiety and whether math attitudes have a direct effect on math anxiety are presented in Figure 2.

Figure 2 shows that the model fit well ($\chi^2$ = 1.79, df = 1, p = .18052, GFI = .99, AGFI = .99, CFI = .98, NFI = 1.00, RFI = 1.00, IFI = 1.00, SRMR = .019 and RMSEA = .030) and also accounted for 30% of the positive attitudes, 28% of the negative attitudes, and 55% of the math anxiety variances. The standardized coefficients in Figure 2 clearly showed that positive attitudes were predicted positively ($\beta$ = 0.55) and negative attitudes predicted negatively ($\beta$ = -0.53) by self-efficacy. Also, self-efficacy and positive attitudes predicted math anxiety in a negative way ($\beta$ = -0.22 and $\beta$= -0.32, respectively) and negative attitudes predicted math anxiety in a positive way ($\beta$ = 0.46).

## DISCUSSION

This study investigated the relationships between self-efficacy, math attitudes, and math anxiety. Self-efficacy and math attitudes were expected to be important determinants of math anxiety. It was hypothesized that math anxiety and negative math attitudes would be associated negatively and positive math attitudes positively with self-efficacy. It was also assumed that math anxiety would be related positively to negative math attitudes and negatively to positive ones. The results of correlation and SEM confirm these hypotheses and the importance of self-efficacy and mathematics attitudes for better understanding of math anxiety. Again, findings show self-efficacy as proximal determinant of math attitudes and math anxiety. In addition, the fact that the fit of the path model indexes was good indicated that the model was acceptable and that correlations among measures were explained by the model (Hu, Bentler, 1999).

Firstly, as hypothesized, the model delineated that math anxiety was predicted negatively by self-efficacy. This result is in agreement with both previous studies (Bourquin, 1999; Hackett, 1985; Pajares, Graham, 1999) investigating the relationships between math anxiety and self-efficacy and with Bandura's (1977, 1986) theory which states that affective arousal, such as anxiety, is a negative co-effect to self-efficacy. Bandura also suggests that self-efficacy is directly related to general confidence but is a more potent predictor of behavior than general confidence or other related global constructs. Furthermore, math anxiety can be considered a result of low self-efficacy, according to the social learning theory. A student who feels anxious about mathematics can almost feel incapable of doing mathematics. Similarly, the stronger the self-efficacy, the more active are one's efforts and the longer he or she will persist at a particular task or behavior in the face of obstacles. Thus, math anxiety could be an indicator of self-efficacy and higher anxiety in math is related to lower reported levels of self-efficacy.

Secondly, as expected, the results demonstrated that math anxiety was predicted positively by negative math attitudes and negatively by positive math attitudes. These findings are consistent with the results of previous research (Betz, 1978; Bourquin, 1999; Meece, Wigfield, Eccles, 1990; Pajares, Miller,

1994; Ramirez, Dockweiler, 1987; Richardson, Suinn, 1972; Wigfield, Meece, 1988) which found that there is a negative association between math anxiety and positive attitudes. Math anxiety is directly related to perceptions of one's own mathematical skills in relation to skills in other subject areas and with negative math attitudes (Wright, Miller, 1981). In other words, negative attitudes can produce negative results in mathematics thus creating math anxiety (Vinson, 2001). Also, when one considers that math anxiety is a state of discomfort which occurs in response to situations involving mathematical tasks which can often create a negative attitude toward the subject (Zettle, Raines, 2002), the relationships between math anxiety and math attitudes are easily understandable. That means that negative math attitudes promoted while positive ones decreased math anxiety.

Finally, as predicted, the model showed that self-efficacy predicted negative attitudes negatively and positive attitudes positively. Students' attitude is an important factor highly associated with success and motivation. Students with positive attitudes are more likely to sustain their efforts and have the desire to be involved in the learning tasks. Correspondingly, according to Bandura (1977), self-efficacy is one's belief in his/her capacity to perform a specific task. Individuals may assess their skills and capabilities prior to performing certain actions or activities. If individuals have high self-efficacy for carrying out certain activities, they are more likely to attempt doing those activities and to develop positive attitudes toward them. On the contrary, if individuals have low self-efficacy for carrying out some activities, they are less likely to attempt doing those activities and to develop negative attitudes toward them (Bandura, Adams, Beyer, 1977). In this context, the correlations found in this research seem reasonable.

It is extremely important to explain the limitations of this research. First of all, because this research intended to build a model rather than test a model that already exists, findings from the research are of explanatory characteristics. Therefore, if it is not tested on another sample, it is wise to avoid taking the findings as definite. Secondly, the samples presented here are limited to university students which restrict the generalizability of the findings. For that reason, it is also important to investigate the variables studied in this research using other sample groups besides university students. In addition, even though structural equation modeling suggests results related to causality, it is difficult to give a full explanation related to causality among the variables examined in the research, due to the use of correlational data.

Received July 9, 2010

## REFERENCES

ABREGO, M.B., 1966, Adolescents' attitudes toward mathematics. *Arithmetic Teacher,* 13, 206-208.

AIKEN, L.R., Jr., 1960, Mathemaphobia and mathemaphilia: An analysis of personal and social factors affecting performance in mathematics. *Dissertation Abstracts International,* 21, 1992A.

AIKEN, L., 1970, Attitudes toward mathematics. *Review of Educational Research*, 40, 551-596.

AIKEN, L.R., Jr., 1976, Update on attitudes and other affective variables in learning mathematics. *Review of Educational Research,* 46, 293-311.

AKIN, A., KURBANOĞLU, N.İ., TAKUNYACI, M., 2009, June, The validity and reliability study of Turkish version of the Revised Mathematics Anxiety Rating Scale. Paper presented at the *30th Stress and Anxiety Research Society Conference,* 16-18 June, Budapest, Hungary.

ARMSTRONG, J., 1985, A national assessment of participation and achievement in women in mathematics. In: S.F. Chipman, L.R. Brush, D.M. Wilson (Eds.), *Women and mathematics: Balancing the equation* (pp. 59-94). Hillsdale, NJ: Erlbaum.

ASHCRAFT, M.H., KIRK, E.P., 2001, The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General*, 130, 224-237.

ASHCRAFT, M., KIRK, E.P., HOPKO, D., 1998, On the cognitive consequences of mathematics anxiety. In: C. Donlan (Ed.), *The development of mathematical skills.* Hove: The Psychological Corporation.

AŞKAR, P., 1986, Development of a scale measuring attitudes towards mathematics. *Education and Science,* 62, 31-36.

AUSTIN, S., WADLINGTON, E., 1992, Effect of beliefs about mathematics on math anxiety and math self-concept in elementary teachers. *Education,* 112, 3, 390-396.

BANDURA, A., 1977, Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review,* 84, 191-215.

BANDURA, A., 1986, *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

BANDURA, A., ADAMS, N.E., BEYER, J., 1977, Cognitive processes mediating behavioral change. *Journal of Personality and Social Psychology,* 35, 125-139.

BETZ, N.E., 1978, Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology,* 25, 441-448.

BOURQUIN, S.D., 1999, The relationship among math anxiety, math self-efficacy, gender, and math achievement among college students at an open admissions commuter institution. *Dissertation Abstracts International, Section A: Humanities and Social Sciences*, 60(3-A): 0679.

BRADLEY, D.R., WYGANT, C.R., 1998, Male and female differences in anxiety about statistics are not reflected in performance. *Psychological Reports*, 82, 245-246.

BRUSH, L., 1978, A validation study of the mathematics anxiety rating scale (MARS). *Educational and Psychological Measurement,* 38, 485-490.

BURSAL, M., PAZNOKAS, L., 2006, Mathematics anxiety and pre-service elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics,* 106, 4, 173-79.

BURTON, G.M., 1979, Getting comfortable with mathematics. *The Elementary School Journal,* 79, 129-135.

BÜYÜKÖZTÜRK, [a]., AKGÜN, Ö., ÖZKAHVECI, Ö., DEMIREL, F., 2004, The validity and reliability study of the Turkish version of the Motivated Strategies for Learning Questionnaire. *Educational Science: Theory & Practice*, 4, 2, 207-239.

CHUI, L.H., HENRY, L.L., 1990, Development and validation of the Mathematics Anxiety Scale for Adolescents. *Measurement and Evaluation in Counseling and Development,* 23, 121-127.

COLLINS, J.L., 1982, March, Self-efficacy and ability in achievement behavior. Paper presented at the *meeting of the American Educational Research Association,* New York.

D'AILLY, H., BERGERING, A.J., 1992, Mathematics anxiety and mathematics avoidance behavior: A validation study of two MARS factor-derived scales. *Educational and Psychological Measurement,* 52, 2, 368-377.

DEW, K.M., H., GALASSI, J.P., GALASSI, M.D., 1984, Math anxiety: Relation with situational test anxiety, performance, physiological arousal, and math avoidance behavior. *Journal of Counseling Psychology,* 31, 580-583.

DONADY, B., TOBIAS, S., 1997, Math anxiety. *Teacher,* 95, 71-74.

DUTTON, W., DUTTON, A., 1991, *Mathematics children use and understand.* Mountain View, CA: Mayfield Publishing Company.

FRARY, R.B., LING, J.L., 1983, A factor-analytic study of mathematics anxiety. *Journal of Research in Mathematics Education,* 17, 145-150.

GIERL, M.J., BISANZ, J., 1995, Anxieties and attitudes related to mathematics in grades 3 and 6. *Journal of Experimental Education*, 63, 139-158.

GRESHAM, G., 2004, Mathematics anxiety in elementary students. *CMC Communicator,* 29, 2, 28-29.

HACKETT, G., 1985, The role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology,* 32, 47-56.

HACKETT, G., BETZ, N.E., 1981, A self-efficacy approach to the career development of women. *Journal of Vocational Behavior,* 18, 326-339.

HEMBREE, R., 1990, The nature, effects, and relief of math anxiety. *Journal of Research in Mathematics Education*, 21, 1, 33-46.

HENDEL, D.D., 1980, Experiential and affective correlations of math anxiety in adult women. *Psychology of Women Quarterly,* 5, 219-230.

HO, H., SENTURK, D., LAM, A.G., ZIMMER, J.M., HONG, S., OKAMOTO, Y., CHIU, S., NAKAZAWA, Y., WANG, C., 2000, The affective and cognitive dimensions of math anxiety: A cross-national study. *Journal for Research in Mathematics Education,* 31, 362-379.

HU, L.T., BENTLER, P.M., 1999, Cutoff criteria for fit indexes in covariance structural analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling,* 6, 1-55.

JORESKOG, K.G., SORBOM, D., 1996, *LISREL 8 reference guide*. Lincolnwood, IL: Scientific Software International.

KAZELSKIS, R., REEVES, C., KERSH, M.E., BAILEY, G., COLE, K., LARMON, M., HALL, L., HOLLIDAY, D.C., 2000, Mathematics anxiety and test anxiety: Separate constructs? *Journal of Experimental Education*, 68, 137-146.

KELLY, W., TOMHAVE, W., 1985, A study of math anxiety/math avoidance in pre-service elementary teachers. *Arithmetic Teacher,* 32, 5, 51-53.

LEE, B.Y., 1992, The effects of learner control and adaptive information in mathematics computer-assisted instruction on achievement and task-related anxiety. *Dissertation Abstracts International,* 52, 3236A.

MA, X., 1999, A meta-analysis of the relationship between anxiety and towards mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, 30, 502-540.

MCLEOD, D.B., 1992, Research on affect in mathematics education: A re-conceptualization. In: D.A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York: Macmillan.

MCLEOD, D., 1988, Affective issues in mathematical problem solving: Some theoretical considerations. *Journal for Research in Mathematics Education*, 19, 134-141.

MEECE, J.L., WIGFIELD, A., ECCLES, J.S., 1990, Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology,* 82, 60-70.

NEALE, D.C., 1969, The role of attitude in learning mathematics. *Arithmetic Teacher,* 16, 631-640.

PAJARES, F., 1996, Self-efficacy beliefs in academic settings. *Review of Educational Research,* 66, 543-578.

PAJARES, F., GRAHAM, L., 1999, Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology,* 24, 124-139.

PAJARES, F., KRANZLER, J., 1995, Self-efficacy beliefs and general mental ability in mathematical problem-solving. *Contemporary Educational Psychology,* 20, 426-443.

PAJARES, F., MILLER, M.D., 1994, The role of self-efficacy and self-concept beliefs in mathematical problem-solving: A path analysis. *Journal of Educational Psychology,* 86, 193-203.

PAJARES, F., MILLER, M.D., 1995, Mathematics self-efficacy and mathematics outcomes: The need for specificity of assessment. *Journal of Counseling Psychology,* 42, 190-198.

PINTRICH, P.R., SMITH, D.A.F., GARCIA, T., MCKEACHIE, W.J., 1991, *A manual for the use of the motivated strategies for learning*. Michigan: School of Education Building, The University of Michigan, (ERIC Document Reproduction Service No. ED338122).

PLAKE, B.S., PARKER, C.S., 1982, The development and validation of a revised version of the mathematics anxiety rating scale. *Educational and Psychological Measurement,* 42, 551-557.

PRESTON, P.A., 1986, Math anxiety: Relationship with sex, college major, mathematics background, mathematics achievement, mathematics performance, mathematics avoidance, and self-rating of mathematics ability as measured by the revised mathematics anxiety rating scale (RMARS). *Dissertation Abstracts International,* 47, A07, 2494.

QUILTER, D., HARPER, E., 1988, Why we didn't like mathematics, and why we can't do it. *Educational Research,* 30, 121-134.

RAMIREZ, O.M., DOCKWEILER, C.J., 1987, Mathematics anxiety: A systematic review. In: R. Schwarzer, H.M. van der Ploeg, C.D. Spielberger (Eds.), *Advanced in test anxiety research* (Vol. 5, pp. 157-175). Berwyn, PA: Swetz North America.

RICHARDSON, S., 1980, Effectiveness of rational-emotive therapy or problem-solving/relaxation in reducing math anxiety and/or improving attitudes toward math in potential elementary school teachers. *Dissertation Abstracts International,* 41, 10, 4340A.

RICHARDSON, R., SUINN, R., 1972, The Mathematic Anxiety Rating Scale. Psychometric data. *Journal of Counseling Psychology,* 19, 551-554.

SATAKE, E., AMATO, P.P., 1995, Mathematics anxiety and achievement among Japanese elemen-

tary school students. *Educational and Psychological Measurement,* 55, 1000-1008.

SCHUNK, D.H., 1991, Self-efficacy and academic motivation. *Educational Psychologist,* 26, 207-231.

SEGELER, E., 1986, Effectiveness of transactional analysis training in improving mathematics achievement, reducing math anxiety, and changing associated negative attitudes and attributions for failure (learned helplessness, developmental math). *Dissertation Abstracts International,* 47, A10, 3691.

SINGH, K., GRANVILLE, M., DIKA, S., 2002, Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research*, 95, 323-332.

SLOAN, T., DAANE, C., GEISEN, J., 2002, Mathematics anxiety and learning styles: What is the relationship in elementary pre-service teachers? *School Science and Mathematics*, 84-87.

SMITH, S., 1997, *Early childhood mathematics*. Boston: Allyn & Bacon.

STEINKAMP, M.W., 1982, Sex-related differences in attitude toward science: A quantitative synthesis of research. Paper presented in the *Annual meeting of the American Educational Research Association,* New York.

THOMAS, P., HIGBEE, J., 1999, Affective and cognitive factors related to mathematics achievement. *Journal of Developmental Education,* 23, 1, 8-16.

TOBIAS, S., 1998, Anxiety and mathematics. *Harvard Education Review,* 50, 63-70.

TOCCI, C.M., ENGELHARD, G., 1991, Achievement, parental support, and gender differences in attitudes towards mathematics. *Journal of Educational Research,* 84, 5, 280-286.

VACHON, J., 1984, Attitudes: Their relationship with intelligence and achievement and their evaluation. Paper presented at the *NATO Scientific Affairs Committee Advanced Study Institute,* Athens, Greece.

VINSON, B., 2001, A comparison of pre-service teachers mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education Journal,* 29, 2, 89-94.

WIGFIELD, A., MEECE, J.L., 1988, Math anxiety in elementary and secondary school students. *Journal of Educational Psychology,* 80, 210-216.

WOLF, F.M., BLIXT, S.L., 1981, A cross-sectional gross-lagged panel analysis of mathematics achievement and attitudes: Implications for the interpretation of the direction of predictive validity. *Educational and Psychological Measurement,* 41, 829-834.

WRIGHT, D., MILLER, D., 1981, *Math anxiety: A research report.* (ERIC Document Reproduction Service No. ED 212 465).

ZETTLE, R.D., HOUGHTON, L.L., 1998, The relationship between mathematics anxiety and social desirability as a function of gender. *College Student Journal,* 32, 1, 81-86.

ZETTLE, R., RAINES, S., 2002, The relationship of trait and test anxiety with mathematics anxiety. *College Student Journal*, 34, 246-258.

ZIMMERMAN, B.J., BANDURA, A., MARTINEZ-PONS, M., 1992, Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal,* 29, 663-676.

## VZŤAH MEDZI STRACHOM Z MATEMATIKY, POSTOJMI K MATEMATIKE A SELF-EFFICACY: MODEL ŠTRUKTURÁLNEJ ROVNICE

A. Akin, I. N. Kurbanoglu

*Súhrn:* Skúmali sme vzťah medzi strachom z matematiky, postojmi k matematike a self-efficacy. Výskumu sa zúčastnilo 372 študentov univerzity v Sakarii, Turecko. V štúdii sme použili Revised Mathematics Anxiety Rating Scale, Mathematics Attitudes Scale a Self-efficacy Scale. Korelačná analýza odhalila negatívny vzťah strachu z matematiky k pozitívnym postojom a self-efficacy a pozitívny vzťah k negatívnym postojom. Naproti tomu, pozitívne postoje boli v pozitívnom vzťahu k self-efficacy a v negatívnom vzťahu k negatívnym postojom. Podľa výsledkov úsekovej analýzy predikovala self-efficacy pozitívne postoje pozitívne a negatívne postoje negatívne. Okrem toho self-efficacy a pozitívne postoje predikovali strach z matematiky negatívnym spôsobom a negatívne postoje predikovali strach z matematiky pozitívnym spôsobom. Výsledky sme diskutovali s ohľadom na použitú literatúru.