



THE RELATIONSHIP BETWEEN SELF-EFFICACY, SELF-REGULATED LEARNING STRATEGIES AND ACHIEVEMENT: A PATH MODEL

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Introduction

Today's research studies on science education generally emphasize "learning how to learn" in science courses because it is possible to develop students' scientific literacy, which includes knowing how to learn and having the ability to apply scientific knowledge in real-life situations (Englert et al., 2009). In examining the setting of scientific literacy, one of the important issues of educational research studies has been the work on motivation and learning strategies which are directly related to the skill of learning how to learn (Warr & Downing, 2000). Parsons, Hinson and Brown (2001) concentrated on this theory and they relate it mostly to self-efficacy for learning and performance, which is one of the variables in motivation. Although the other motivational beliefs, namely goal orientations, control of learning beliefs, task value and test anxiety, can be included in the model, self-efficacy seems particularly important in students' academic achievement (Ning & Downing, 2010; Hampton & Mason 2003). Self-efficacy consists of people's judgments about their ability to perform a task and learners' confidence in their cognitive skills to learn (Pintrich, 1999). Researchers stressed the importance of self-efficacy to have high academic achievement (Diseth, 2011; Israel, 2007). Learners who have high self-efficacy generally attribute their failure to low effort rather than low ability, whereas learners who have low self-efficacy attribute their failure to low ability (Akin, 2008). Students with higher self-efficacy are likely to be sure of themselves when facing a complex problem, to search for a solution, to be patient in the process of solution, to put greater effort to be successful and to show intrinsic interest in the work (Sungur & Gungoren, 2009). Furthermore, educational studies indicated that self-efficacy is often a predictor of academic achievement (Ning & Downing, 2010; Hampton & Mason, 2003). According to Diseth (2011), self-efficacy

Abstract. *This structural equation modeling study aimed to investigate both direct and indirect relationships among self-efficacy for learning and performance, cognitive self-regulated learning strategies (CSR), metacognitive self-regulated learning strategies (MSR), time and study environmental management strategies (TSEM), effort regulation strategies and biology achievement of Turkish high schools students. Results of a path analysis showed that students who have high self-efficacy, MSR, TSEM and organizational strategies to complete a task in the face of difficulties can become successful in biology. Also, the findings were found that higher levels of self-efficacy directly associated with CSR, MSR, TSEM and effort regulation strategies. Moreover, mediator analyses explained several mediator effects between these variables that are discussed with the importance of motivational and learning strategies in achievement.*

Key words: *biology achievement, resource management strategies, self-efficacy, self-regulated learning strategies.*

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makes a positive contribution to academic achievement. Therefore, educational research studies try to show the relations between self-efficacy and students' academic achievement in different course subjects.

Due to the important effect of learning strategies on academic achievement, most researchers also concentrated on the relationships between students' achievement and self-regulated learning strategies. Self-regulated learning is defined as the strategies that students use to regulate their cognition (use of various cognitive and metacognitive strategies) as well as the use of resource management strategies which students use to manage and control their environment and also their learning (Pintrich, 1999). Cognitive learning strategies are one type of self-regulated learning strategies that serves to support the learners in order to be more successful and these strategies involve rehearsal, elaboration, organization and critical thinking (Bartels, Jackson & Kamp, 2009). Firstly, rehearsal strategies involve strategies such as recitation, reading aloud, highlighting or underlining. These strategies help students attend the lesson, select important information and keep information in the memory longer (Pintrich, 1999). Secondly, elaboration includes summarizing, creating analogies, generative note-taking, explaining the ideas and asking and answering questions (Weinstein & Mayer, 1986). Thirdly, organizational strategies include selecting the main idea, outlining and using a variety of specific techniques for selecting and organizing the ideas (Weinstein & Mayer, 1986). Finally, critical thinking is the other cognitive self-regulated learning strategy (CSR). Paul (1992) defined critical thinking as an important process to shape and evaluate decisions about definite circumstances. In all educational systems, the programs should be evaluated according to the appropriateness of the needs of evolving and rapidly changing world and they should allow students to have critical thinking skills to detect problems and investigate the solutions. It is very important that students learn by examining, thinking critically and making some regressions and inferences. Besides all of these strategies, educational studies involved another important strategy called metacognitive self-regulated strategy (MSR) which enables students to control and regulate their own learning (Pintrich, 1999). Pintrich, Woters, and Baxter (2000, as cited in Tobias, 2006) stated that metacognition learning strategies are divided into three components: monitoring of learning processes, knowledge about cognition, and control of the processes. Other aspects of self-regulating learning include time management (TSEM) and the ability to regulate one's own effort (Zimmerman & Risemberg, 1994). TSEM involves planning the necessary time for learning and making use of time well and it is minimizing external stimulus which causes learning disabilities in order to regulate the study environment (Weinstein & Mayer, 1986). The study of Vrugt and Oort (2008) noted that students, who were better time planners, were more efficient in using cognitive strategies than others. Parallel to this idea, Ning and Downing (2010) indicated the relationships among TSEM, self efficacy and self-regulated learning strategies of undergraduates in Hong Kong. Moreover, they examined the reciprocal interplay between students' self efficacy and self-regulation in influencing academic achievement. Another self-regulation strategy, namely effort regulation, is the ability to deal with failure (Chen, 2002). Effort regulation is "the tendency to maintain focus and effort toward goals despite potential distractions" (Corno, 1994, p. 229). It reflects a commitment to completing one's study goals by directing and controlling one's energy toward them. In an academic situation, effort regulation can be used to build learning skills gradually and to help students handle many distractions in and outside schools (Alderman, 1999). Research shows that effort regulation was a strong predictor of academic success; however, traditional college instruction generally assumes that students possess such skills and does not provide opportunities for effort regulation skills to develop (Lee, 1997).

Problem of Research

Over the years, educational studies have presented the relationships among motivational strategies, learning strategies and achievement by using correlation analysis (Veenman, Wilhelm, & Beishuizen, 2004), crosstab analysis (Panaoura, Philippou, & Christou, 2003), qualitative methods (Wilson & Clarke, 2004) and experimental methods (Kramarski, Mevarech, & Arami, 2002). Many of the afore-cited studies provide evidence in favor of the positive unilateral relation among the components of motivational variables, learning strategies and science achievement. This, however, cannot explain specifically to



what extent these variables influence one another, directly or indirectly (Aydın & Ubuz, 2010). Therefore, it is possible to investigate the structural relations among motivational strategies, learning strategies and academic achievement with each other (Sungur & Gungoren, 2009). This is why the purpose of the study is to investigate the structural relations among the variables by using LISREL analysis in order to determine multivariate relations through path analysis. Veenman, Van Hout-Wolters, and Afflerbach (2006) stated that the structural equation modeling (SEM) could be used to determine multivariate relations among latent variables.

Most of previous research particularly focused on structural relations between university students' academic achievement and motivational self-regulated strategies (Henning & Shulruf, 2011; Rahim & Fariba, 2011; Al-Harthy, Was & Isaacson, 2010; Roman, Fenollar & Cuestas, 2008; Vrugt & Oort, 2008). These studies were interested in psychology, social sciences, computer-supported learning. Moreover, in recent literature, much is known about the structural relations between high school students' science achievement and their motivational self-regulated strategies (Sungur, 2011; Reyes, 2011; Lou & Roeser, 2010; Partin, 2008). These studies, however, cannot provide specifically substantial evidence in favor of the direct or indirect relations among motivational self-regulated strategies and students' learning outcome and accomplishment in biology. Generally, context of the assessments mainly focused on students' natural science achievement, but rarely on pure biology achievement (Yoon, 2009). However, natural science includes not only biology but also astronomy, geology, physics and chemistry courses. The work of Reyes (2011) showed that the types of motivation effecting performance differ across different subjects. Parallel to this idea, Mayr (2001) stated that most people receive the meaning of science as physics, chemistry, mechanics and astronomy which rely heavily on mathematics. Unlike other disciplines, biology is the science of the living world. The teaching of biology at high schools focuses on the whole organism, life history, behavior and ecology. Therefore, student's answer could vary according to which science courses they think while filling out questionnaire in the studies. Especially, in Turkey, a few studies used SEM to emphasize to what extent motivational self-regulated strategies and high school students' biology achievement influence one another, directly or indirectly (Cakıcı, Arıcağ & İlğaz, 2011). In line with the related literature, the current study specifically aimed at testing structural equation model to investigate the relationships between motivational self-regulated strategies and students' achievement in biology. Besides that, the relevant literature stressed that the relationships between motivational self-regulated strategies and students' academic achievement may diverge when the culture, grade level, subject area and age of participant are taken into consideration (Reyes, 2011; Pintrich, 2000). According to Purdie and Hattie (1996), the students' strategy use may vary in different countries and cultures and it would be significant to have variety of studies in literature. Therefore, much more research is needed in different cultural environments, grade levels, different subject areas and different age levels to draw structural associations between motivational self-regulated strategies and students' academic achievement (Akyol, Sungur & Tekkaya, 2010). Having established these facts mentioned above, the present study emphasized the structural relations among Turkish high school students' motivational and self-regulated learning strategies and biology achievement.

Research Focus

As discussed in the literature review above, research hypothesized that self-efficacy, rehearsal, elaboration, organization, critical thinking, MSR, TSEM and effort regulation would be related to high school students' biology achievement. Abundant research revealed that higher achievers have high level of self-efficacy, control their learning environment and use more self-regulatory learning strategies, namely TSEM and effort regulation. Limited research, however, was conducted specifically in high school biology classes in Turkey. Consequently, the current paper presents a path model to investigate the structural relationships among self-efficacy, rehearsal, elaboration, organization, critical thinking, MSR, TSEM, effort regulation and biology achievement of high schools students. The proposed structure of the model is summarized schematically in Figure 1.

The first link in the conceptual model concerns the effect of self-efficacy beliefs and self-regulated



learning strategies on biology achievement in line with the related literature (Kurbanoglu & Akın, 2010; Sungur & Güngören, 2009; Hampton & Mason 2003).

It was hypothesized that self-efficacy (SELF), rehearsal (REH), elaboration (ELAB), organization (ORG) and critical thinking strategies (CRITIC), metacognitive self-regulated learning strategies (MSR), time/study environmental management (TSEM) and effort regulation (EFFORT) were related to students' biology achievement.

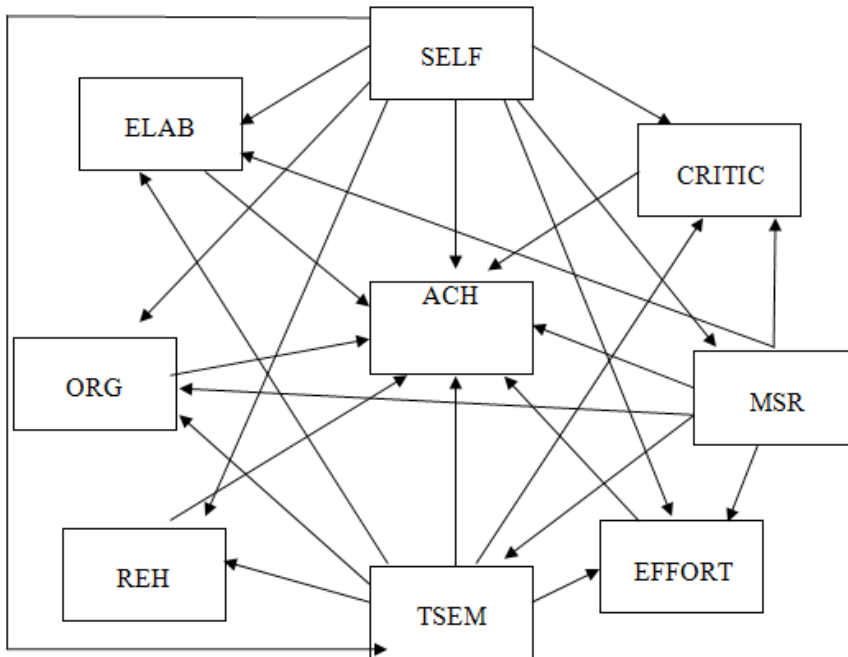


Figure 1: Conceptual path model evaluating self-efficacy (SELF), rehearsal (REH), elaboration (ELAB), organization (ORG) and critical thinking (CRITIC), metacognitive self-regulated learning strategies (MSR), time/study environmental management (TSEM), effort regulation (EFFORT) and students' achievement in biology (ACH).

In the second pattern, since it was confirmed that self-efficacious students can use different cognitive strategies (Sungur, 2007), a link was specified between SELF and all cognitive learning strategies (REH, ELAB, ORG, CRITIC). Also, links were specified between SELF and TSEM since students with a high sense of self efficacy are expected to be a better time or study environment planner (Ning & Downing, 2010). Additionally, a direct link was specified between SELF and EFFORT because students who are self-efficacious in their learning have an effort to learn even when they encounter with a difficult task (Sungur, 2011). Since students who are better time planners are more efficient in using cognitive self-regulated learning strategies than others (Hurk, 2006), a link was specified between TSEM and CSR use. Moreover, as the CSR and MSR are used by self-regulated learners who have high motivation to regulate their cognition and effort (Sungur, 2011; Sungur & Gungoren, 2009), links were specified between MSR and CSR, MSR and SELF and finally, MSR and EFFORT.

In the proposed model, as mentioned above, a direct link was specified between students' biology achievement and motivational self-regulated learning strategies. Also, theoretical assumptions and previous research findings provide a basis for the investigation of the mediating variables in the model (Reyes, 2011; Ning & Downing, 2010; Al-Harthy & Wos, 2010). For example, the work of Lau and Roeser (2002) indicated the indirect effects of cognitive variables on students' science engagement (Lau & Roeser, 2002). Similarly, Al-Harthy and Wos (2010) found that there were no significant direct effects of



cognitive strategies on students' total scores. However, they can be effective when other motivational self-regulated variables were taken into consideration as the mediator. Although more connections can be indirectly included in the model, the effects of rehearsal, elaboration, organization and critical thinking strategies on achievement mediated by the other variables of the study seem particularly important to constitute the conceptual model. Therefore, we had also hypothesized that CSR would have indirect effect on students' biology achievement through the mediator of self-efficacy, MSR, TSEM and effort regulation.

Methodology of Research

This study is based on a survey design with a purpose of exploring relationships between the ninth and tenth grade students' self-efficacy, self-regulated learning strategies use and biology achievement during the spring semester of 2012 in Anatolian High Schools in Karaman, Turkey.

Sample of Research

The sample was 428 9th/10th grade students from an urban area, called Karaman, in the Turkey. Students' age ranged from 14 to 18 years, with a mean age of 15, 29 (SD=0.60). Of the group, 236 (55.1%) were women and 192 (44, 9%) were men. A random sample of convenience was used in the study. All tenth and ninth grade students in all Anatolian High School in Karaman were identified as the target population of this study. This is the population which the results of the study has been generalized.

Instrument and Procedures

The students who participated in the study took the questionnaire (explained below) at the same time in each school. All questionnaires were completed during a class hour, which was approximately 40 min. Teachers made all required disclosures before the administration of the survey. All students knew that their names would be absolutely kept secret.

Six biology exam grades of the students in 2011-2012 academic year were taken from school administrator to be used in the statistical analyses of the study. The participants of the study are responsible for six general biology exams during one academic year. In each semester, the students take three general biology exams. The examination scores range from 1 to 5 (higher numbers reflected better grades). In the study, these six biology exam grades were used as current biology achievement.

The Motivated Strategies for Learning Questionnaire (MSLQ) was developed by Pintrich, Smith, Garcia and McKeachie (1991). The Turkish version of the Motivated Strategies for Learning Questionnaire was used to collect the data. The instrument was translated and adapted into Turkish by Sungur (2004). The MSLQ is a self-report instrument to measure motivational orientations and self-regulated learning strategies. The motivation section consists of 31 items with six subscales (intrinsic and extrinsic goal orientations, task value, control of learning beliefs, self-efficacy for learning and performance, text anxiety) and learning strategies section consists of 50 items with nine subscales (Rehearsal, elaboration, organization, critical thinking, MSR, TSEM, effort regulation, peer learning, help seeking). These two scales are modular and can be used to fit what the researcher wants to search in his/her study. In this study, only one subscale of motivation section (self-efficacy for learning and performance) and four subscales of learning strategies section (CSR, MSR, TSEM and effort regulation) were used to assess students' motivational belief and learning strategies. In accordance with the purpose and hypothesis of the study, these subscales were selected to identify the importance of both learning and motivational variables as predictors of students' biology achievement. The MSLQ was designed to be rated on a 7-point rating type of format from 1 point (not at all true of me) to 7 point (very true of me). Sample items and Cronbach's alpha reliability for each scale are summarized in Table 1.



Table 1. Sample items and reliabilities for the MSLQ scales.

Scale	Sample item	Reliability Coefficient
Self-efficacy	I expect to do well in biology courses.	0.80
Rehearsal	When I study biology, I read my notes over and over again.	0.65
Elaboration	I try to understand biology by making connections between the readings and the concepts from the lesson.	0.60
Organization	I make simple charts, diagrams, or tables to help me organize biology material.	0.62
Critical thinking	Whenever I read a conclusion in biology courses, I think about possible alternatives.	0.57
Metacognitive self-regulation	If biology readings are difficult to understand, I change the way I read the material.	0.72
Time/study environmental management	I make good use of my study time for biology course.	0.61
Effort regulation	I study hard for biology course even if I don't like what we are doing.	0.61

Results of Research

Descriptive Statistics

Descriptive statistics related to scores about students' motivational beliefs, self-regulated learning strategies and biology examination grades were presented in Table 2. Basic statistics like mean, range and standard deviation (SD) were obtained by means of SPSS 16.0.

Table 2. Descriptive statistics with respect to students' motivational beliefs and learning strategies.

	Mean	Range	SD
Self-efficacy	3.83	1-7	1.75
Rehearsal	4.81	1-7	3.29
Elaboration	4.50	1-7	3.83
Organization	4.43	1-7	3.16
Critical thinking	4.34	1-7	3.16
Metacognitive self-regulation	4.46	1-7	3.26
Time/study environmental management	3.62	1-7	3.65
Effort regulation	4.14	1-7	2.15
Biology examination grades	3.31	1-5	1.06

Mean scores of the variables are similar to values in other studies in Turkey (Akyol, Sungur, Tekkaya, 2010).



The Relationships among Variables of the Study

Pearson correlation analysis was carried out to explore the relationships that might exist among students' biology examination grades, self-efficacy, rehearsal, elaboration, organization, critical thinking, MSR, TSEM strategies and effort regulation (Table 3).

Table 3 shows that biology examination grades were significantly and positively correlated with self-efficacy ($r=0.32$, $p<0.000$), rehearsal ($r=0.28$, $p<0.000$), elaboration ($r=0.18$, $p<0.000$), organization ($r=0.23$, $p<0.000$), critical thinking ($r=0.15$, $p<0.000$), MSR ($r=0.18$, $p<0.000$), TSEM ($r=0.20$, $p<0.000$) and effort regulation ($r=0.19$, $p<0.000$). Of particular interest among the correlations is the one between biology examination grades and self-efficacy for learning ($r=0.32$). This correlation is the largest correlation of all motivational self-regulated strategies with biology examination grades.

Table 3. Correlation coefficients among variables of the study.

	1	2	3	4	5	6	7	8	9
1. Biology examination grades	-	0.32**	0.28**	0.18**	0.23**	0.15**	0.18**	0.20**	0.19**
2. Self-efficacy		-	0.34**	0.42**	0.29**	0.05	0.35**	0.34**	0.24**
3. Rehearsal			-	0.51**	0.54**	0.06	0.41**	0.39**	0.15**
4. Elaboration				-	0.62**	0.05	0.42**	0.28**	0.18**
5. Organization					-	0.03	0.41**	0.31**	0.26**
6. Critical thinking						-	0.30**	0.01	0.11*
7. Metacognitive self-regulation							-	0.35**	0.14**
8. Time/study environmental management								-	0.23**
9. Effort regulation									-

(** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level)

Moreover, all motivational self-regulated variables were significantly and positively correlated with each other as specified by the theory. On the other hand, critical thinking ability was significantly correlated with only biology examination scores, MSR and effort regulation. The correlations between critical thinking ability and students' other motivational self-regulated strategies were not found in the study.

Path Analysis

The LISREL 8.72 program in the SIMPLIS programming language was used to test the hypothetical model with maximum likelihood estimation. The most widely used fit indices namely, Comparative Fit Index (CFI), Goodness-of-Fit Index (GFI) and Root Mean Squared Error of Approximation (RMSEA) gave us evidence to support adequate model-to-data fit (Vierra, 2011). For example, the CFI and GFI values mostly exceeded 0.90 for the present study and indicated a good fit to data. Moreover, the RMSEA values below 0.05 indicate a good fit to the data and below 0.08 indicate reasonable fit to the data (Vieira, 2011). The RMSEA values for the present study were acceptable to show how well the model fit to data.

Since the fit indices appeared to be suitable in the assessment of the proposed model, the direct and indirect effects of the motivational self-regulated variables on students' biology achievement were analyzed and graphically presented (Figure 2).

In the path model, self-efficacy for learning and performance (SELF), organizational strategies (ORG), metacognitive self-regulated learning strategies (MSR), time/study environmental management (TSEM) and effort regulation (EFFORT) had a significant positive direct effect on biology achievement (ACH) (RMSEA=0.054, GFI=0.97, CFI=0.89). Students who have high self-efficacy beliefs, MSR, TSEM,



organizational strategies and ability to complete a task in the face of difficulties can become successful in biology. Also, parameter estimates revealed that higher levels of self-efficacy were positively and directly associated with CSR variables ($\beta=0.06$ for rehearsal, $\beta=0.17$ for organization, $\beta=0.56$ for elaboration), MSR ($\beta=0.19$), TSEM ($\beta=0.52$) and effort regulation ($\beta=0.26$). Students who have a high level of self-efficacy tend to be self-regulated learners and to use resource management strategies such as time, environment, and effort. Moreover, MSR had a significant direct effect on CSR variables ($\beta=0.16$ for rehearsal, $\beta=0.20$ for organization, $\beta=0.15$ for elaboration $\beta=0.09$, for critical thinking), TSEM ($\beta=0.41$) and effort regulation ($\beta=0.40$). Students who use MSR skills can also use the appropriate ways of cognitive processing and manage their time and effort. Similarly, TSEM were positively associated with rehearsal ($\beta=0.09$), organization ($\beta=0.18$), elaboration ($\beta=0.28$) and effort regulation ($\beta=0.52$). The model accounted for 27% of the variance in biology examination grade, and it showed very good fit to the data ((RMSEA=0.0060, GFI=0.91 and CFI=0.95) according to the recommended cut-off values for these fit indexes (Vierra, 2011). Alternative paths (direct effects), as shown at Figure 1, were tested but they did not produce significant results.

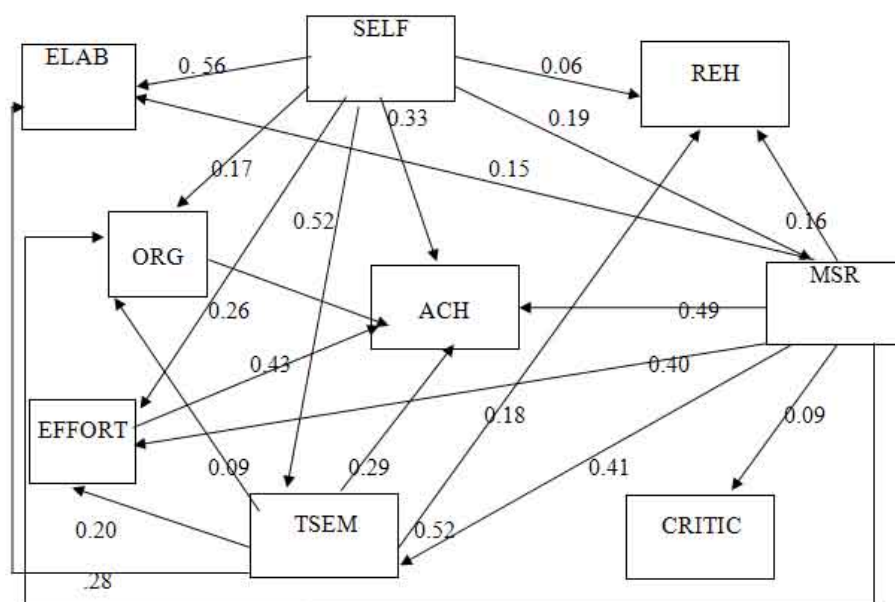


Figure 2: Structural Equation Modeling of the Relationship Among Self-Efficacy (SE), Rehearsal (REH), Elaboration (ELAB), Organization (ORG), Critical Thinking (CRITIC), Metacognitive Self-Regulated Learning Strategies (MSR), Time/Study Environmental Management (TSEM), effort regulation (EFFORT) and Achievement of High School Students in Biology (ACH).

The indirect effect of rehearsal on biology achievement was $\beta=0.15$, via MSR (RMSEA=0.041, GFI=0.98, CFI=0.99). Similarly, MSR significantly mediated the effect of critical thinking ($\beta=0.12$) on biology achievement (RMSEA=0.054, GFI=0.98, CFI=0.98). Additionally, self-efficacy for learning and performance mediated the impact of the elaboration ($\beta=0.26$) on student' biology achievement (RMSEA=0.041, GFI=0.98, CFI=0.99).

Discussion

In the present study, a structural model was utilized to explain the relationships among self-efficacy for learning and performance, CSR, MSR, TSEM and effort regulation self-regulated learning strategies



use in biology courses. There was strong support for the hypothesized relationships. With respect to the structural model estimating the effects of motivational and learning factors on biology achievement, the findings mentioned below are discussed.

Results revealed that self-efficacy for learning and performance predicted high school students' biology achievement, as hypothesized. This is in accordance with previous research (Diseth, 2011; Ning & Downing, 2010; Israel, 2007) indicating that students who feel more efficacious about performance in the classroom are more successful than students who are concerned about their ability to do well in the lesson. Students with high self-efficacy beliefs appeared to have a plan to persevere when confronting obstacles in biology course and they approach difficult biological tasks and activities with confidence. Therefore, self-efficacy can be a major focus for biology education and for educators who desire to increase students' achievement and responsibility in biology. Moreover, the present study's findings showed that metacognitive self-regulated learning strategies had the strongest predictive power on biology achievement ($\beta = 0.49$). Accordingly, students know how to control their cognition and show a higher performance in biology classes. When students organize, comprehend and understand material easier and integrate new knowledge with prior knowledge and adjustment of cognitive activities in biology classes, they take the responsibility for their learning and know how it is possible to control their cognitive strategies to have an effective learning progress. This finding could be possible for Turkey since the national science curriculum was reorganized to support problem solving and decision-making ability (Akyol, Sungur & Tekkaya, 2010; MONE, 2006). Therefore, the study provided a support to the growing body of literature showing that achievement of the students who use the metacognitive as well as CSR (who are self-regulated learners) are higher than others who are not self-regulated learners (Ning & Downing, 2010; Cekolin, 2001).

In the present study, among CSR, only organization strategy was found to be a significant predictor of ninth and tenth grade students' biology achievement. This is not surprising since organization strategies such as out-lining and concept mapping, help to build connections among ideas (Al-Harthy & Was, 2010), so these higher-level strategies provide a unity of meaning and enhance the understanding of the subject. Also, previous research studies supported this finding that organization strategies were found to be positively correlated to achievement (Stefanou & Salinbur-Gelonon, 2001). However, the present study could not demonstrate the direct effects of other CSR, namely rehearsal, elaboration and critical thinking on biology achievement. Akyol, Sungur and Tekkaya stated that elaboration, organization and MSR directly contributed to the prediction of students' science achievement. Vanderstoep, Pintrich and Fagerlin (1996) found that rehearsal, elaboration and organization strategies use distinguish high and low-achieving students in biology because high-achieving students can use appropriate surface/deep strategies to achieve their goals. The previous studies also stated that students who reported using strategies such as rehearsal, elaboration, organization and critical thinking were more likely to do better than students who reported lower frequency use of these strategies (Puzziferro, 2008). They revealed that CSR are highly related to the quality of learning and they promote students' achievement in biology. Although all cognitive self-regulated learning strategies significantly predicted students' achievement in the literature given above, the direct effects could not be found in the present study among these variables. Consequently, the indirect effects between CSR and biology achievement were investigated within the scope of this study. As a result, the indirect effects were found between CSR and biology achievement via MSR and self-efficacy for learning and performance. One of the indirect effects is that MSR mediated the effect of rehearsal strategies and biology achievement. The studies which have been determined the relationships between CSR and MSR have been supported by the current study (Loyens, Rikers & Schmidt, 2008; Kert, 2008). The results showed that there are structural relations between conceptions of constructivist learning and regulation and processing strategies. Moreover, findings showed that students regulate their performance in academic tasks by using a variety of cognitive, volitional and motivational strategies and also, the students' motivational regulation were related positively to their goal orientation, use of some cognitive strategies and achievement. It is clear that both CSR and MSR are necessary to be successful. Pintrich et al. (1991) confirmed that self-regulation included CSR and MSR use and they were all significantly correlated with each other. In addition, some of the studies stated that the relationship between rehearsal or surface cognitive strategies and achievement was significant and



negative (Diseth, 2011; Vrugt, 2008). The reason for this could be that rehearsal strategies just help to encode new information into short-term memory by repetition, highlighting and memorization (Pintrich, 1999). As a result, information is forgotten very quickly. Although rehearsal is one of the surface learning strategies, if a student does planning, monitoring and regulating while learning, rehearsal strategies will be useful to increase his/her achievement. The results of the present study also showed that MSR have a mediator effect between critical thinking strategies and biology achievement. The reason for this could be the relation between CSR and MSR. All these strategies complement each other. Like the relation between MSR and CSR, there is a relation between self-efficacy for learning and performance and CSR. A review of most of the studies showed that self-efficacy is positively correlated with CSR (Pajares, 2003, Shrunck & Ertmer, 2000). Accordingly, students' self-efficacy and use of CSR in science class were the most important factors directly influencing their scientific inquiry skills. In addition, they reported that self-regulated learning activities were significantly related with knowledge acquisition, skilled performance and self-efficacy. Based on the previous studies, the present study also demonstrated that self-efficacy is linked in important ways to the use of learning strategies through the use of CSR. The model provides evidence that students who have high self-efficacy for learning and performance are more likely to be cognitively engaged in learning. On the other hand, findings of the limited number of studies showed that deep and surface learning strategies mediated the effect of self-efficacy for learning and performance on biology achievement (Reyes, 2011; Yang, 2005). However, these previous studies did not adequately test whether self-efficacy for learning and performance mediates the effect of elaboration strategies on biology achievement. In the present study, this question is also answered. The model provides evidence that self-efficacy for learning and performance mediated the effects of elaboration strategies on biology achievement. This evidence reveals the importance of having both strategies together. It means that not only using elaboration strategies, such as summarizing and creating analogies, but also having high self-efficacy should be important to be successful in biology class.

The other direct effects in the study are between self-efficacy and rehearsal, organization, elaboration, MSR, TSEM and also effort regulation. These findings support previous research (Sungur, 2011; Pintrich, 1999) indicating the relations between self-efficacy and MSR and CSR, TSEM and effort regulation. Higher levels of self-efficacy for learning and performance were related to higher levels of CSR and MSR use. Students who have high level self-efficacy can focus on learning and need to plan and seek for their motivational and learning strategies and monitor their progress. They can be responsible for their work and evaluate their understanding. Moreover, it is believed that regulating time and study environment is important to be successful and that their efforts to study are influential in having self-efficacy in learning and performance. Students with high levels of self-efficacy make an effort to learn in spite of some difficulties with the help of the CSR and MSR, TSEM and also effort regulation strategies.

The significantly positive direct effects of TSEM and effort regulation on biology achievement presented in the model could shed some light on the relationship claiming that students who regulate their time and study environment are more successful than the other students who do not, which is raised by several researchers (Vrugt & Oort, 2008; Dupeyrat & Marine, 2005). TSEM involves making use of time well and regulating the environment for learning. Also, MSR use includes planning, monitoring, and regulating. These similar explanations may be reason why MSR strategy use predicted TSEM. Thus, students who were more efficient in using MSR were better time planners and better organizers for their study environment than others.

Conclusion and Implication

In the present study, a structural model was utilized to explain the relationships among self-efficacy for learning and performance, self-regulated learning strategies and achievement of high school students in biology. The findings of the study showed that students who use the strategies to regulate their cognition are more successful than the students who do not control and regulate their own learning. This is because all CSR help students' select and keep important information in their memory and self-efficacy for learning and performance involves beliefs about how well to perform academic activities. Cognitive and motivational strategies are useful to predict and improve the students' learning goals,



social reinforcement goals, and achievement. In other words, students' self-efficacy beliefs play an important role in their academic motivation, learning and achievement. In conclusion, results show that students who are proficient in using self-regulated learning strategies, improving their feeling of well-being self-assessment, managing their time and study environment and having study goals and efforts have become more successful in studying than the others have.

The educational implications of these findings lead us to believe that teachers and parents can promote students' academic performance in biology by focusing on how their students/children learn. What are their learning processes? Which motivation and learning strategies do they use? They can benefit from this study by enhancing skill development and learning directly motivation and learning strategies; and by enhancing young people's motivation to learn these strategies and how to learn. This dual focus should enhance students' ability to feel more successful, solve complex problems, control their cognition, organize learning material easier, regulate their performance, time and study environment and also complete their study goals.

According to the study's findings, following suggestions are made to students and teachers. Teachers should be trained on learning and motivational strategies before teaching the students how to use the strategies effectively. In addition to teachers should concentrate on how it is possible to improve motivation and learning strategies during the learning process and at this point, they can benefit from theoretical framework and empirical findings as exemplified by the present study. Also, students are required more effective and independent, they need more training to be given in the form of CSR and MSR, TSEM and also, effort regulation strategies during biology class. This study shows that learning and motivational strategies drive students to success in biology. Providing students with knowledge about various strategies during learning will encourage them to learn effectively.

The present study has some limitations for researchers to consider in any attempt to generalize the results. First, the participants of the study were limited to 428 ninth and tenth grade students at four public high schools located in an urban area. Data from other school districts and from different school types might provide different results. Second, all subjects of the study responded sincerely to the items on the self-report questionnaire; however, it may be difficult to obtain reliable reflections of subjects. Therefore, future research studies should use different materials to verify the findings of the present study.

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