STUDENTS' MOTIVATIONAL BELIEFS, SELF-REGULATION STRATEGIES AND MATHEMATICS ACHIEVEMENT

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In this study we examine the relationships between motivational beliefs, self-regulation strategies use, and mathematics achievement in Cypriot pre-service teachers. Specifically, we developed a model depicting connections and causal relations among cognitive and affective factors, which was tested on the basis of self-report data collected from 194 pre-service teachers using a modified version of MSLQ and a mathematics achievement test. We found that the data fits the theoretical model very well, meaning that the model explains the structure of the above relationships, with self-efficacy being a strong predictor of mathematics achievement and self-regulation strategies use having a negative effect on achievement.

INTRODUCTION AND THEORETICAL FRAMEWORK

Social cognitive theory (Bandura, 1986) has provided a theoretical basis for the development of a model of self-regulated learning in which personal, contextual and behavioral factors interact in such a way as to give students an opportunity to control their learning. Within this framework, Pintrich (1999) describes self-regulated learning as an active, constructive process whereby learners set goals for their learning plan actions and monitor, regulate and control their cognition, motivation and behavior. These actions are guided and constrained both by their goals and the contextual framework and can mediate the relationships between individuals and the context and their overall achievement (Zimmerman, 2000).

Using a theoretical framework for conceptualizing student motivation, Pintrich and De Groot (1990) proposed that there exist three motivational components that may be linked to the three corresponding dimensions of self-regulated learning, namely: (a) an *expectancy component*, which refers to students' beliefs about their expected success in performing a task, (b) a *value component,* which concerns students' appreciation of and beliefs about the importance of the task for them and (c) an *affective component,* comprised of students' emotional reactions to the task. In line with that, motivational components were found to be significantly linked to students' cognitive engagement and academic performance in the classroom, with mastery goal orientation strongly related to the use of cognitive strategies, self-regulation and self-efficacy (Pintrich & De Groot, 1990).

Self-regulation has been found to be positively correlated to achievement, with highly self-regulated students being more motivated to use planning, organizational, and self-monitoring strategies than low self regulated students (Pintrich & De Groot, 1990). Pintrich and his colleagues (1994) have articulated a model of student cognition, which argued that students regulate their cognition by using motivational strategies in addition to cognitive and metacognitive strategies. Pintrich and De Groot (1990) found a positive correlation between motivational beliefs and self-regulated learning and furthermore, all affective components were related to academic performance. In line with these findings, Schunk and Zimmerman (1994) reported that there was a positive relationship between self-efficacy and academic achievement and that if students are trained to have higher self-efficacy beliefs their academic performance also improves.

THE PROPOSED MODEL

The proposed model is based on the theoretical assumption that views motivational beliefs as factors that may help to promote and sustain different aspects of self-regulated learning. Moreover, how these affective factors, that are the motivational beliefs and the self-regulation strategies use, may influence mathematics achievement (Pintrich, 1999). In other words, in the context of mathematics learning and teaching, how do self-regulation strategies influence the development of positive motivational beliefs and especially self-efficacy and how self-regulation strategies use and motivational beliefs influence mathematics achievement of pre-service teachers.

The model for self-regulated learning described in the present study comprises of two main components. The first refers to self-regulation strategies use and the second to motivational beliefs. In addition, the self-regulation strategies involve cognitive learning strategies and self-regulatory strategies to control cognition (metacognitive learning strategies) (Garcia & Pintrich, 1994). Cognitive learning strategies consisted of elaboration and organizational strategies. Elaboration strategies include paraphrasing or summarizing the material to be learned, creating analogies, generative note taking and connecting ideas in students' notes. The organizational strategies include behaviours such as selecting the main idea from text, outlining the text or material to be learned, and using a variety of specific techniques for selecting and organizing the ideas in the material (Garcia & Pintrich, 1994).

Students' metacognitive and self-regulatory strategies can have an important influence upon their achievement. Self-regulation would then refer to students' ability to setting goals planning activities, monitoring progress, controlling, and regulating their own cognitive activities and actual behaviour (Pintrich et al., 1993). Planning activities include analysis of the task, choosing strategies and making decisions on specific behaviours. Monitoring stands for comparing progress against goals or standards in order to guide the following actions. For instance, a type of self-regulatory strategy for reading occurs when a student slows the pace when confronted with more difficult or less familiar text (Tanner & Jones, 2003).

In the present study we have focused on three general types of motivational beliefs: (a) self-efficacy beliefs, (b) task value beliefs, and (c) goal orientation. The construct self-efficacy beliefs stands for a student's sense of ability to plan and execute actions to achieve an academic goal (Bandura, 1997). Self-efficacy also represents students' confidence in their cognitive and learning skills in performing a task. Task value beliefs refer to students' evaluations about the importance and usefulness of the task. Task value beliefs in mathematics could refer to beliefs that mathematics is useful in academic settings (other school subjects) and in finding a good job (Hannula, 2002). Goal orientation is discussed on two dimensions, named mastery goal orientation and extrinsic orientation. A mastery goal orientation refers to a concern with learning and mastering the task using self-set standards and self-improvement. Extrinsic orientation refers to expected reward or avoiding punishment, as the main criterion for investing resources e.g., pleasing teachers or parents (Pintrich, 1999).

Pintrich's research indicated that there are strong relationships between motivational beliefs and self-regulation strategies use. More specifically, in terms of self-efficacy, the findings showed positive correlations between self-efficacy and self-regulated learning (Pintrich & Garcia, 1991). Students who felt more efficacious with respect to a certain task or course were more likely to report using all types of cognitive strategies to succeed in pursuing the task. It has also been reported that self-efficacy was positively related to self-regulatory strategies use and strongly related to academic performance (Pintrich & De Groot, 1990). In addition, task value beliefs were correlated positively with cognitive strategy use including elaboration, and organizational strategy. Task value was also correlated to performance, albeit these relations were not as strong as those for self-efficacy (Pintrich, 1999).

Research in the field of goal orientation resulted in consistent relations between the different goals and self-regulation (Tanner & Jones, 2003). As reported by Pintrich (1999), mastery goal orientation was positively related to the use of cognitive strategies as well as self-regulatory strategies. In addition, mastery goal orientation was positively related to actual performance in the class. On the contrary, extrinsic goal orientation was consistently found to be negatively related to self-regulated learning and performance.

In arguing that motivational beliefs and self-regulation strategies use formulate a model for self-regulated learning, which influences mathematics achievement, we propose the following latent factors; self-efficacy, mastery goal orientation, extrinsic goal orientation and task value beliefs represents the motivational beliefs factors. With regard to self-regulation strategies use, cognitive strategies, a second order factor, is comprising two variables: elaboration and organization strategies. Self-regulation strategies use, represented by a high order latent factor, consisted by cognitive strategies and metacognitive self-regulation strategies.

We hypothesise that self-efficacy and self-regulation strategies use affect directly mathematics achievement, while mastery goal orientation, extrinsic goal orientation and task value affect academic achievement in mathematics via their effects on self-efficacy. We further assume that achievement is related to the cognitive strategies that students use to learn and that motivational beliefs and self-regulation strategies use constructs influence students' cognitive engagement and achievement in mathematics.

Based on these assumptions, the purpose of the study was to test the prediction of a causal model that explains the impact of self regulated learning, which encompasses students' motivational beliefs and self-regulation strategies use on their achievement in mathematics. More specifically, the present study addresses the following questions: (a) what are the relationships between mathematics achievement and self-regulation strategies use and motivational beliefs? (b) What is the predicting value of the proposed model for self-regulated learning on mathematics achievement? The above-mentioned questions are addressed through the estimation of a theoretically informed causal model in which the hypothesized relationships between the factors (motivational beliefs, self-regulation strategies use and mathematics achievement) are decomposed through the introduction of mediating second order latent factors. The proposed model is estimated using a Structural Equation (MPlus) program.

METHOD

Participants and Measures

The analysis in the present study was based on data collected from 194 sophomore pre-service teachers who attended a course on mathematics and its didactics during the autumn semester in 2004. The 26-item questionnaire used in this study was based on the MSLQ questionnaire (see Pintrich et al., 1993). Responses were recorded on a 7-point scale with extreme points labelled *strongly disagree* (1) and *strongly agree* (7). Achievement in mathematics was measured using students' score in their midterm examination. The questionnaire and the test were distributed on two days during the semester. Using listwise deletion of missing values in drawing the variables that were needed for the analysis, the final sample included 187 students. Of these 18% were males and 82% females.

Variables

The tested model contained both observed (measured) variables and latent constructs. The observed variables were specified as indicators for each of the latent constructs. One of the first order factors was measured by six indicators (Self-Efficacy (SE)), two factors were measured by four indicators (Task Value (TV) and Elaboration (El)) and four of the first order factors were measured by three indicators each (Mastery Goal Orientation (MGO), Extrinsic Goal Orientation (EGO), Organization (Org) and Metacognitive Strategies (MCS)). The Cognitive strategies (CS) latent factor was measured by the two first order factors Elaboration (El) and Organization (Org). Finally, the high order factor Self-Regulation Strategies use (SRSu) was measured by Cognitive Strategies (CS) and Metacognitive Strategies (MCS). Table 1 is a brief description of the latent constructs with specimen items (For a full set of items you can contact the first author of the paper).

RESULTS

In this study, 26 indicators were hypothesized to represent one high order, one second order and nine first-order factors (see Table 1). The parameter estimates were reasonable and all factor loadings were large and statistically significant. Moreover, the loadings of the Elaboration and Organization factors that comprised the Cognitive Strategies factor were also large and statistically significant. Finally, the loadings of the Cognitive and Metacognitive Strategies factors that comprised the high order Self-Regulation Strategies Use factor were also large and statistically significant. The goodness-of-fit index was good in relation to typical standards (e.g., Comparative Fit Index (CFI) for the total sample .923, which indicates a ‘‘good’’ fit; X^2 = 450.907, df = 303 and RMSEA = 0.056).

Factors	Items
Mastery Goal Orientation (MGO)	In a class like this, I prefer course material that really challenges me so I can learn new things.
Extrinsic Goal Orientation (EGO)	Getting a good grade in this class is the most satisfying thing for me right now.
Task Value (TV)	Understanding the subject matter of this course is very important to me.
Self-Efficacy (SE)	I am certain I can understand the most difficult material presented in the readings for this course.
Elaboration (Elab)	When reading for this class, I try to relate the material to what I already know.
Organization (Org)	When I study the readings for this course, I outline the material to help me organize my thoughts.
Metacognitive Strategies (MCS)	Before I study new course material thoroughly, I often skim it to see how it is organized.

Table 1: Factors and Specimen Items of the Proposed Model.

Specifically, all indicators loaded strongly and distinctly on each of the latent constructs, with the standardized loadings being all above 0.46. As Figure 1 shows, the loadings of the two first order factors comprising the Cognitive Strategies second order factor were statistically significant and above 0.50. These results indicated that the hypothesized structures can be adequately represented through the one second order factor and the two first order factors.

A standardized solution for the model is presented in Figure 1. The results showed that self-efficacy is a good predictor of mathematics achievement; on the contrary self-regulation strategies use showed a statistically significant negative effect on mathematics achievement. It was also found that only task value beliefs constitute predictive factor of self-regulation strategies use, while on the contrary mastery and extrinsic goal orientation do not constitute predictive factors, since their loadings to self-regulation strategies use were not statistically significant. The fact that task value beliefs have a high effect on self-regulation strategies use shows that students who believe in the value of mathematics tend to use different cognitive and metacognitive strategies while working on mathematical tasks. The results of the study confirmed that mastery goal orientation, that is, intrinsic goals can predict a student's self-efficacy. Its causal effect on self-efficacy was very high, being .846. This finding indicates that mastery goal orientation is a strong predictive factor of self-efficacy and therefore has an indirect effect on achievement through self-efficacy.

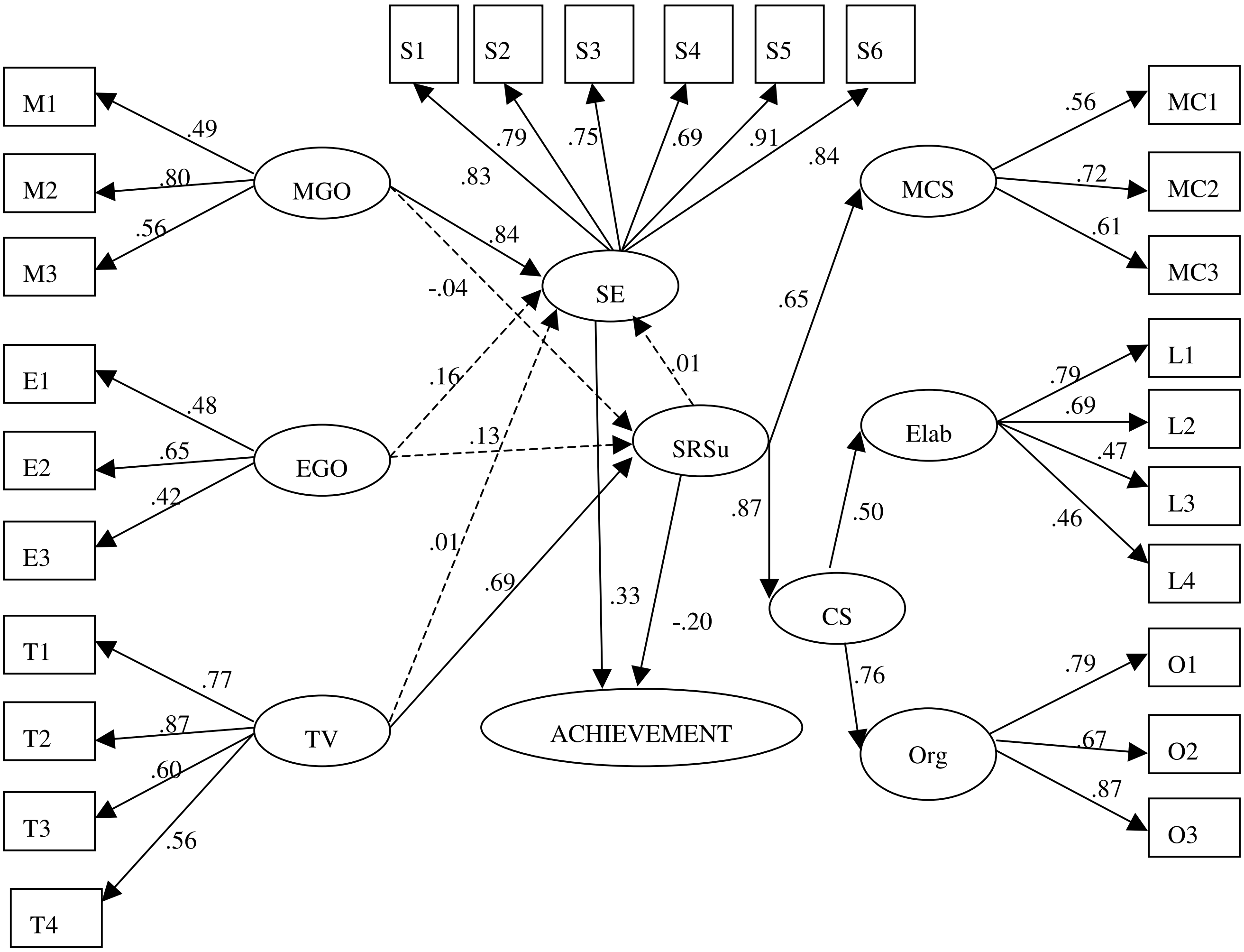

Figure 1: The proposed model with regression coefficients

Note: Regression values between latent factors appear in bold. Not statistically significant regressions appear in dotted line.

The main finding of the present analysis is that the developed model fits very well. This indicates that, first, the factor loadings reflect the relations between the particular indicators and the corresponding latent constructs and, second, the hypothesized constrained- data-based model can adequately explain the structure of the relationships between mastery goal orientation, self-efficacy, cognitive strategies, metacognitive strategies, and mathematics achievement. The second finding of the study is that self-efficacy is a strong predictor of mathematics achievement, while on the contrary self-regulation strategies use is a moderately negative predictor of achievement in mathematics.

DISCUSSION

The purpose of this study was to examine the relationships between motivational beliefs, self-regulation strategies use and mathematics achievement in Cypriot pre-service teachers. Consistent with our hypothesis and Pintrich and De Groot's findings (1990), we found that self-efficacy was a strong predictor of academic performance in mathematics. It seems evident that students with strong self-efficacy beliefs, mastery goal orientation and high task value, employ different kinds of cognitive and metacognitive learning strategies more actively and they are more sensitive to regulate their motivational beliefs (Pintrich, 1999). This finding is in line with efficacy theory (Bandura, 1986) and suggests that self-efficacy is adaptive and do help to promote and sustain self-regulated learning. However, there is need for more developmental and longitudinal research on how different motivational beliefs can influence self-regulation strategies use and at the same time how the use of various cognitive and metacognitive strategies influence students efficacy for learning, interest in the task, and the goals they adopt in mathematics (Tanner & Jones, 2003).

On the contrary, we found that self-regulation strategies use had a moderate negative effect on mathematics achievement. We particularly expected to replicate the results of studies which found a positive relationship between mathematics achievement and self-regulated strategies use (Pintrich & DeGroot, 1990). A possible reason for this may be the fact that pre-service teachers in Cyprus were found to hold high beliefs regarding their self-regulation strategies use regardless of their ability (Christou, Philippou & Menon, 2001). However, the present study is more specific than previous ones in that it examined a model for self-regulation in the domain of mathematics and explored how motivational beliefs like mastery goal orientation, task value and self-regulation strategies use affect the formation of self-efficacy and therefore mathematics achievement. In a more technical aspect, the contribution of the study can be drawn from the framework in which the analysis was conducted. The fact that the model containing the examined factors was validated using confirmatory factor analysis, ensured that motivational and self-regulation factors were correctly measured and therefore any relations that appeared hold true.

In this context, the results provide a strong case for the role of educators in the formation of pre-service teachers' self-efficacy beliefs both as students and as future teachers. On a practical level, prospective teachers should be well trained self-regulators so as to be able to teach these skills, since instructions to monitor the very early stages of skill acquisition may disturb the learning process (Bandura, 1997). In line with this, Boekaerts (1997) recommends that teachers should be trained to create effective environments in which students can learn to regulate their learning process and design tasks that help students improve their planning, organizational and metacognitive abilities.

Finally, a possible direction for future research in the area could be the investigation of the relationships between motivational beliefs and self-regulation strategies use in non traditional mathematics classroom settings, where teaching and learning should be designed to improve motivation or self-regulated learning (Pintrich, 1999).

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