

# The Reliability and Validity of the Mathematics Self-Efficacy Informative Sources Scale

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## Abstract

This study focused on the convergent and discriminate validity of the Mathematics Self-Efficacy Informative Sources Scale for high school students. A total number of 692 high school students participated in the study. Both explanatory and confirmatory factor analyses were conducted for the content of the scale. Whether the Mathematics Self-efficacy Informative Sources showed any differences in terms of personal variables such as gender and class level was also examined as part of discriminant validity. According to the results of the factor analyses, the four-factor model of math-inform was supported. According to the distinguished validity results, it would be stated that class level variables were not effective in explaining the variables informative resources. The results were discussed in light of literature and some suggestions were given for further studies.

## Key Words

Math self-efficacy informative sources.

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This study focused on the convergent and discriminate validity of the Mathematics Self-Efficacy Informative Sources Scale for high school students. Both explanatory and confirmatory factor analyses were conducted for the content of the scale. Whether Mathematics Self-efficacy Informative Sources showed any differences in terms of personal input such as gender and class level was also examined as part of discriminate validity. A total number of 692 high school students participated in the study. According to the results of the factor analyses, the four-factor model of the Math-inform was supported and multivariate comparisons were performed according to gender and class level. The results were discussed in light of literature and some suggestions were given for further studies.

This study is related to informational sources of mathematics self-efficacy expectations; personal performance accomplishments, social persuasion, peer modeling, and perceived physiological, and affective states (Bandura, 1977, 1986, 1997). The purpose of this present study was to contribute to counselors' practices regarding their studies to enhance mathematics self-efficacy expectations of high school students (Betz & Hackett, 1981; Hackett & Betz, 1981; Lent, 2005; Lent et al, 2000; Lent & Brown, 2006; Lent, Brown & Hackett, 1994, 1996a). In this respect, the convergent and discriminate validity of the Mathematics Self-Efficacy Informative Sources Scales developed for high school students (Aybay-Köröğlü, 2005; Lent, Lopez & Bieschke, 1991; Lent, Lopez, Brown & Gore, 1996b; Lopez & Lent, 1992; Matsui, Matsui & Ohnishi, 1990; Özyürek, 2002, 2005) was emphasized. The study had two main aims, one of which stressed on the factor structure of the scale as part of convergent validity. By means of both explanatory and confirmatory factor analyses, it was aimed to decide which factor structure of applications was the most convenient for counselors to do evaluations. Based on theory (Bandura, 1986, 1987) and accepted as a basic model, this four-factor model was predicated on these four informative sources. However, the Personal Performances and the Social Persuasion sources scales were composite for the three-factor alternative model and used as a single factor. The present study involved high school students from different cities in Turkey while high school students from the same city were involved in two studies of Özyürek. The relationship of these scales to the scales measuring negative and biased opinions about mathematics (Math-opinions) was also examined.

Second, it was also analyzed whether mathematics self-efficacy resources showed any differences in terms of personal variables such as gender and class level as part of discriminate validity (Hampton, 1998; Holland, 1997; Multon, Brown & Lent, 1996; Tokar, Thompson, Plaufcan & Williams, 2007; Williams & Subich, 2006).

## Method

### Participants

A total of 692 high school students enrolled in 9<sup>th</sup> grade (n = 327), 10<sup>th</sup> grade (n = 234) and 11<sup>th</sup> grade (n = 129) participated in the study. 284 of the participants were female students while 392 were male students (missing = 16). The participating students were chosen randomly from various high schools in different cities of Turkey. Not only students from vocational high schools, but also students from different fields of academic high schools such as science, social sciences, Turkish-mathematics, and foreign language were included in the study. Their mean age was found as 16.28 (SD =1.12).

Since confirmatory factor analysis (CFA) was run after conducting explanatory analysis, the data had to be split in half at random one of which was calibration (n= 348) and the other was cross-validation (n= 344). While CFA was being conducted, listwise deletion method was used and then the number of participants became 282.

### Instruments

**The Mathematics Self-Efficacy Informative Sources Scales (Math-inform):** This scale (Özyürek, 2002, 2005) consisted of subscales of Personal Performances and Peer Modeling scales with 9 items, Social Persuasion scales with 6 items and Perceived Physiological and Effective States scales with 10 items. The participants were asked to rate on a 4-point Likert scale, the degree of agreeableness (from 1-I never agree to 4-I completely agree). The high scores in this scale mean the existence of the related feature.

**The Negative and Biased Opinions about Mathematics (Math-opinions):** This scale developed by Özyürek (2002, 2005) measures negative opinions about mathematics courses arising from students' lack of self-efficacy (cf., "*avoidance behaviour*" in Betz, 2004; p. 342). The scores of the scale showed negative correlations with mathematics in-

terest, mathematics self-efficacy, personal performances and social persuasion scales while showing positive correlations with peer modeling and perceived physiological arousal scales. Mathematics self-efficacy was used as one of the latent variables. Based on results obtained from calibration sample, Cronbach alpha value of the scale was .79.

## Results

### Explanatory Factor Analysis Results

Since the Math-inform was conducted for students from various cities different from the previous research (Özyürek, 2002, 2005), it was needed to do a new exploratory factor analysis so that it would be possible to investigate whether the scale was determined or had a simple factor content.

In order to achieve this purpose, factor analysis was done through oblique rotation and principal axis factor extraction methods. A three-factor solution, which was also found in previous studies (Özyürek, 2005), was evaluated in these analysis. As a criterion of a simple factor structure, the factor loading of an item was accepted as minimum .30 value as a cut off. In addition, the minimum cross loading value was considered as .30. After conducting the factor analysis for the second time, a simple three-factor structure was found.

### Correlation Analyses

After the three-factor solution found by exploratory factor analysis, correlation matrix was computed (Table 2) according to both this model and theory based four-factor model.

### The Results of Confirmatory Factor Analysis

Chi-square value was found significant in the structural equation modeling analysis run by LISREL 8.30 for both models (Jöreskog & Sörbom, 1993). Considering the fit indices (Bollen, 1989; Byrne, 1998; Hoyle & Panter, 1995; Hu & Bentler, 1995; Kline, 1998; Ullmann, 1996), the values were found unsatisfactory and a new modification was needed. As for the basic model, the maximum modification index of output file was investigated and two modifications were made. The maximum modification index was investigated for the three-factor alternative model and two modifications of the basic model had to be conducted. The fit indices of both models are shown in Table 3.

As it can be seen from the table, the fit indices of the four-factor model were more satisfactory. In addition, the AIC value (1007.986) of the four-factor model was found lower than that of the three factor model (1025.410). Although a new cross-validation study needed because of the modification, the researcher decided to run the rest of the analyses according to the four-factor model.

### **The Effects of Gender and Class Level on Informative Sources**

The mean scores and standard deviation values of informative sources according to gender and class level were shown in Table 4. As for the second purpose of the present study, a 2 (gender) X 3 (class level) multivariate analyses of variance (MANOVA) was conducted (Tabachnick & Fidell, 2001). While gender and class level (9<sup>th</sup>, 10<sup>th</sup>, and 11<sup>th</sup> year) were independent variables, composite variable (Personal Performances + Social Persuasion) and the Peer Modeling and the Perceived Physiological Arousal Scales were used as dependent variables. The following results were obtained; the mean scores of the Peer Modeling Scales of eleventh-year male students were found significantly higher than those of both tenth-year male students and eleventh-year female students. The Perceived Physiological Arousal and the Math-opinion mean scores of female students were found higher than male students while male students' mean scores of composite variable (Personal Performances and Persuasion) were found higher than those of female students.

### **Discussion**

Although the three-factor solution was obtained through exploratory factor analysis related to the Math-inform scale, theoretically, Bandura (1997) mentioned four sources. However, the results of confirmatory analyses revealed the validity of the four-factor model. In addition, referring the items of the Personal Performance Accomplishments and Social Persuasion Sources to the same factor might not be contradictory because it would be natural for students showing successful performances in mathematics classes to get persuasive messages from both teachers and peers.

No significant relationship was found between the Peer Modeling Scale and the Personal Performances Accomplishments + Persuasion Scales, which was also the same in the previous studies (for instance, Özyürek,

2002, 2005). It was interesting to find that the Math-inform Scales showed positive relations with peer modeling and perceived physiological arousal variables but negative relations with the other two scales. On the other hand, if this scale related to negative thoughts was seen as self-inefficacy then the reason could be understood better. Counselors could use this scale as “mathematics fear” scale. However, in accordance with social cognitive theory (Bandura, 1986), it would be more rationalistic to concentrate on how students would improve themselves in mathematics classes via positive thinking (see also Cardoso & Marques, 2008; Rivera, Blumberg, Chen, Ponterotto & Flores, 2007).

According to the distinguished validity results, it would be stated that class level variables were not effective in explaining the variables informative resources. The fact that the mean of personal performances of female students was lower than male students while the mean of excitement levels was higher would indicate that female students had a disadvantage in mathematics. It was also obvious in the study that female students have significantly more negative opinions ( $p < .001$ ) than male students. Based on informative resources, counselors could find out the students’ mathematical background rather than focusing on gender and class level.

One of the most important results of this study was that no significant differences were found in the main effect of class level in terms of both resources and negative ideas. The most important reason would be the lack of specific skills in the scale statements that could be developed within the items of the scale. Whether the similar results are repeated according to the level of skills would have been investigated (Tang, Fouad & Smith, 1999; Schaub & Tokar, 2005; Ali & McWhirter, 2006). However, if content specific scales had been used, then it would have been possible to evaluate these results better.

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