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The predicting model of math anxiety: the role of classroom goal structure, self-regulation and math self-efficacy

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Abstract

The purpose of the present study was to examine a predicting model of high school students' math anxiety based on classroom goal structure, self-regulation and math self-efficacy. For this reason 436 first grade male high school students were selected through multiple cluster sampling. They completed a questionnaire consisting of perceived classroom goal structure (Midgley et al. 2000), Math anxiety (Bai et al. 2009) and researcher-made math self-efficacy scale. Data was analyzed using path analysis technique. Results indicated that mastery and performance-approach structures negatively influence math anxiety, directly and indirectly. All goal structures have a positive effect on self-regulation and performance-approach structure affects math self-efficacy positively, performance-avoidance structure affects it negatively, however. Math self-efficacy affects math anxiety directly and negatively, while negative effect of self-regulation is indirect through math self-efficacy. The mediating role of self-regulation and math self-efficacy in relationship between classroom goal structure and math anxiety was confirmed.
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Keywords:Classrom goal structure; self-regulation; math self-efficacy; math anxiety

1. Introduction

Academic achievement in Mathematics and avoiding academic failure has become the concern of educational systems all over the world. According to the majority of educational psychologist, cognitive factor (intelligence) is believed to be a necessity in learning Math. Nevertheless, Suinn and Edwards (1982) argue that more than half of the academic achievement variance in Mathematics is explained particularly by affective variables. As one of the affective variables, mathematic anxiety has been taken into account since 1960 (Ignacio et al, 2006). Ma and Xu (2004) define math anxiety as a distasteful feeling students experience while doing assignments or performing math-related daily routine. Lossi (2007) asserts that math anxiety accounts for the worrying statistics of academic failure in Mathematics. Furthermore, conducting research on the phenomenon, in order to fully understanding its dimensions and consequently to prevent and treat it is of great importance (Ashcraft and Moore, 2009).

Bandura (1997), from a social-cognitive perspective, defines anxiety as "a state of anticipatory apprehension over possible deleterious happenings" (p. 137). In Bandura's (1988, 1997) viewpoint, person's self-efficacy has a crucial role to play in anxiety. Self-efficacy denotes the person's ability to exert desirable effects (Flammer, 2004) and can directly affect the anxiety responses (Mishaelides, 2008). Kim (2002) observed that a strong correlation existed between self-efficacy and depression.

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In some studies (Dykeman, 1994; Hodapp and Benson, 1997; Keith et al. 2003, all cited in Jain and Downson, 2009), negative significant correlations between test anxiety and self-efficacy were also observed.

With respect to Bandura's social-cognitive theory (1986, 1977), on one hand, anxiety or physiological arousal is one of the four sources of self-efficacy and on the other hand it is formed by the sense of weak self-efficacy in responding to the environmental demands. In classroom environment, type of goals which is emphasized by teacher, can be considered as on the most important environmental demands.

Ames (1992) used the term 'classroom structure' for explaining such emphasis. Accordingly, classroom goal structure can be mastery (to develop competence), performance-approach (to demonstrate competence) or performance-avoidance (to avoid demonstrating incompetence) (Midgleyet et al. 2000; Murayama & Elliot, 2009). Most research in the field of classroom structure have been conducted based on a bi-dimensional model (mastery/ performance) (for example, Urdan and Schoenfeld, 2006; Friedel et al. 2007; Erdan and Midgley, 2003) and less research have been carried out based on the above mentioned tri-dimensional model (Wolters, 2004, for example). In these studies mastery structure of classroom correlated with positive outcomes such as more well-being (Kaplan & Maehr, 1999), positive affect (Anderman, 1999) and high self-efficacy (Wolters, 2004). Also, the performance structure of classroom correlated with avoidant behaviour such as help-seeking avoidance and self-handicapping (Turner et al. 2002; Urdan, 2004).

Researches that conducted in the field of goal orientations are not consistent about the negative effects of performance goals (Friedel et al. 2007). Friedel et al. (2007) argue that performance-approach orientation is generally more adaptive than performance-avoidance orientation. Accordingly, since goal orientations have a high correlation with goal structures (Wolters, 2004; Andermanand & Midgley, 1997; Rian, Alfred-Liro and Pintrich, 1996), we also expect that in goal structures negative effects (decrease in self-efficacy and self-regulation& increase in math anxiety) be observed in only performance-avoidance structure and not in performance-approach structure.

In Schoenfeld's (1992) view, self-regulation consists of the learner's ability to employ cognitive and metacogntive strategies. According to Pintrich et al. (1991), cognitive strategies involve rehearsal, elaboration and organization and metacognitive strategies consist of planning, monitoring and regulating. In many studies, self-regulation correlated with problem-solving enhancement in Science and Mathematics (Zan, 2000; Taylor and Corrigan, 2005; De Corte, Verschaffel and Spetand, 2000), decrease in math anxiety, (Pintrich, Hofer and Yu , 2003) and increase in self-efficacy and math performance of students (Servon et al. 2006; Brown and Hirshfield, 2007; all cited in Jain and Downson, 2009). In jain and Downson's (2009) view, we would better to highlight the indirect effect of self-regulation on anxiety through self-efficacy, because self-regulation acts in cognitive domain rather than affective domain. Self-regulation can however amplify the feeling of self-efficacy and efficacy as a positive affect influences anxiety as a negative affect. The purpose of this study is to present a math anxiety predicator model based on the variables of classroom goal structure, self-regulation math self-efficacy. This study broadens our knowledge about the role of environment and the mediating effect of the person himself in math anxiety as an intertwined network of possible causal relationships and can bring about the situation for avoiding interventions.

2. Method

2.1. Participants

The participants were 436 first grade male high school students (mean age=15.7 & SD=1.44 years old) sellected through multiple cluster sampling among Tehran's male high school students.

2.2. Instruments

Classroom goal structure: revised perception of classroom goal structure scale adapted from "patterns of adaptive learning scales"(PALS, Midgley et al.,2000) was used for assessing the construct. This five-point likert scale have 6, 3 and 5 items for assessing mastery, performance-approach and performance-avoidance goale structure, respectively. We utilized confirmatory factor anslysis for determining construct validity of the scale.CFA indices (X2/df= 2.04, CFI=0.95, GFA=0.95, RMSEA=0.05) revealed fitness of the model. Cronbach's alpha coefficient, as shown in Table 1, indicated sufficient reliability of the subscales.

Self-regulation: we used subscales of rehersal, elaboration, organization and metacognitive self-regulation from motivated strategies for learning questionnaire (MSLQ) (Pintrich et al, 1991)for assessing the construct.

After removing an item because of low factor loading, second order CFA indices(X2/df= 1.79, CFI=0.92, GFA=0.92, RMSEA=0.04) for this 26 five-point likert items reveald sufficient construct validity of the model. Furthoremore, high Cronbach's alpha (0.85) indicated reliability of the scale.

Math anxiety: 14 five-point likert items of bidimentional math anxiety scale (Bai et al, 2009; Ekizoglu & Uzunboylu, 2009). were used for assessing student's math anxiety. After removing an item because of nonsignificant and low factor loading, CFA indices (X2/df= 2.64, CFI=0.94, GFA=0.93, RMSEA=0.06), and Cronbach's alpha(0.86) revealed acceptable validity and reliability of the scale.

Math self-efficacy: this researcher-made 12-item scale was developed by a math teacher based on Bandura's(2006) guidances on constructing self-efficacy scales.each item consisted of a math problem based on curriculum of the first grade high school's math course, and asked students to score themseves confidence for true solving the problem from 0 to 20. Exploratory factor analysis revealed that the scale consisted of one factor that explained %60 of the variance. Reliability of the scale was also high (0.94).

3. Results

Descriptive statistics and correlation among variables are presentsd in Table 1. As shown, correlation of all goal structures to self-regulation is positive and significant. Relationships of mastery and performance-approach structures with math self-efficacy is positive and with math anxiety is negative and Performance-avoidance structure have no significant correlation to them. self-efficacy is positivly Ralated to self-regulation and negativly related to math anxiety.

Path analysis technique was conducted trough AMOS18 (Arbucle, 2009) for testing the fitness of the default path model. Mode fit indices (X2/df= 1.65, df=1, sig=0.19, CFI=0.99, GFA=0.99, RMSEA=0.04) indicated that the model has a good fitness to the data. The fitted model is presented in Figure 1. Standardized direct, indirect and total effects of exogeneous variables on endogeneous variables are also presentad in Table 2.

Table1. Descriptive statistics and correlation among variables

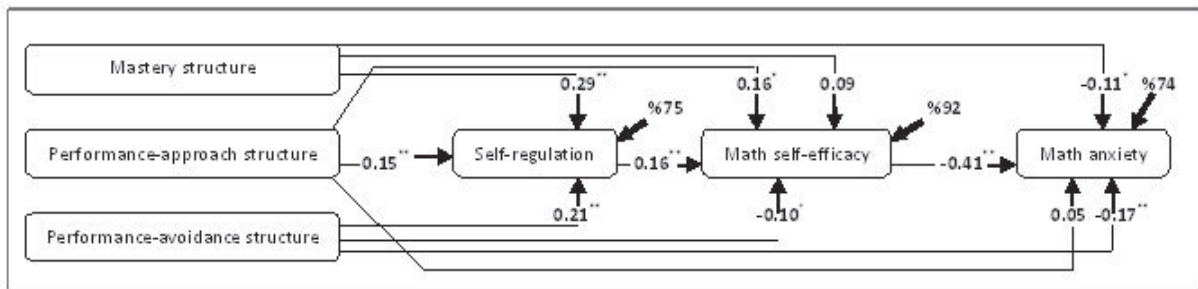| Variables	Min-Max	M	SD	α	1	2	3	4	5
1- Mastery structure	6-30	23.42	4.32	0.73	-				
2- Performance-Approach structure	3-15	11.34	2.51	0.57	0.47**	-			
3- Performance-Avoidance structure	5-25	17.71	4.19	0.72	0.27**	0.45**	-		
4- Self-Regulation	36-124	86.87	15.3	0.85	0.41**	0.38**	0.36**	-	
5- Math Self-efficacy	0-240	164.53	56.93	0.94	0.20**	0.21**	0.05ns	0.22**	-
6- Math anxiety	13-65	38.07	10.02	0.86	-0.25**	-0.28**	-0.07ns	-0.22**	-0.46**

** p<0.01, ns= non significant

Figure1. Fitted path model of math anxiety

Table 2. Standardized direct, indirect and total effects of the path model

Path	Direct effect	Indirect effect	Total effect	R2
To self-regulation from:				
Mastery structure	0.29**	-	0.29**	
Performance-approach structure	0.15**	-	0.15**	%25
Performance-avoidance structure	0.21**	-	0.21**	
To math self-efficacy from:	-	-	-	
Mastery structure	0.09	0.05*	0.14*	
Performance-approach structure	0.16*	0.02*	0.18**	%8
Performance-avoidance structure	-0.10*	0.03*	-0.07	
Self-regulation	0.16**	-	0.16**	
To math anxiety from:				
Mastery structure	-0.11*	-0.05*	-0.16**	
Performance-approach structure	-0.17**	-0.07**	-0.24**	%26
Performance-avoidance structure	0.05	0.02	0.07	
Self-regulation	-	-0.06*	-0.06*	
math self-efficacy	-0.41**	-	-0.41**	

*p<0.05 **p<0.01

As it is demonstrated, all goal structures affect self-regulation directly and positively. Highest effect is firstly related to the mastery structure, then to the performance-avoidance structure and finally to performance-approach structure. Mastery structure is not significantly effects on math self-efficacy but it indirectly effects on math self-efficacy through self-regulation. Performance approach structure has direct as well as indirect positive effect on self efficacy. Direct effect of performance-avoidance structure on math self-efficacy is negative and its indirect effect is positive, though week. Regarding the total effects, as presented in Table 2, both mastery and performance-approach structures have positive total effect on math self-efficacy but effect of performance-approach structure is higher than mastery structure, whereas total effect of performance-avoidance structure is not significant. Self-regulation has also a positive significant direct effect on math self-efficacy.

As shown in Table 2, direct, indirect and total effects of mastery and performance-approach structures on math anxiety are negative and significant, but effect of the former is greater than that of the latter. Moreover, performance-avoidance structure has no significant effect on math anxiety. Math self-efficacy affects math anxiety directly and negatively, while negative effect of self-regulation is indirect and only through math self-efficacy.

4. Discussion

In this study a model for predicting high school freshmen' math anxiety was provided on the basis of goal structures as the exogenous variables and the two constructs of self-regulation and math self-efficacy as the mediating variables. The results indicate that mastery structure have a direct and positive effect on self-regulation. However, the direct effect of mastery structure on self-efficacy is not significant. Previously researchers like Wolters (2004) pointed out the direct effect of mastery structure on self-efficacy, but the important finding of this study is that mastery structure affect self-efficacy indirectly through self-regulation. The implication is that the self-efficacy of the individuals who perceive the structure of the classroom to be mastery is independent of the external

environment, it is however internal and dependent on their effort to regulate their own learning. In this structure because of supporting the student's autonomy and providing him/her with the opportunity to make mistakes, his self-regulation will increase and by increasing self-regulation and self-efficacy the individual's math anxiety will decrease. Results pointed out that the performance-approach structure has positive effects on self-regulation and math self-efficacy and a negative effect on math anxiety. The performance-avoidance structure has a direct and positive effect on self-regulation and has a negative effect on math self-efficacy but does not have a significant effect on math anxiety. In interpreting these findings, the role of the control variable (educational level) should not be overlooked. In Iran's educational system, high school freshmen are required to select their desired field of study.

Since the subject Mathematics plays a crucial role in selecting prestigious and money making majors (people compete for achieving engineering majors in the society), the climate of the freshmen classrooms turns out to be performance-approach in which the essential feature is competition. Not surprisingly, such a climate fosters individuals to be more self-regulated and to have more self-efficacy and therefore decreases their math anxiety.

In performance-avoidance structure because the environment is oppressive and not motivational, in spite of his great effort for self-regulation, the person's self-efficacy will decrease,. Also, as Kramarski, Weisse and Kololshi-Minsker (2010) argue, such self-regulation remains on the surface level and does not result in the emergence of problem solving ability and accordingly does not increase self-efficacy. The issue is raised that this structure does not have any relationship with math anxiety. It is safe to say that the individual in this structure due to high self-regulation and low self-efficacy may experience a kind of learned helplessness by which he/she does not even feel a little amount of anxiety, which is motivational. These findings are inconsistent with the findings of the previous studies (such as Urdan, 2004) in which performance structure was concerned with negative outcomes and recommend that the future studies will need to examine performance-approach structures and performance-avoidance structures separately. The other finding of the study is the direct effect of self-efficacy and the indirect effect of self-regulation on math anxiety. Previous to this study, Kramarski, Weisse and Kololshi-Minsker (2010) also observed the negative relationship between self-regulation and math anxiety. Indirect effect of self-regulation through math self-efficacy is also consistent with Jain and Downson's (2009) study. With respect to social-cognitive theory (Bandura, 1997) as it was expected, the most diminishing effect of math anxiety concerned math self-efficacy. The implication is that, excluding the role of environment, any action that can increase the person's sense of efficacy is the most powerful action in avoiding math anxiety.

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