Elementary Students' Self-efficacy, Reported use of Self-regulatory Strategies, and Enjoyment of Mathematics Learning

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Research showed that students with a positive self-efficacy in a given domain tend to use strategies for achieving learning objectives and tend to report improved feelings of enjoyment and higher motivation toward this given domain. The aim of this study was to investigate the relationships of students' self-efficacy regarding mathematics learning with the self-regulatory strategies they report using as well as with their reported enjoyment during mathematics engagement. Students of the fifth and sixth grade (N= 344) responded to a 5-point scale questionnaire regarding their self-efficacy in mathematics learning. They were also asked to report the strategies they use to self-regulate mathematics learning and the enjoyment they feel when engaging in mathematics. Exploratory factor analyses showed that self-efficacy items loaded on one single factor. The items of the self-regulatory strategy use questionnaire loaded on two factors. The first factor reflected use of strategies for Deep Comprehension and Memorizing, and the second factor reflected use of strategies for Metacognition and Reflection in mathematics learning. Inspection of Pearson correlation coefficients revealed that students' self-efficacy in mathematics was related to reports for using both groups of self-regulatory strategies. Self-efficacy was also strongly associated to students' reported enjoyment during engaging in mathematics. Students' reported use of strategies for Metacognition and Reflection was more strongly associated with their self-efficacy and with their enjoyment during engagement with mathematics than strategies for Deep Comprehension and Memorization. Partial correlations confirmed this result by revealing that the relationship of the reported use of strategies for Deep Comprehension and Memorization with self-efficacy and with feelings of enjoyment becomes much weaker when strategy use for Metacognition and Reflection was partialled out. The results are discussed within the frame of the interplay of students' motivational and affective factors with their learning behavior and the educational implications for students' mathematics learning.

Theoretical Framework

Currently, being competent in mathematics means both understanding, and being able to use mathematical concepts and procedures. To hold productive beliefs and affect, and to deploy strategic competence, metacognitive ability and self-regulatory skills are also important aspects of mathematical competence (Schoenfeld, 2006). A critical aspect in students' system of self-beliefs is self-efficacy. Bandura (1986) defined self-efficacy beliefs as: "Peoples judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (p. 391). A large amount of research showed that students' self-efficacy influences their academic motivation, learning, and achievement (Bandura, 1997; Lane & Lane, 2001; Pietsch, Walker, & Chapman, 2003; Zimmerman, 2000).

High self-efficacy may lead to more positive learning habits such as deeper cognitive processing, cognitive engagement, persistence in face of difficulties, initiation of challenging tasks, and use of self-regulatory strategies (Pintrich, 2000). At any level of ability, students with high perceived self-efficacy are more successful in school activities and use more effective learning strategies (Zimmerman 1995; Schunk & Ertmer, 2000). More specifically, students who believe that they are capable of performing academic tasks tend to use more cognitive and metacognitive strategies for achieving learning objectives and persist longer than those who do not hold such positive beliefs (Pajares, 1997; Wolters & Pintrich, 1998). Strategic action to effectively monitor and regulate learning and problem solving processes is considered as an essential component of self-regulated

learning and it is critical for successful performance (Alexander, Graham, & Harris, 1998; Weinstein, Husman, & Dierking, 2000). It has been proposed that self-efficacy operates during all the three phases of self-regulation, that is, forethought, performance, and self-evaluation based on reflection (Schunk & Ertmer, 2000). Literature on self-efficacy illustrates that it is positively related to the use of self-regulatory strategies during all the three phases of self-regulated learning (Zimmerman, Bonner & Kovach, 1996).

Findings also support that increasing students' feelings of competence in a given domain should improve their enjoyment and motivation towards this domain (Falco, Crethar, & Bauman, 2008). Moreover, it has been shown that students' reported enjoyment when dealing with mathematics has been associated with self-regulated learning and the use of strategies (Goetz, Hall, Frenzel & Pekrun, 2006). Research has shown that students often report that the aftermath of having been deeply involved in a task included strong positive emotions (Reed, Schallert, & Deithloff, 2002). These positive feelings, coming at the conclusion of a task, acted retrospectively, allowing students to bask in the pleasure of the experience and, prospectively, leading them to want to become involved again. However, this is a longitudinal process that was not addressed in the present investigation.

The Present Study

Aim

The aim of this study was to investigate the relationships between students' self-efficacy regarding mathematics learning, the learning strategies they report using during mathematics learning, and their reported enjoyment when dealing with mathematics. It was predicted that: a) students' self-efficacy would be positively related to the reported use of learning strategies in mathematics; b) Students' self-efficacy would be positively related to students' reported enjoyment when dealing with mathematics; and c) Students' reported enjoyment when dealing with mathematics would be positively related to the reported use of learning strategies.

Method

Participants

The study involved 344 primary school students from seven different primary state schools in Greece. The students were about equally distributed to the fifth and the sixth grade of primary school (173 students from 5th grade and 171 students from the 6th grade). Concerning the gender of the participant students, 52.6 % were males (181 students) and 47.4 % were females (163 students).

Instruments

Self-efficacy in learning mathematics. This questionnaire developed by Dermitzaki (1997) assessed students' reports about their self-efficacy in learning mathematics with 5 items. Answers were given on a 5-point scale from 1 (Not at all true for me) to 5 (Totally true for me). Principal component factor analysis using oblimin rotation suggested 1 factor with eigen value >1. The total variance explained by this one factor was 47.24% (5 items, α= .72, e.g., "I believe that I will get a very good grade this year in mathematics").

Self-regulatory strategies in mathematics learning. This questionnaire developed by Dermitzaki (1997) assessed self-regulatory strategies that primary school students report using during problem solving in mathematics. Eleven strategies and practices are included. Answers were given on a 5-point scale from 1 (I never do it) to 5 (I always do it). Principal component factor

analysis using oblimin rotation suggested two factors with eigenvalues greater than one, explaining 42.49 % of the variance. The first factor of the reported self-regulatory strategies was named "Metacognition and Reflection" (8 items, α= .75, e.g. "I think of different ways of solving a problem in mathematics, and then I choose the best way"). The second factor was named "Deep Comprehension and Memorization" (3 items, α= .60, e.g. "After I read carefully the problem to be solved or the unit to be learnt in mathematics, I verbalize in order to understand what the problem asks for").

Enjoyment when dealing with mathematics. This questionnaire was based on the work of Price and Mueller (1981) for adults and it was adapted to students' population. It includes three items assessing students' enjoyment when dealing with mathematics learning. Pilot study conducted with 125 students showed that the scale's internal consistency and structural validity were acceptable. Answers were given on a 5-point scale from 1 (I totally disagree) to 5 (I totally agree). Principal component factor analysis using oblimin rotation suggested one factor with an eigenvalue greater than one. The total variance explained by the one factor was 72.07% (3 items, α= .80, e.g., "I get real enjoyment when dealing with mathematics learning").

Procedure

Before distributing questionnaires, consent was sought from the Headmaster of each participating primary school. Once access was obtained, primary school teachers of the fifth and the sixth grade were personally approached during their break. They were asked to permit the researcher to distribute the questionnaires to their students and were informed that the whole process would last for 15 minutes. During questionnaire completion, all items were read aloud by the researcher, leaving a sufficient time between items for students to record their answers.

Results

Table 1 presents the descriptive statistics (means and standard deviations) of the variables under study and Table 2 shows the Pearson's r correlation coefficients between each of the factors. It has been found that the students' self-efficacy regarding mathematics learning was significantly and positively correlated with both factors of the reported strategy use, but most strongly related to the reported use of strategies for Metacognition and Reflection. Moreover, students' self-efficacy in mathematics learning and their reported enjoyment shared a strong positive correlation. Correlation coefficients also showed a significant positive relationship between both factors of self-regulatory strategy use reports and students' reported enjoyment when dealing with mathematics. Students' feelings of enjoyment when dealing with mathematics were most strongly correlated to the reported use of Metacognition and Reflection strategies.

A series of partial correlations were also performed on the data (see Table 3). In order to investigate the unique relationship of students' self-efficacy with the two categories of reported strategy use, two different analyses were conducted, one for each dyad of variables. In order to investigate the unique relationship of self-efficacy and of the two categories of the reported strategy use with students' enjoyment three different analyses were conducted. Table 3 shows that the correlation of self-efficacy with the reported use of strategies for Deep Comprehension and Memorization becomes much weaker when strategy use for Metacognition and Reflection was partialled out. Moreover, the correlation of students' reported enjoyment with their reported use of strategies for Deep Comprehension and Memorization was almost close to zero when the reported strategy use for Metacognition and Reflection and self-efficacy was partialled out.

Discussion

The purpose of this study was to explore, in a sample of fifth and sixth grade students, the relationships of students' self-efficacy regarding mathematics with their reported use of self-regulatory strategies underlying mathematics learning, and their reported enjoyment when dealing with mathematics. In general, the present study showed that there is a complex interplay between students' sense of personal efficacy in mathematics, their reported use of different categories of self-regulatory strategies, and their enjoyment when dealing with mathematics learning. Specifically, it has been demonstrated that students' self-efficacy was closely related to the reported use of self-regulatory strategies in mathematics learning. This finding is consistent with previous research showing that students who believe they are capable of performing academic tasks tend to use more cognitive and metacognitive strategies for achieving learning objectives and persist longer than those who do not hold such positive beliefs (Pajares, 1997; Pintrich, 2000; Wolters & Pintrich, 1998). The present study also showed that students' self-efficacy regarding mathematics learning was more closely related to the reported strategy use concerning Metacognition and Reflection than to the reported strategy use for Deep Comprehension and Memorization. This finding resembles previous research findings illustrating that students' self-efficacy is significantly related to critical thinking, and metacognitive self-regulation in traditional classrooms (Pintrich & De Groot, 1990; Zimmerman, 2000). Thus the first hypothesis of the study concerning the positive relationship between students' self-efficacy in their abilities to learn mathematics and their reported use of self-regulatory learning strategies in mathematics has been confirmed by the results of the study.

It has also been shown that students' self-efficacy was closely related to their reported enjoyment when dealing with mathematics. This finding confirms the second hypothesis of the study and it is consistent with previous findings supporting that increasing students' feelings of competence in a given domain should improve their enjoyment and motivation towards this domain (Falco, Crethar, & Bauman, 2008). The findings of this study also showed that students' feelings of enjoyment when dealing with the domain of mathematics share a close relationship with reported use of self-regulatory strategies supporting previous findings (e.g., Goetz, Hall, Frenzel & Pekrun, 2006) and confirming the third hypothesis of the study.

Partial correlations showed that students' self-efficacy in mathematics and their feelings of enjoyment when dealing with mathematics were mainly associated with the reported use of strategies for Metacognition and Reflection. Their relation with the reported use of strategies for Deep Comprehension and Memorization shares part of the variance with the reported use of strategies for Metacognition and Reflection. This finding supports the view that students' self-efficacy in mathematics and their reported enjoyment when dealing with mathematics are associated with their learning behaviors reflecting metacognitive and reflective processes, rather than with cognitive processing behaviors. Therefore, the findings of the present study underline the crucial role of motivational and affective factors for higher level processes in school mathematics.

Consequently, the present data suggest that students' beliefs of self-efficacy regarding mathematics learning might be significantly associated to their reported self-regulatory strategy use as well as to their enjoyment when dealing with mathematics. One of the limitations of the present study is that it focuses on students' self-reports concerning their self-regulatory strategy use and not the students' actual strategy use. In future research, there is a need for more objective measurements relying not only on self-reports but also recording the actual use of strategies in the classroom with their self-efficacy in mathematics learning, which should add important information for educators and teachers. Another limitation of the study is that these relationships have been investigated concerning only the mathematics domain, meaning that they do not necessarily hold in other domains as well. Future research should further investigate such relations by replicating them in other subject domains such as English or science.

Overall, this study provides further insight into the interplay between students' motivational and affective factors such as their self-efficacy in learning mathematics and their enjoyment when

dealing with learning processes such as self-regulatory strategy use. Thus, students' motivational and affective factors seem to play as an important role in the learning process as cognitive factors and, therefore, should be taken into consideration and not be undermined.

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Tables and Figures

Table 1. *Descriptive statistics*

	Mean	S. D.
Self-efficacy in learning mathematics	4.16	.62
Self-regulatory strategies		
1. Metacognition and Reflection	3.88	.65
2. Deep Comprehension and Memorization	4.13	.76
Enjoyment when dealing with mathematics	3.79	.89

Table 2. *Pearson r correlations coefficients*

Variables	1.	2.	3.	4.
1. Self-efficacy in learning mathematics	-			
Self-regulatory strategies				
2. Metacognition and Reflection	.52**	-		
3. Deep comprehension and Memorization	.42**	.62**	-	
4. Enjoyment when dealing with mathematics	.54**	.54**	.40**	-

Note. $N = 344$, * $p < .05$, ** $p < .01$

Table 3. *Partial correlation coefficients among the variables of the study.*

Variables	Self-regulatory strategies		
	Metacognition and Reflection	Deep comprehension and Memorization	Enjoyment when dealing with mathematics
1. Self-efficacy in learning mathematics	.36**[1]	.14**[2]	.35**[3]
2. Enjoyment when dealing with mathematics	.30**[4]	.04[5]	-

* $p < .05$, ** $p < .01$

Note: The partial correlation coefficient for each dyad of variables was computed partialling out all the rest variables. Specifically:

1. The effect of Deep comprehension and Memorization was partialled out.
2. The effect of Metacognition and Reflection was partialled out.
3. The effect of Deep comprehension and Memorization and of Metacognition and Reflection was partialled out.
4. The effect of Deep comprehension and Memorization and of self-efficacy was partialled out.
5. The effect of Metacognition and Reflection and of self-efficacy was partialled out.