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Development of the revised form of the coping with mathematics scale

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Abstract

This study was conducted for the purpose of revising and improving the Coping with Mathematics Scale developed to evaluate the coping strategies of individuals when faced with difficulties in mathematics. The adopted theoretical framework was the adolescent coping model of Frydenberg and Lewis (1993). Initially 36 items had been generated by adaptation of items from Frydenberg and Lewis' Adolescent Coping Scale for contexts of dealing with mathematics. The first study for the development of the scale was conducted with 751 students preparing to take the university entrance examination in Turkey. The final form of the scale in the initial study comprised 36 items in three sub categories: 13 items in *coping focused on solving the problem*, 13 items in *non-productive coping* and 10 items in *coping with reference to others* (Ader, 2004). Data on the revised short form of the scale with 18 items that were collected from 174 adolescents were analyzed in the present study. The results indicated satisfactory psychometric characteristics for the revised short form of the Coping with Mathematics Scale.

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1. Introduction

One particular reason for mathematics under achievement has been shown to be mathematics anxiety (Aschcraft, 2002; Hembree, 1990; Ma, 1999). Defined as the feeling of pressure that limits the use of numbers and solving mathematical problems in academic settings and everyday life (Richardson & Suinn, 1972), math anxiety leads to emotional symptoms, such as panic, fear of failure, self doubt, frustration, hopelessness, shame, powerlessness as well as sweating, nausea, stomach disturbance, difficulty in breathing and inability to concentrate turning mathematics into a source of stress for many people (Bursal & Paznokas, 2006; Hembree, 1990).

Coping is the sum of responses that an individual uses to deal with a stressful situation faced in life. According to Lazarus (1991), coping consists of the cognitive and behavioral efforts to manage specific external or internal demands beyond the resources of an individual. In this frequently cited theory, coping is described to be dependent on context and as a process following the appraisal of the situation rather than being conceptualized as a trait (Folkman & Lazarus, 1985). In coping theories, coping strategies are discussed as having different dimensions. In earlier studies coping has generally been divided into two main categories: problem-focused and emotion-focused coping. Problem focused coping is characterized as an active, task-oriented response pattern aiming to solve the

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problem or changing the source of stress. However, emotion focused coping is described as an emotional response aiming to deal with or to withstand the stressful situation (Jackson, Mackenzie & Hobfoll, 2000). Social aspects of coping have been emphasized in some other theories. Individual coping efforts are considered to have social consequences as they affect the well being of individuals who are socially intertwined (Jackson et al., 2000). Hobfoll, Dunahoo, Ben-Porath and Monnier (1994) introduced a multiaxial model of coping which posits that individuals' coping strategies differ on a communal, namely social and direct-indirect dimensions as well as on an individual level. Coping styles are determined by the importance of the situation, conservation of resources of individuals and their connections and relationship with others.

It is claimed that coping is regarded as a means of finding equilibrium by reducing the influence of a particular concern (Frydenberg & Lewis, 1993). According to this claim, coping could occur by actively trying to solve the problem or by manipulating the concern without finding a solution. In their theory of adolescent coping, Frydenberg and Lewis (1993) categorized coping acts in three styles. The first style "solving the problem" describes attempts to solve the stressful problem while remaining optimistic, fit, relaxed and socially supported. The second style "non-productive coping" consists of avoidance strategies, which are linked with an inability to cope actively and in a task-oriented manner. The third style "reference to others" consists of actions aiming to receive support from other individuals. Among the body of research on coping, there are varying views about effective coping. Generally, problem focused coping is regarded as a more healthy way of dealing with stressful situations (Frydenberg & Lewis, 1993).

The fact that all the major theories of coping are based and tested on samples from Western societies is noteworthy. Due to their action-orientation, problem focused coping strategies are more highly valued in Western societies (Lazarus, 1993). In various studies, Hong Kong Chinese students were compared to Euro Canadian students (Dyal & Chan, 1985) and Chinese college students to students from the United States (Gerdes & Ping, 1994). Results showed that the former groups used more emotional and group-oriented coping strategies. Similarly, Indian university students made greater use of emotion-focused coping such as confrontive coping (facing the problem with aggression), distancing (reducing the importance of the event in their heads), positive reappraisal and social coping strategies than Canadian university students, even though the two groups did not differ significantly in their use of problem focused coping strategies (Sinha, Willson & Watson, 2000).

In a study carried out on Turkish high school students (Aysan, Thompson & Hamarat, 2001), the interactions between test anxiety, coping strategies and perceived health were examined. The findings indicated that students having higher levels of test anxiety tended to rely on more ineffective coping strategies such as self-blame, wishful thinking and avoidance. No correlation was observed between test anxiety and problem focused coping and coping strategies of seeking social support. In a more recent study with Turkish university students, Gencoz, Gencoz and Bozo (2006) determining the dimensions of coping styles found that the first two dimensions were problem focused coping and emotion focused coping. The third dimension indicated an indirect coping style, namely seeking social support.

The purpose of this study was to devise an effective tool to determine students' coping strategies to overcome mathematics anxiety when faced with difficulties in mathematics. Mathematics anxiety which is a source of stress for many students is thought to be overcome by successful students who can cope with mathematics anxiety in various ways. Coping with Mathematics Scale was developed to evaluate strategies for coping with math anxiety and difficulties in mathematics (Ader, 2004). The adolescent coping model of Frydenberg and Lewis (1993) was adopted as the theoretical framework. It is assumed that as the prevalent coping strategies for math anxiety are unfolded, the obtained information can be utilized to train math anxious students for more effective coping strategies.

2. Method

This study was carried out in order to create a short revised form of Coping with Mathematics Scale, initially developed by Ader (2004). The aim was to develop a more compact and easy to implement tool for investigating individuals' ways of coping with difficulties in mathematics. For this purpose, each subscale of the Coping with

Mathematics Scale was carefully considered retaining the most representative items and eliminating the others. The items of the original scale were reduced to 18 in this study.

2.1. Sample

The revised form of the scale was administered to 182 6th to 8th grade students (12 to 15 year olds) from two public primary schools. The total number of students who responded to all of the items in the scale was 174, 82 of which were male and 92 were female. The schools were in close proximity of each other but their catchment areas were slightly different in terms of SES of students' families, where one of the schools had predominantly low SES students and the other low to medium SES students.

2.2. Instrument.

Coping with Mathematics Scale was prepared to evaluate the coping strategies of individuals when faced with difficulties in mathematics based on the adolescent coping model of Frydenberg and Lewis (1993). This specific model categorizes coping acts and approaches of individuals into three categories as "solving the problem", "non-productive coping" and "reference to others". These broad categories are further divided into strategies. For the development of Coping with Mathematics Scale the following categories were considered from the range of strategies mentioned above:

- *Coping focused on solving the problem*: concentrating on the difficulty caused by the problem, working hard to resolve the difficulty, focusing on the positive, seeking relaxing diversions and physical recreation.
- *Non-productive coping*: worrying, ignoring the problem, not coping, wishful thinking, keeping to self, self-blame and blaming others.
- *Coping with reference to others*: seeking professional help, seeking spiritual support, seeking social support, social action, seeking to belong and investing in close friends.

The sample items developed by Frydenberg and Lewis (1993) were reviewed and studied and consequently, based on the above categories and strategies, 36 items were generated by the researcher. Coping focused on solving the problem and coping with reference to others" styles had 11 related items each, while "non-productive coping" style had 14 items in the test.

Each item in the scale describes a coping strategy that can be used when faced with difficulties in learning mathematics. The individual is expected to respond by stating how often s/he facilitates the stated strategy. The items are all Likert-type scaled from "always" to "never". Therefore, according to his/her responses, the individual's frequency of using each strategy is obtained by the use of this scale.

As the next step, the scale was administered to 751 students, 335 males and 416 females. The α reliability value for the scale was obtained as 0.81. When the reliability analysis was run for each sub-scale separately, the corresponding item-total correlations for all three items were above 0.4. To confirm the validity of the scale, expert opinions on the appropriateness of items for measuring the desired construct were taken. 4 experts in the faculty of education were consulted as judges and they were asked to categorize the items according to the three coping styles. 11 of the items were categorized under the coping style it had been associated with by all four of the judges, and 25 of the items by three of the judges. Another evidence for the validity of the scale was the factor analysis carried out on the data. According to the factor analysis, only four items were grouped in a different category than initially conceptualized. This was accepted as evidence for construct validity.

2.3. Procedures in Preparation and Implementation of the revised form of the Coping with Mathematics Scale.

As the first step in the development of the revised form of the Coping with Mathematics Scale, the items in the initial form of the scale were reviewed for their loadings in the initial factor analysis (Ader, 2004). Items for

different coping strategies in each of the three categories were considered and reduced in number according to mainly the factor loadings from the factor analysis on the initial phase.

The scale was reduced to a total number of 18 items. The wording of five items was modified with an effort to make the expressions more clear and understandable for adolescents. There are no reversed items in the revised form of the scale since item 6, which was a reversed item in the initial scale, was rephrased to make the item directly linked with the strategy.

Revised form of the Coping with Mathematics Scale was administered to 182 students during the data collection process. As the next step, coding of the responses were done as 4 for a (always), 3 for b (often), 2 for c (sometimes) and 1 for d (never). Listwise elimination method was selected for data analysis and consequently the sample size decreased to 174.

3. Results

The α reliability value for the revised form of the scale was obtained as 0.60. The item total correlations varied between -0.14 and 0.38, with a mean of 0.21. Items 2, 3, 5 and 6 were considered for revision since their item-total correlation values were below 0.15 in the reliability analysis for the whole scale. Considering the multidimensionality of the scale, α reliability analysis was further conducted for each category. This will be discussed after the results from the factor analysis are reported.

The outcome from the factor analysis conducted to check the dimensions in the revised form of the scale, necessitated reconsideration of the structure of the scale. The matrix displaying the cross comparisons among the theoretical categories and the factors from the analysis are shown in Table 1. 11 of the 18 items were confirmed to be dimensionally overlapping with the initial categories according to Frydenberg and Lewis' model (1993). Items relating to three strategies initially included in the non productive coping category (item 2 for "not coping" strategy, item 5 for "ignoring" strategy, item 3 for "blaming others" strategy) had strong negative correlations with items in coping focused on solving the problem (items 12, 15 and 16) addressing taking action for tackling the difficulties in mathematics in a direct and action oriented style. The strategies in these three negatively correlated items all shared a common notion of avoiding to take action and hence had strong conceptual links with the coping focused on solving the problem category. Similarly item 6 addressing "wishful thinking" strategy had elements of focusing on the positive. Due to its connotations of working towards a goal, this item can be linked with coping focused on solving the problem category.

Items 9 and 17, focusing on individuals' engagement with sports and hobbies as coping strategies, were initially conceptualized under coping focused on solving the problem category. Yet they were found to be linked with the items in coping with reference to others category. This can be interpreted as involving strategies not directly taking action to deal with difficulties in mathematics by staying focused on studying, but endeavoring to deal with these difficulties by seeking relaxations through other activities. These items do not involve other individuals but their involvement of "other" activities was the rationale for considering them within coping with reference to others category.

The only other item that did not overlap with the initial categorization was item 13, which concerned a spiritual support through individuals' relationships with religion. Even though it was conceptually listed under coping with reference to others category, its link with non productive coping category can be explained through the interpretation of the differences between religious beliefs in Western and Islamic cultures. Islamic cultures do not attribute personification to God and within a Turkish context, it can be deemed implausible to include this strategy in coping with reference to others category. Seeking religious support is an emotion and belief focused approach to coping and it does not address an action oriented approach towards tackling the difficulties faced in mathematics, as indicated by the items in the coping focused on solving the problem category. Hence this item was considered under non productive coping category.

Table 1. Matrix displaying the initial categories and the outcome from the factor analysis

	Factor 1	Factor 2	Factor 3
Coping focused on solving the problem	15, 16, 12	9, 17	12
Coping with reference to others		1, 4, 7, 10, 11	13
Non productive coping	2, 3, 5, 6		8, 14, 18

As a result of these considerations, the revised form of Coping with Mathematics Scale reached its final form:

Coping focused on solving the problem category consists of seven items (2, 3, 5, 6, 12, 15, 16) three of which are negatively linked with this category (2, 3, 5) as they still address action-oriented strategies but in a negative manner of not taking action.

Non productive coping category consists of four items (8, 13, 14, 18) concerning coping strategies which do not embody an action orientation. They are emotion focused strategies such as worrying, keeping to self, blaming the self and taking refuge in religion.

Coping with reference to others category was enlarged to include strategies not only addressing the social dimension of coping but also included strategies involving activities “other” than directly tackling the difficulties faced in mathematics such as engaging in physical sportive activities and relaxing through one’s favorite activities. This category consists of seven items (1, 4, 7, 9, 10, 11, 17) in the final revised form of the scale.

When the α reliability analysis for each category was conducted, the values for the categories were 0.74, 0.52 and 0.61 for coping focused on solving the problem, non productive coping, coping with reference to others categories respectively. In the reliability analysis run for each category separately, the item-total correlations for all 18 items, including the items having values below 0.15 in the initial reliability analysis, were above 0.15. This was taken as evidence for reliability of the revised form of Coping with Mathematics Scale.

The revised form of the Coping with Mathematics Scale, in its final form can serve as a tool to display the coping profiles of students according to specific coping strategies as well as the three coping categories. The means for individual items function as indicators of individuals’ frequency of use of specific coping strategies. The averages of the means of the items in each category indicate average measures of their frequency of using coping strategies grouped under each of the three categories. Thus one can obtain three values for individuals or a group of individuals as their coping profile, corresponding to coping focused on solving the problem, non productive coping and coping with reference to others categories.

As a measure of validity of the scale, Pearson product moment correlation coefficients between students’ use of strategies in the three coping categories and their mathematics grades in school were calculated. Theoretically, it has been claimed that use of problem focused coping strategies are considered as a healthier way of coping with difficulties faced (Frydenberg & Lewis, 1993). Hence students adopting such strategies more frequently can be expected to cope with difficulties and this can contribute to their achievement in mathematics. The results showed that there was a substantial relationship between students’ use of problem focused coping strategies and their grades ($r=0.56$, $p<0.01$) with higher frequencies of use of such coping strategies relating to higher grades in mathematics in school. This was accepted as evidence for criterion related validity of the revised form of the Coping with Mathematics Scale. Use of non productive coping and coping with reference to others did not correlate significantly with students’ mathematics grades.

4. Discussion

The revised form of the Coping with Mathematics Scale comprises of three main categories of coping approaches: coping focused on solving the problem, non productive coping and coping with reference to others. However, the strategies under these categories were reorganized as a result of this study. The reorganization of the strategies under the three categories necessitates further analysis of the revised form of the scale with a focus on the overlapping of the strategies and the categories.

The revised form of the Coping with Mathematics Scale is suggested for use as a tool to display coping profiles of individuals or a group of individuals. These profiles can be constructed for individuals through their use of 18 different strategies for coping with mathematics. Even more importantly coping profiles can be formed across three categories in a comparable way, by calculating average scores per item for each of the three categories. This would designate the group of strategies that are used more frequently by the respondents, and provide information about their coping styles. The scale can also be used by researchers intending to plan intervention programs to develop individuals' coping skills and strategies, both as a diagnostic tool and as a means for following potential changes in individuals' coping preferences.

Relationships between different coping styles and achievement have been particularly highlighted for careful analysis in previous publications in this area (Frydenberg & Lewis, 1999; Frydenberg, 2004; Jose & Huntsinger, 2005). This study pointed to a strong link between the use of problem focused coping strategies and achievement in mathematics. Such findings need to be substantiated by further studies. Similarly links between coping and anxiety need to be studied for making sense of how coping strategies influence individuals' achievement in mathematics. Revised form of the Coping with Mathematics Scale can be useful for understanding the role of coping in relation with other major constructs in mathematics education, particularly within a Turkish context.

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