The Adaptation of the Mathematics Anxiety Rating Scale-Elementary Form into Turkish, Language Validity, and Preliminary Psychometric Investigation

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Abstract

The purpose of the present study was to adapt the Mathematics Anxiety Rating Scale-Elementary Form (MARS-E, Suinn, 1988) into Turkish by first doing the translation of its items and then the preliminary psychometric investigation of the Turkish form. The study included four different samples: 30 bilingual language experts, 50 Turkish language experts, 50 mathematics subject matter experts, 21 school counselors, and 336 elementary school students. After each item was independently translated into Turkish by three experts, the accuracy of the translation was investigated. Next, the Turkish form was studied in terms of understandability. In order to study, the Turkish form's preliminary properties, the scale was administered to 336 elementary school students. Results showed evidence for language validity, structural validity, content validity, and concurrent validity. In addition, the Turkish form's items were found to have acceptable internal consistency reliabilities. Results were discussed in relation to previous mathematics anxiety literature. It is concluded that the Turkish MARS-E appears to be a valid and reliable instrument in measuring mathematics anxiety levels of Turkish elementary school children.

Key Words

Mathematics Anxiety, Language Validity, Mathematics Anxiety Rating Scale-Elementary, MARS-E.

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Reseach on mathematics anxiety have started in the 1950s with the personal observations of mathematics teachers. In 1956, Dreger and Aiken formally defined mathematics anxiety as "an emotional syndrome response to arithmetics and mathematics" (p. 344). Even though mathematics anxiety has been conceptualized to be a difficult construct to measure; nonetheless, several attempts have been made to assess it in the literature. Atkinson (1988) described three distinct periods in the measurement of mathematics anxiety. In the first period, most studies were merely the authors' opinions and did not employ any standardized mathematics anxiety measures. During this period, an awareness of anxiety about mathematics arose and mathematics anxiety was being defined (e.g. Gough, 1954). Next, studies focused on assessing attitudes toward mathematics through surveys that included several variables such as state-trait anxiety, confidence, enjoyment, misconceptions, and attitudes toward mathematics (e.g., Dutton, & Blum, 1968). The third period saw the development and refinement of the standardized mathematics anxiety instruments.

The first mathematics anxiety instrument, the Number Anxiety Scale, was developed by Dreger and Aiken in 1957 from a modification of the Taylor Manifest Anxiety Scale (Taylor, 1953). Afterwards, more comprehensive scales such as the Mathematics Anxiety Rating Scale (MARS; Richardson, & Suinn, 1972), the Fennema-Sherman Mathematics Attitudes Scales (Fennema, & Sherman, 1976), the Anxiety toward Mathematics Scale (Sandman, 1980) and the Mathematics Anxiety Questionnaire (Wigfield, & Meece, 1988) were developed.

Of the all mathematics anxiety measures listed above, the MARS (Richardson & Suinn, 1972) has consistenly been the most frequently employed mathematics anxiety measure in the literature. The MARS is a 98-item, 5-point, Likert-type instrument that assesses the levels of anxiety in situations involving numbers (Richardson, & Suinn, 1972). The instrument asks participants to rate each item for "how much [they] are frightened by [mathematics] nowadays" (Richardson, & Suinn, 1972, p. 1). The sum of the items gives a total score, where higher scores indicate higher levels of mathematics anxiety (Richardson, & Suinn, 1972). This measure has also been translated into many other languages and validated in other populations.

The validity and reliability of the MARS have been extensively studied. The MARS scores had higher correlations with direct questions about

the intensity and persistence of mathematics anxiety (Camp, 1992) and lower correlations with physiological measures of anxiety (Dew, Galassi, & Galassi, 1984). The MARS was also found to have significant relationships with test anxiety (Dew et al., 1984; Rounds, & Hendel, 1980).

Concurrent validity of the MARS was found by Brush (1976). The MARS was correlated negatively with mathematics grades (r = -.29, p < .001), number of years of mathematics (r = -.44, p < .001), and number of years of calculus (r = -.21, p < .05), and is correlated positively with the reported dislike of mathematics (r = .39, p < .001). In addition, Brush (1980a) found that students who had higher mathematics anxiety avoided mathematics-related majors. Students who had the highest MARS scores were majoring in Humanities and Social Sciences, and those with the lowest scores were majoring in Physical Sciences. Correlations between the MARS and the Attitude toward Mathematics Scale (r = .67) and the MAS (r = .68) supported the instrument's validity (Brush, 1976).

Studies confirmed content validity of the MARS' single factor (e.g., Richardson & Suinn, 1972; Suinn, Edie, Nicoletti & Spinelli, 1972), two-factor (e.g., Alexander & Cobb, 1984; Brush, 1976, 1978, 1980a, 1980b; Plake & Parker, 1982; Rounds & Hendel, 1980; Resnick, Viehe, & Segal, 1982; Suinn, & Edwards, 1982), three-factor (Alexander & Martray, 1989; Ferguson, 1986; Resnick et al., 1982), or multi-factor structures (Bessant, 1995; Kazelskis, 1998; Ling, 1982; Satake & Amato, 1995). In the present study, single, two, and multi-factor structures of the MARS-E were tested. Also, two-week and seven-week test-retest reliability coefficients of the MARS were .78 and .85, respectively (Richardson, & Suinn, 1972). Dew, Galassi, & Galassi (1983) reported a two-week test-retest reliability of .87, and the internal consistency reliability of .97.

In order to assess the mathematics anxiety levels of elementary school students, an elementary form of the MARS (i.e., MARS-E) was developed by Suinn in 1988. The instructions of the MARS-E ask students to "circle among the items listed that may bother them or cause them to be nervous or anxious or tense when they have to do them." With the assumption that the students in the intended age group having very little experience in responding to such an instrument, the instrument helps students go through two examples before they start responding to the its items. Instrument includes 26 5-point Likert type items, such

as "being given a set of division problems to solve on paper" (item 20), that measure computational anxiety; "when counting how much change you should get back after buying something, how nervous do you feel?" (item 6) that measure anxiety in using mathematics in real life situations; "starting to read a hard new chapter for your math homework" (item 11) that measure mathematics course anxiety; "being asked by your teacher to tell how you got your answer to a math problem" (item 12) that measure mathematics teacher anxiety; and "taking a big test in you math class" (item 13) that measure mathematics exam anxiety. When the score from each item is added a total scale score is obtained which may range from zero and 104, higher scores indicating higher levels of mathematics anxiety.

A review of the national literature indicates that there is not any objective mathematics anxiety assessment instrument in elementary level that has appropriate psychometric properties and that can be used in national and international research. Therefore, the purpose of the present research was to translate the MARS-E which has been studied intensively in terms of its validity and reliability into Turkish and study the Turkish form's language validity. Consequently, the study intended to investigate the Turkish form's validity and reliability on a group of Turkish elementary school students.

Method

Sample

Four different samples were used in the study. The language validity of the instrument was studied in two phases. In the first phase, each item was studied in terms of Turkish-English translation validity. In the second phase, the Turkish form was studied in terms of language and meaning. In the first phase, English language experts who had graduate or undergraduate degrees in the English language; or were working as faculty at colleges or universities; or obtained graduate or undergraduate degrees in the U.S. or Great Britain participated in the study. In the first sample, a total of 30 language experts participated in the study.

The second phase included Turkish language experts who had undergraduate or graduate degrees in Turkish language and literature or were working as Turkish language teachers, or studying Turkish language as graduate students. In this group, a total of 63 Turkish language experts rated the understandability of the Turkish scale.

The third sample consisted of 71 mathematics experts who rated mathematics anxiety items in terms of their ability to measure the construct of mathematics anxiety. Experts in this phase were either mathematics teachers, graduate students in mathematics, or school counselors.

After the language validity studies were completed, a group of Turkish elementary school students were selected and studied as a sample. These students were selected from the population of students who were enrolled in elementary schools in Tokat, Turkey. There were 336 elementary school students in the sample, 213 boys and 123 girls. The ages of the students ranged from 8 years to 15 years ($\bar{x}$= 12.19, *SS* = 1.63). In the sample, there were 12 third graders (3.6%), 42 fourth graders (12.5%), 38 fifth graders (14.3%), 52 sixth graders (15.5%), 74 seventh graders (22.0%), and 108 eighth graders (32.1%).

Instrument

The Mathematics Anxiety Rating Scale-Elementary form (MARS-E; Suinn, 1988), English-Turkish Translation Adequacy Rating Form, Turkish Understandability Rating Form, and Mathematics Anxiety Measurability Rating Form were used to collect the data. In addition, students rated their perceived self-achievement levels (i.e., low, medium, or high) and perceived stress levels (i.e., low, medium, or high).

Procedure and Analysis

The Turkish scale was investigated in terms of content validity and construct validity. Results obtained from experts were used in the content validity study. Results obtained from the pilot student sample were used for investigating construct validity and reliability. For construct validity, confirmatory factor analysis was performed. One-factor, two-factor, and five-factor structures were tested. Additionally, internal consistency coefficients (Cronbach α) were computed as evidence of reliability.

Two main software programs were used to analyze the data: Statistical Package for Social Sciences (SPSS) 17.0 (SPSS Inc, 2008) and Equations 6.2 (EQS Inc, 2004). Data were coded onto SPSS 17.0 database and arranged so that they could be transferred onto EQS 6.2. Data were screened for the assumptions of parametric statistics. Normality, homogeneity of variances, and linearity assumptions were tested at mul-

tivariate level. Content validity was studied by Lawshe content validity coefficients (Lawshe, 1975). Pearson product-moment correlation coefficients among the subscales and between the subscales and the total scale score were computed.

Confirmatory factor analyses were specified and estimated using EQS 6.2 (EQS Inc, 2004). A covariance matrix was computed using the 26 items of the Turkish MARS-E and model parameters estimated using maximum-likelihood method. All factors were allowed to correlate and no correlated errors were included in the estimation models. In order to evaluate the fit of the models, observed model covariances were compared with the null hypothesis model (Yadama & Pandey, 1995). Fit of any model was assessed by a non-significant x^2, Incremental Fit Index (IFI; Bollen, 1989) ≥ .90, Normalized Fit Index (NFI; Bentler & Bonett, 1980; Marsh, Balla, & McDonald, 1988) ≥ .80, Non-normalized Fit Index (NNFI; Bentler & Bonett, 1980) ≥ .90, Comparative Fit Index (CFI; Bentler, 1990) ≥ .90, Goodness-of-fit Index (GFI; Jöreskog & Sörbom, 1988; Marsh et al., 1988) ≥ .85, Adjusted Goodness-of-fit Index (AGFI; Marsh et al., 1988) ≥ .80 Standardized Root Mean Square of Errors < .10 (SRMR; Marsh, Balla, & McDonald, 1988), and Root Mean Square Error Approximation (RMSEA; Steiger, 1990; Bentler & Bonnet, 1980; Marsh, et al, 1988) < .10. As suggested, internal consistency coefficients for the total and subscales of the Turkish MARS-E were reported (Table 8).

Results

First, the items of the original English scale were translated and translation validity was investigated. Bilingual language experts read both the original items and the Turkish translations and rated the items between 0 (translation is not valid at all) and 10 (translation fits perfectly). The average rating for all 26 items was 9.61 (*SD* = .14). The item that received the lowest rating was "starting to read a hard new chapter for your math homework (Mean = 9.30, *SD* = .75). Of the 26 items, 21 items were rated over 9.50 or above. Out of 30 language experts, only two rated the English-Turkish translation accuracy below 9.00. Therefore, it can be concluded that translation validity was obtained at a very high level.

After the translation accuracy was confirmed and suggested changes

were made in some items, the Turkish language experts rated the Turkish items in terms of understandability by elementary school populations and Turkish grammar conformity. Results showed that the ratings ranged from 6.50 and 8.36 (Mean = 7.47; Median = 7.38; *SS* = .42), where the maximum possible rating was 10.00. Out of 50 experts, 24 rated the understandability of the items below 8.00. Out of all the items, "starting to read a hard new chapter for your math homework" had the lowest understandability rating (Mean = 6.50, *SD* = 2.96). The items' understandability ratings for all the items were presented in Table 2. In the next phase of the study, another bilingual expert back translated the Turkish items into English. In the last step, the original scale items and back-translated items were compared by two English language experts and found acceptable.

In summary, results showed that there is a high level of agreement between the English and Turkish items. The Turkish scale was found to be sound in its language structure and was rated as understandable by elementary school students. This concluded the translation and language adaptation part of the study.

Next, the Turkish scale was investigated in terms of content validity, concurrent validity and internal consistency reliability. This was not a full investigation of the Turkish scale's psychometric properties but a preliminary one.

For the structural validity of the MARS-E, confirmatory factor analysis (CFA) was used. EQS 6.2 (EQS Inc, 2004) was used for CFA and maximum-likelihood method was employed. Relevant literature shows mathematics anxiety as a single-factor (Dreger & Aiken, 1957; Richardson & Suinn, 1972), two-factor (Alexander & Cobb, 1984; Brush, 1976, 1978, 1980b; Plake & Parker, 1982; Rounds & Hendel, 1980), or multi-factor construct (Alexander & Martray, 1989; Bessant, 1995; Ferguson, 1986; Kazelskis, 1998; Ling, 1982; Resnick et al., 1982; Satake & Amato, 1995). In the present study, single, two, and multi-factor structures were tested. Results showed that one-factor and two-factor structures did not fit well with the data.

Multi-factor structure with a five-factor model showed a good fit. In this model, seven items (1, 2, 3, 4, 10, 19, and 20) loaded on mathematical computation anxiety; six items (5, 6, 21, 22, 23, and 24) loaded on application anxiety; three items (7, 11, and 14) loaded on mathematics

course anxiety; four items (8, 9, 12, 25, and 26) loaded mathematics teacher anxiety; and five items (13, 15, 16, 17, and 18) loaded on mathematics test anxiety. As it is seen in Table 3, the five-factor model of mathematics anxiety showed a good fit according to fit indecies. In addition, RMEA was found to be around .10.

In order to test the scales content validity, mathematics experts were asked to rate each item between zero (item does not measure mathematics anxiety at all) and a ten (item definitely measures mathematics anxiety). The average measurability rating was 5.82 (*SD* = 1.71) while ratings ranged from 3.03 to 8.87. Mathematics subject expert ratings (Mean = 5.66, *SS* = 1.74) were higher than school counselors (Mean = 6.15, *SS* = 1.30); however, the difference between the groups was not significant (t = -1.11, p < .27). In addition, Lawshe (1975) content validity ratios were computed for each item, using the acceptable criterion as .20. Results showed that seven items did not reach to acceptable content validity ratio.

To give an idea regarding the scale's concurrent validity, students' perceived stress levels (i.e., low, medium, and high) and mathematics anxiety total and subscale scores as measured by the MARS-E were compared by one-way analysis of variance (ANOVA). As Table 5 shows, three stress groups differed significantly on the total MARS-E scores. In addition, significant correlations were found between the subscales of the MARS-E (Table 8). Finally, the MARS-E was administered to a group of elementary school student sample. Scores varied between 0.00 and 93.00 with $\bar{x}$= 37.97(*SD* = 18.84).

The scale's reliability was investigated in terms of internal consistency (Table 8). Cronbach alpha reliability coefficient for the whole MARS-E was found to be .94. Subscale alpha reliability coefficients ranged from .77 to .86. Thus, the items of the Turkish scale were found to be reliable as evidenced by internal consistency scores.

As conclusion, the Mathematics Anxiety Rating Scale Elementary form's translation into Turkish and the Turkish form's adaptation was completed by this study. In addition, preliminary psychometric properties of the scale indicated promising results. However, full validity and reliability studies are still needed including construct validity, concurrent validity, predictive validity, convergent validity, divergent validity, and etc.

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