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Abstract. *Self-regulated learning skills (such as goal setting, organizing environment and time, seeking help and self-evaluation) are critical for students to be able to successfully and meaningfully learn abstract concepts such as reduction, oxidation and electrolysis. The purpose of this research was to examine the relationships between self-regulated learning skills and chemistry achievement in Turkish secondary school students. Therefore, a structural equation model was developed and tested to model the relationships among task value, control of learning beliefs, performance-approach goals, mastery-approach goals, self-efficacy for learning and performance, metacognitive learning strategies, time and study environment management, effort regulation, and achievement in electrochemistry. Data was collected from 481 secondary school students through administration of the Achievement Goal Questionnaire, the Motivated Strategies for Learning Questionnaire and the Electrochemistry Concept Test. The results showed that students' task value, performance-approach goals, and time and study environment management significantly positively correlated with achievement. Path analysis demonstrated that metacognitive learning strategies, mastery-approach goals, and effort regulation were predictors of students' time and study environment management. Moreover, effort regulation, metacognitive learning strategies, and mastery-approach goals were found to have indirect effects, which were mediated by time and study environment management.*

Key words: *chemistry achievement, direct and indirect effects, self-regulated learning skills, secondary school students, path model.*

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THE RELATIONSHIP BETWEEN SECONDARY SCHOOL STUDENTS' SELF-REGULATED LEARNING SKILLS AND CHEMISTRY ACHIEVEMENT

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Introduction

Self-regulation develops in social settings according to social cognitive theory and it is internalised by individuals through time. Bandura (1986) defines self-regulation as individuals' observation of their own behaviour and their making judgements by making comparisons according to their criteria, and regulating their behaviours again according to their criteria when necessary. Self-regulation is individuals' thoughts, feelings and behaviours, which emerge in a planned and cyclical way, which individuals develop to attain their personal goals (Zimmerman, 2000). Pintrich (1999), however, describes self-regulation as an active and constructive process, in which learners identify their learning goals, monitor and regulate their cognition, motivation and behaviour. Self-regulation contains cognitive, metacognitive and motivational components. Therefore, self-regulated learners play active roles in the learning process metacognitively, motivationally and behaviourally, they set their own learning goals, and they control the process (Zimmerman, 2000). The cognitive component of self-regulation is associated with strategies learners use in performing a task. The strategies may be in the form of rehearsal (reciting or naming items from a list), elaboration (interpret, summarize, simulate and take notes) and organisation (grouping or classification, outlining, identifying the main idea). Motivational component contains students' beliefs about their skills such as self-efficacy and task value. Metacognitive component involves setting goals, students' monitoring their progress through self-reflection (Ramdass & Zimmerman, 2011).

In the literature, the relationship between learning strategies and motivational components (task value, control of learning beliefs, goal orientation, and self-efficacy) has been explored in several studies (Alpaslan, 2016; Pintrich, 1999; Pintich & DeGroot, 1990; Pintrich & Schunk, 2002; Yumuşak, Sungur, & Çakıroğlu, 2007; Zusho, Pintrich, & Coppola, 2003). Thus, in this research, students' task value, control of learning beliefs, goal orientation, and self-efficacy were examined in relation to their use of metacognitive learning strategies, effort regulation, time and study environment management, and chemistry achievements. Self-efficacy for learning and performance



(expectancy component) contains learners' expectancy for success and for self-efficacy. Expectancy for success includes performance-based expectancy mostly and it is related especially with task performance. Expectancy for self-efficacy is the self-appraisal of ability to perform a task (Pintrich, Smith, Garcia & McKeachie, 1991). A student can have self-efficacy of differing levels in differing topics, or he/she can have self-efficacy of differing levels in differing situations or settings. It is thought that the environment influences self-efficacy and that it influences the environment. It is also thought that students with high level of self-efficacy tend to control the stimulants coming from the environment and distracting them in their efforts to perform their task of learning. Students considering themselves competent in fulfilling a task and having self-confidence in terms of their capabilities are more successful (Bandura, 1997; Schunk, 1991).

The second motivational component in this research is beliefs in task value. Task value is different from goal orientation. Task value includes students' beliefs in their evaluations of how interesting, how important and how useful a task is. (What do I think of this task?). Goal orientation, on the other hand, demonstrates students' reasons for why they have participated in a task (Why am I doing this?). High task value assures more participation in learning process. Another motivational component included in this research is the variable of control of learning beliefs. Control of learning beliefs are learners' beliefs that their efforts for learning will yield positive outcomes. Students with high level of control of learning beliefs believe that learning outcomes depend on their own efforts, not on external factors such as the teacher. On encountering failure, such students do not accuse their teacher of their own failure, but they think that it is connected with their efforts. If students believe that their own efforts cause big differences in their learning process as in this case, they are more like to study in a more strategic and effective way (Pintrich et al., 1991).

The final motivational component included in this research is goal orientation. Goal orientation is students' perceptions of their reasons for why they have engaged in a learning task (Pintrich et al., 1991). Goal orientation can be defined as individuals' goals when approaching, engaging in and responding to achievement situations. Goal theorists describe two types of goal orientation- namely, mastery goals and performance goals (Zusho et al., 2003). Students with mastery goals make more efforts and are more persistent, and they use effective cognitive and metacognitive learning strategies in fulfilling challenging tasks. However, students with performance goals display behaviours and strategies to support achievement less frequently (Zimmerman & Schunk, 2008). Performance goals are divided into performance approach and performance avoidance; and mastery goals are divided into mastery approach and mastery avoidance. While performance approach goals involve such as outpacing others and being the best, performance avoidance goals involve such as avoiding being ordinary and appearing stupid. While mastery approach goals target learning and in-depth understanding, mastery avoidance goals emphasise failure to learn, and misunderstanding (Dweck & Leggett, 1988; Elliot & McGregor, 2001; Elliot & Reis, 2003).

One of the variables included in this research is metacognitive self-regulation. Metacognition is related with awareness, knowledge and control of cognition. There are three general metacognitive self-regulatory activities: planning, monitoring, and regulating of one's cognitive activities. Planning activities such as goal setting and task analysis help to activate prior knowledge to enable understanding a topic more easily. Planning activities include the processes of goal setting, task analysis, strategy preference and decision-making. Monitoring activities, on the other hand, include individuals' monitoring their attention while reading, self-testing and questioning. These activities enable learners to understand the material and help them to integrate the new knowledge with the previous knowledge. Monitoring activities contain the process of monitoring the process by considering mastery goals. Regulating means continually adjusting individuals' cognitive activities. Regulating activities contain individuals' adjustment process on cognitive activities based on learners' monitoring stage. It is assumed by researchers that regulating activities will help learners to adjust and control their behaviours in the process, and thus will raise their performance. Self-regulated learners can regulate their time and study environments by managing them. Students managing their time and study environments make programmes, regulate their planning, and study time. They try to find how to benefit from time in the most efficient way in attaining their goals. Apart from regulating their study time, those students also set realistic goals by trying to use their study time effectively. Management of study environment is regulation of space where they do classroom work. Ideally, learners' study environment should be neat and quiet, and there should not be visual and auditory distracting factors. Self-regulation includes effort regulation (effort management). The latter can be defined as students' persistence and resilience on encountering a difficult or challenging task. Effort management depends on task value and commitment to goals. Self-regulated learners tend to keep their efforts and attention when they face uninteresting tasks or distractions. Effort management is self-management, and it shows individuals' determination to attain their goals despite difficulties and distract-



tions available in their environment. Effort management does not only reflect learners' determination to attain their goals, but it also influences their use of learning strategies. For this reason, effort management is important in academic achievement (Pintrich et al., 1991).

Research Focus

This research has made an attempt at analysing the correlations between students' task value, control of learning beliefs, goal orientation, self-efficacy, metacognitive learning strategies, time and study environment management, effort regulation, and achievement in electrochemistry through path model. Thus, task value, control of learning beliefs, goal orientation, and self-efficacy were identified as the motivational components in the research. Besides, students' achievement was determined in the topic of electrochemistry in the chemistry course. The reason for this was that electrochemistry is difficult to learn since it contains abstract concepts (Bojczuk, 1982; Lin, Yang, Chiu, & Chou, 2002; Osman & Lee, 2014). Therefore, it was found in several studies that learners had misconceptions in this respect (Brandriet, 2014; Garnett & Treagust, 1992; Sanger & Greenbowe, 1997; Sulcius, 2014; Şeşen & Tarhan, 2013; Şen, Yılmaz, & Geban, 2015). Literature review showed that the studies conducted in relation to mastery goals were mostly on mastery (or learning) and performance goals. This present research, however, analyses the correlations between mastery approach and performance approach goals and achievement and other variables. Veenman, Van-Hout-Wolters and Afflerbach (2006) emphasise the need for analysing the correlations between students' metacognition, contextual factors and motivation in different cultures and countries, and they state that theoretical models of metacognition can be developed in this way. Students' use of self-regulatory skills can differ even in different lessons depending on academic tasks. This research analyses the correlations between Turkish high school students' achievement and their motivational variables and metacognitive strategies. During the analyses, the direct and indirect effects of the variables were examined, and efforts were made to find whether the variables had any mediating effects. The proposed structure of the model is shown schematically in Figure 1. The hypotheses of research are as follows:

H1, H2, H3, H4, and H5: Students' task value (TV) will be a positive predictor of self-efficacy for learning and performance (SELP), effort regulation (ER), achievement in electrochemistry (ACH), mastery approach goals (MAG) and performance approach goals (PAG).

H6, H7, and H8: Students' control of learning beliefs (CLB) will be a positive predictor of mastery approach goals (MAG), self-efficacy for learning and performance (SELP), and performance approach goals (PAG).

H9, H10, H11, and H12: Students' performance approach goals (PAG) will be a positive predictor of mastery approach goals (MAG), effort regulation (ER), achievement in electrochemistry (ACH), and metacognitive learning strategies (MSR).

H13 and H14: Students' mastery approach goals (MAG) will be a positive predictor of metacognitive learning strategies (MSR) and time and study environment management (TSEM).

H15: Students' metacognitive learning strategies (MSR) will be a positive predictor of time and study environment management (TSEM).

H16 and H17: Students' self-efficacy for learning and performance (SELP) will be a positive predictor of metacognitive learning strategies (MSR) and effort regulation (ER).

H18 and H19: Students' effort regulation (ER) will be a positive predictor of time and study environment management (TSEM) and achievement in electrochemistry (ACH).

H20: Students' time and study environment management (TSEM) will be a positive predictor of achievement in electrochemistry (ACH).

H21: The relationship between achievement in electrochemistry (ACH) and task value (TV) will be mediated by effort regulation (ER) and performance approach goals (PAG).



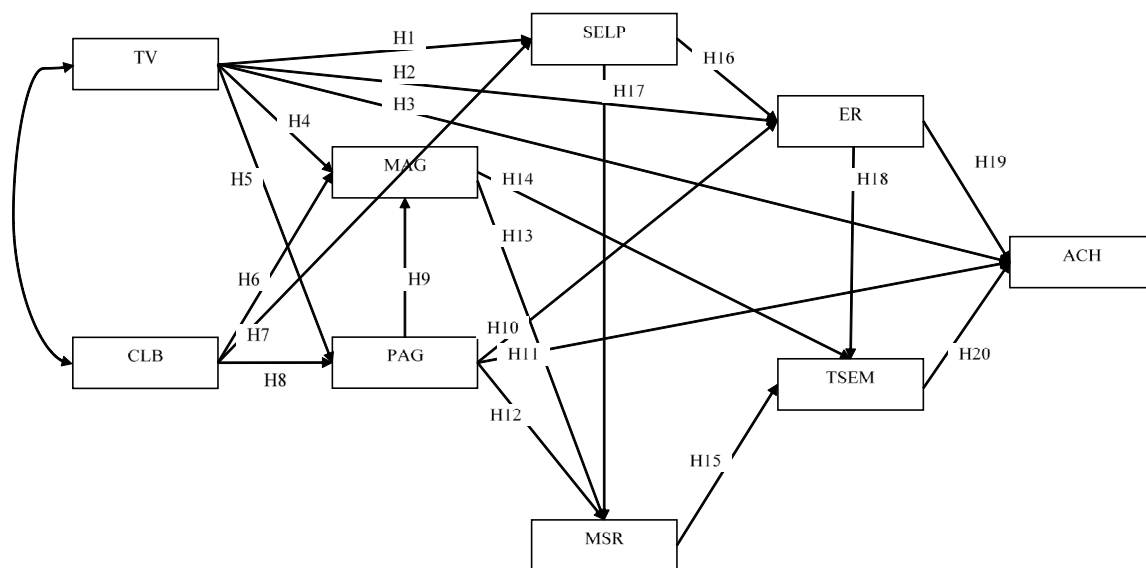


Figure 1: The proposed model.

Methodology of Research

Sample of Research

A total of 481 high school students took part in the research. Participation by the students was voluntary. The students were in 16-20 age range, and the average age was 17.5 (SD=1.17). In addition, 197 of the participants were girls, whereas 284 were boys.

Instruments

Motivated Strategies for Learning Questionnaire (MSLQ). MSLQ was developed by Pintrich et al. (1991) to analyse university students' motivation and their use of different learning strategies for their courses at university. The questionnaire was adapted into Turkish by Büyüköztürk, Akgün, Özkahveci and Demirel (2004), and was piloted on secondary school students by Şen (2015). It is a 7-pointed Likert type questionnaire. Administering the questionnaire took approximately 20-30 minutes. The MSLQ includes two parts: motivation and learning strategies. The motivation part contains 31 items and 6 sub-scales while the learning strategies part contains 50 items and 9 sub-scales. The subscales of questionnaire are modular and can be used either fully or selected subscales for the purpose of the research. In this research, task value (TV), control of learning beliefs (CLB), self-efficacy for learning and performance (SELP), metacognitive learning strategies (MSR), time and study environment management (TSEM) and effort regulation (ER) subscales were used. The reliabilities for the subscales and sample items were presented in Table 1.

Table 1. Sample items and reliabilities for the subscales of MSLQ.

Scale	Sample item	Cronbach's alpha
Task Value	I like the subject matter of this course.	.88
Control of Learning Beliefs	It is my own fault if I do not learn the material in this course.	.77
Self-efficacy for Learning and Performance	I expect to do well in this class.	.89



Scale	Sample item	Cronbach's alpha
Metacognitive Learning Strategies	When reading for this course. I make up questions to help focus my reading.	.87
Time and Study Environment Management	I make good use of my study time for this course.	.79
Effort Regulation	I work hard to do well in this class even if I do not like what we are doing.	.78

Achievement Goal Questionnaire (ACQ). AGQ developed by Elliot and McGregor (2001) to assess achievement goals. ACQ was translated and adapted into Turkish by Şenler and Sungur (2007) for elementary school students and piloted on secondary school students by Şen (2015). Responses were scored using a 7-point Likert-type scale. The AGQ is composed of four subscales, namely mastery-approach goals, performance-approach goals, mastery-avoidance goals, and performance-avoidance goals. In this research, mastery-approach goals (MAG) and performance-approach goals (PAG) subscales were used. The reliabilities for the subscales and sample items were presented in Table 2.

Table 2. Sample items and reliabilities for the subscales of ACQ.

Scale	Sample item	Cronbach's alpha
Mastery-approach Goals (MAG)	I want to learn as much as possible from this class.	.83
Performance-approach Goals (PAG)	My goal in this class is to get a better grade than most of the other students.	.60

Electrochemistry Concept Test (ECT). Electrochemistry concept test used in this research was developed by Şen (2015). The ECT is three tier and it contains 19 items. The first tier of the test items is composed of multiple-choice questions with five alternatives. The second tier is about the reasons for the responses given to the questions in the first tier, and the students are asked to choose from five alternatives. The third tier was used to check whether the participants were confident in terms of their answers in the first and second tiers. The questions were about such topics as reduction, oxidation, electrodes, electrochemical cells, galvanic cells, concentration cells, electrolysis, and Faraday's laws. In scoring the ECT, the students who answered the first and second tiers correctly and who were confident in the third tier in terms of their answers in the first and second tiers received one point for each question. Those students who incorrectly answered the questions in the first or second tier or in both tiers received zero point. Moreover, those students who answered the questions in the first and second tiers correctly but who were not confident in the third tier also received zero point. Following the analysis performed for test reliability, Cronbach Alpha internal coefficient was found to be 0.81.

Data Analysis

The data obtained in this research were analyzed by using both descriptive statistics and structural equation model. Descriptive statistics (mean, standard deviation, skewness, and kurtosis) were used to explore the students' profiles about achievement in electrochemistry and self-regulated learning skills. Firstly, the relationships between variables of the research were evaluated using Pearson correlation analysis and then structural equation modeling. In addition, structural equation modeling was used for the hypothesis testing.

Results of Research

Mean, standard deviations, and correlations among task value, control of learning beliefs, goal orientation, self-efficacy, metacognitive learning strategies, time and study environment management, effort regulation and achievement in electrochemistry are shown in Table 3. It is clear from skewness and kurtosis values that the data are normally distributed. On examining the correlations between the variables in the research, it was found that all the variables had positive and significant correlations between them.



Table 3. Descriptive statistics and correlations among variables of the research.

Variables	1	2	3	4	5	6	7	8	9
1. ACH									
2. TV	.55(**)								
3. CLB	.48(**)	.72(**)							
4. SELP	.43(**)	.79(**)	.73(**)						
5. MAG	.49(**)	.48(**)	.52(**)	.43(**)					
6. PAG	.49(**)	.43(**)	.45(**)	.38(**)	.56(**)				
7. TSEM	.47(**)	.49(**)	.53(**)	.47(**)	.59(**)	.51(**)			
8. ER	.49(**)	.72(**)	.64(**)	.65(**)	.45(**)	.49(**)	.50(**)		
9. MSR	.50(**)	.52(**)	.54(**)	.51(**)	.55(**)	.51(**)	.74(**)	.46(**)	
Mean	10.49	26.02	17.33	33.61	13.92	12.84	33.45	17.95	51.99
SD	4.69	8.76	5.84	10.64	4.37	4.36	9.49	5.65	13.85
Skewness	-.29	-.01	-.20	-.07	-.18	-.24	-.06	-.14	-.11
Kurtosis	-.82	-1.04	-.91	-.97	-.94	-.90	-1.04	-.94	-1.13

**Correlation is significant at the .01 level (2-tailed)

Path analysis was employed in analysing the correlations between variables in the research. A close examination of the data following the analyses made it clear that the fit indices for the conceptual model fitted the data very well. Yet, it was found that the path between effort management and students' achievement was not significant in the research (Hypothesis 19 is rejected). In consequence of the analyses, the non-significant path which was not available in the model was removed from the model, and the new model was tested (Figure 2). The fit indices for both the conceptual model and the alternative model are shown in Table 4.

Table 4. The fit indices of conceptual and alternative models.

Model	χ^2	df	χ^2/df	RMSEA	CFI	GFI	AGFI	NFI	NNFI
Conceptual Model	49.70	15	3.31	.070	.99	.98	.93	.99	.98
Alternative Model	51.36	16	3.21	.068	.99	.98	.93	.99	.98

On examining Table 4, the fit indices for the alternative model may be said to be better ($\chi^2 = 51.36$, $\chi^2/df = 3.21$, RMSEA=.068, CFI=.99, GFI=.98, AGFI=.93, NFI=.99, and NNFI=.98) (Garver & Mentzer, 1999; Hoe, 2008; Schermelleh-Engel, Moosbrugger, & Müller, 2003). Accordingly, it is evident that the RMSEA and the χ^2/df values were better in the alternative model than the conceptual model.

In the alternative model, the findings indicated that task value was a significant positive predictor of self-efficacy for learning and performance ($\beta = .56$), effort regulation ($\beta = .48$), achievement in electrochemistry ($\beta = .36$), mastery approach goals ($\beta = .13$) and performance approach goals ($\beta = .21$) (Figure 2) (Hypothesis 1, Hypothesis 2, Hypothesis 3, Hypothesis 4, and Hypothesis 5 were accepted). As seen in Figure 2, students' control of learning beliefs had statistically significantly a positive effect on mastery approach goals ($\beta = .25$), self-efficacy for learning and performance ($\beta = .33$), and performance approach goals ($\beta = .29$) (Hypothesis 6, Hypothesis 7, and Hypothesis 8 were accepted). Additionally, students' performance approach goals were statistically significantly associated with mastery approach goals ($\beta = .39$), effort regulation ($\beta = .22$), achievement in electrochemistry ($\beta = .25$) and, use of metacognitive learning strategies ($\beta = .24$) (Hypothesis 9, Hypothesis 10, Hypothesis 11, and Hypothesis 12 were accepted). Mastery approach goals were statistically significantly correlated to use of metacognitive learning strategies ($\beta = .30$) and time and study environment management ($\beta = .21$) (Hypothesis 13 and Hypothesis 14 were



accepted). In addition, the standardized path coefficient from metacognitive learning strategies to time and study environment management was significant ($\beta=.56$) (Hypothesis 15 was accepted). Students' self-efficacy for learning and performance was statistically significantly associated with metacognitive learning strategies ($\beta=.29$) and effort regulation ($\beta=.19$). While the standardized path coefficient from effort regulation to time and study environment management was found to be significant ($\beta=.14$), the standardized path coefficient from effort regulation to achievement in electrochemistry was found to be not significant ($\beta = .06, p > .05; t=1.08$) (Hypothesis 18 was accepted and Hypothesis 19 was rejected). Additionally, time and study environment management was statistically significantly associated with achievement in electrochemistry ($\beta=.17$) (Hypothesis 20 was accepted). The indirect effects of task value on achievement in electrochemistry mediated by effort regulation and performance approach goals were statistically significant (Hypothesis 21 was accepted).

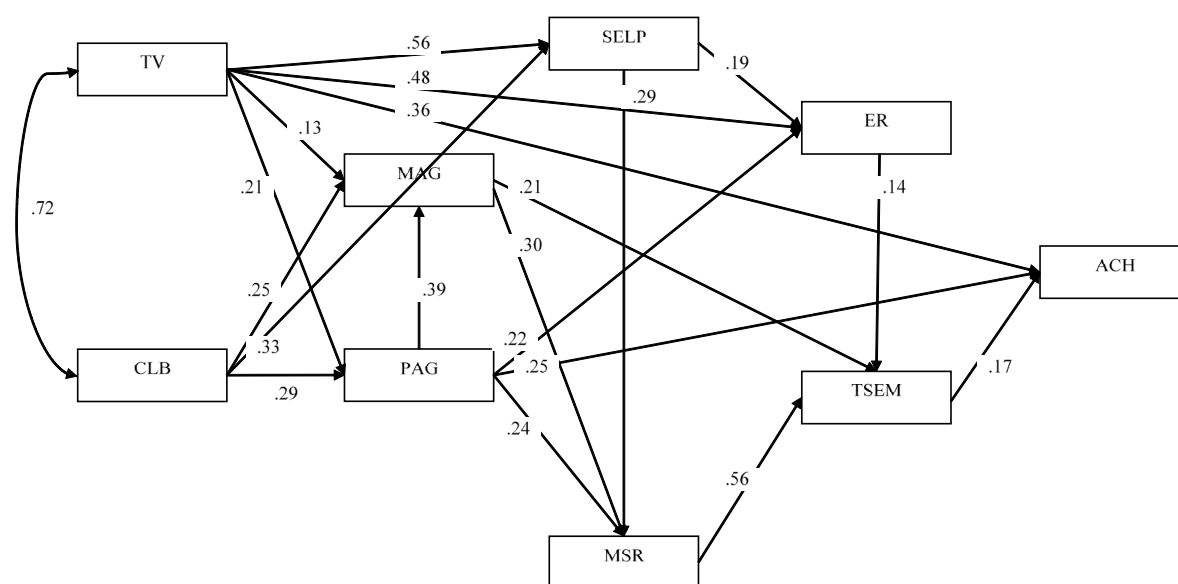


Figure 2: Path Coefficients in Alternative Model.

In the alternative model, performance approach goals, time and study environment management, and task value were accounted for 40% of the variance in achievement in electrochemistry scores. In the model, task value and control of learning beliefs were accounted for 68% of the variance in students' self-efficacy for learning and performance. Moreover, 43% of the variance in metacognitive learning strategies was explained by self-efficacy for learning and performance, performance approach goals, and mastery approach goals. Additionally, task value and self-efficacy for learning and performance, and performance approach goals were accounted for 58% of the variance in effort regulation. Metacognitive learning strategies, effort regulation, and mastery approach goals were explained 61% of the variance in time and study environment management. Finally, 41% of the variance in mastery approach goals was explained by performance approach goals, control of learning beliefs and task value. Further examination of the model revealed that the covariance between task value and control of learning beliefs is .72.

Standardized direct, indirect, and total effects' coefficients of the study variables were presented in Table 5. As seen in Table 5, task value is indirectly associated with time and study environment management ($\beta=.29$), achievement in electrochemistry ($\beta=.10$), mastery approach goals ($\beta=.08$), metacognitive learning strategies ($\beta=.28$), and effort regulation ($\beta=.15$). Additionally, control of learning beliefs is indirectly associated with time and study environment management ($\beta=.25$), achievement in electrochemistry ($\beta=.12$), mastery approach goals ($\beta=.11$), metacognitive learning strategies ($\beta=.27$), and effort regulation ($\beta=.13$). The strongest total indirect effect from variables of the study on achievement in electrochemistry is from control of learning beliefs ($\beta=.12$).



Table 5. Statistically significance direct, indirect, and total effects in the alternative model.

Variables		TV	CLB	SELP	MAG	PAG
ACH	Direct	.36	-	-	-	.25
	Indirect	.10	.12	.03	.006	.05
	Total	.46	.12	.03	.006	.30
TSEM	Direct	-	-	-	.21	-
	Indirect	.29	.25	.19	.17	.31
	Total	.29	.25	.19	.38	.31
SELP	Direct	.56	.33	-	-	-
	Indirect	-	-	-	-	-
	Total	.56	.33	-	-	-
MAG	Direct	.13	.25	-	-	.39
	Indirect	.08	.11	-	-	-
	Total	.21	.36	-	-	.39
PAG	Direct	.21	.29	-	-	-
	Indirect	-	-	-	-	-
	Total	.21	.29	-	-	-
MSR	Direct	-	-	.29	.30	.24
	Indirect	.28	.27	-	-	.11
	Total	.28	.27	.29	.30	.35
ER	Direct	.48	-	.19	-	.22
	Indirect	.15	.13	-	-	-
	Total	.63	.13	.19	-	.22

Discussion

This research analysed the correlations between Turkish high school students' achievement in electrochemistry and the variables such as task value, control of learning beliefs, performance-approach goals, mastery-approach goals, self-efficacy for learning and performance, metacognitive learning strategies, time and study environment management, and effort regulation through path analysis. It was found that achievement was not directly affected by effort regulation in the conceptual model constructed based on the literature in consequence of the analyses. Because the path between effort regulation and achievement was statistically significant, the alternative model, which did not have this path, was tested. The fit indices for the alternative model displayed goodness-of-fit ($\chi^2 = 51.36$, $\chi^2/df = 3.21$, RMSEA = .068, CFI = .99, GFI = .98, AGFI = .93, NFI = .99, and NNFI = .98) (Garver & Mentzer, 1999; Hoe, 2008; Schermelleh-Engel, Moosbrugger, & Müller, 2003). In the literature, there are a few studies about students' chemistry achievement and self-regulated learning skills. For example, the study conducted by Uzuntiryaki Kondakçı and Senay (2015) revealed that students with higher chemistry self-efficacy for cognitive skills are more likely to perform better in chemistry achievement. Cheung (2015) found that students who used deep learning strategies tended to have higher levels of chemistry self-efficacy. In addition, Taasobshirazi and Glynn (2009) found in consequence of path analysis that students' chemistry self-efficacy affected their strategy use and chemistry self-efficacy was indirectly associated with problem-solving success.

In consequence, positive correlations were found between students' task value, self-efficacy for learning and performance, effort regulation, achievement in electrochemistry, mastery approach goals, and performance approach goals. Additionally, it was also found that task value did not have direct effects on metacognitive learning strategies. However, task value was found to have indirect effects on metacognitive self-regulation ($\beta = .28$). The similar results were obtained in studies available in the literature. Al-Harthy, Was, and Isaacson (2010) found in



consequence of path analysis that task value was positively correlated with performance avoid goal orientation and with mastery goals. Students' task values are correlated with deep learning strategies (elaboration, organisation, etc.) and academic achievement (Pintrich & Schunk, 2002). De Backer and Nelson (1999) state that there are direct correlations between task value and learners' achievement goals. Wolters, Yu and Pintrich (1996) examined the correlations between students' achievement goals (mastery goals, performance approach goals, and performance avoidance goals) and motivation. It was found at the end of the study that students' task value had a positive correlation with mastery and performance approach goals and a negative correlation with performance avoidance goals. Liem, Lau and Nie (2008) found that task value predicted achievement goals and that there were positive correlations with mastery goals and performance goals. Some other studies in the literature found positive correlations between mastery goals and task value (Bong, 2004; Hulleman, Durik, Schweigert, & Harackiewicz, 2008). This current research has found positive correlations between self-efficacy and task value. Other studies available in the literature also found positive correlations between self-efficacy and task value (Cole & Denzine, 2004; Eccles & Wigfield, 2002; Senler & Sungur, 2009).

It was found in consequence of path analysis at the end of the research that there were positive and significant correlations between control of learning beliefs, mastery approach goals, self-efficacy for learning and performance, and performance approach goals. Control of learning beliefs had the greatest direct effects on self-efficacy for learning and performance. On examining the indirect effects of control of learning beliefs, it was found that the greatest indirect effects were on metacognitive learning strategies ($\beta=.27$) and on time and study environment management ($\beta=.25$). It was found in the literature that students' control of leaning beliefs influenced their goal orientation (Valle et al., 2003). Students with high self-efficacy and control of learning beliefs set more challenge goals, use different strategies; and if the old strategies do not work, they find new strategies and make more efforts to perform their task (Hoy, 2004). Sungur (2007) points out that control of learning beliefs directly influence metacognitive strategy use and self-efficacy, whereas they indirectly influence effort regulation and metacognitive strategy use. Paulsen and Gentry (1995) found that students' academic achievement (final grade) had significant correlations with time, study environment management and effort regulation, metacognitive strategy use and motivation (intrinsic and extrinsic goal orientation, task value, control of learning, test anxiety, and self-efficacy).

This research analysed the correlations between students' mastery goals and performance goals and other variables, and in consequence, it found that mastery approach goals did not have direct effects on achievement but that performance approach goals had direct effects. It was found in the literature that there were no positive correlations between students' performance approach goals and cognitive and metacognitive learning strategies (Liem et al., 2008; Wolters et al., 1996). This research, however, found that performance approach goals predicted students' achievement in electrochemistry. According to Al-Harthy et al. (2010), students with performance approach goals are anxious about their grades and they wish to be better than others are. Therefore, such students would need higher order metacognitive self-regulatory skills to enable them to use learning strategies in attaining their goals. Al-Harthy et al. (2010) point out that there are positive correlations between mastery goals and metacognitive self-regulation. Schraw, Horn, Thorndike-Christ and Burnig (1995) evaluated the correlations between achievement goals and metacognitive strategy use. In consequence, they found that students having mastery goals had high metacognitive awareness and high level of knowledge of cognition, and that they used different learning strategies more effectively. Yet, Wolters, Yu and Pintrich (1996) found that not only mastery goals but also performance goals predicted the use of metacognitive strategies. Other research studies in the literature also found similarly that students having mastery goals used deep cognitive and metacognitive learning strategies more, and that students having performance goals preferred rather superficial learning strategies more (Coutinho, 2007; Mousoulides & Phillippou, 2005; Somuncuoğlu & Yıldırım, 2001). Shih (2005a; 2005b) pointed out that mastery goals and performance approach goals were positive predictors of metacognitive strategy use. Vrugt, Oort and Zeeberg (2002) found in their research that mastery and performance approach goals were significant predictors of deep cognitive and metacognitive strategy use.

This research found that metacognitive learning strategies predicted students' time and study environment management significantly. In addition to that, this research also found that there were positive and significant correlations between self-efficacy and metacognitive self-regulation and effort management. While there were direct effects of time and study environment management on achievement, there were indirect effects of self-efficacy, effort management and metacognitive self-regulation. On examining the indirect effects, it was found that metacognitive learning strategies had the greatest indirect effect. Pintrich et al. (1991) say that self-regulated students can manage both their time and study environment, and that they can regulate them. This research also found that



students' effort management had direct effects on their time and study environment management but indirect effects on achievement ($\beta=.02$). The research also found that students' self-efficacy did not have direct effects on achievement. While significant effects were found between self-efficacy and achievement in some studies in the literature (Pajares & Miller, 1994; Randhawa, Beamer, & Lundberg, 1993), no such findings were obtained in some other studies (Bandalos, Yates, & Thorndike-Christ, 1995; Benson, Bandalos, & Hutchinson, 1994; Norwich, 1987). Motivation has important effects on students' use of metacognitive learning strategies (Al-Ansari, 2005; Coutinho, 2007; Neber & Schommer-Aikins, 2002; Pintrich & De Groot, 1990; Shu-Shen, 2002; Sungur & Şenler, 2009; Tung-hsien, 2004; Valle et al., 2003). In studies concerning self-efficacy, on the other hand, it was found that self-efficacy played an important part in their metacognition (Kanfer & Ackerman, 1989; Sungur, 2007). Students with high self-efficacy use more metacognitive learning strategies than those with low self-efficacy (Bouffard-Bouchard, Parent, & Larivee, 1993; Kanfer & Ackerman, 1989). Pajares (2002) points to the fact that high levels of self-efficacy are related with a higher frequency of use of cognitive and metacognitive learning strategies.

Analysis done exhibited that students' time and study environment management had direct effects on achievement. Credé and Phillips (2011), and Fallon (2006) also found that there were significant correlations between time and study environment and effort regulation. Britton and Tesser (1991) examined the correlations between the sub-dimensions of time management (short-range planning, time attitudes and long-range planning) and cumulative grade point average. In consequence, they found that students' time attitudes and short-range planning explained 21% of the variance in their achievement. Apart from that, Garcia-Ros, Gonzales, and Hinojosa (2004) analysed the effects of time management factors on Spanish high school students' achievement through multiple regression analysis. As a result, they found that time management factors were predictive of students' achievement. Zimmerman, Greenberg and Weinstein (1994) found that time planning and management training helped students to increase their achievement and to regulate their research time. Zimmerman and Pons (196) state that successful students' use more environment management than those of unsuccessful students, and that self-regulated learners tend to re-regulate their physical environment according to their needs in the process of learning. In Yumuşak, Sungur and Çakıroğlu (2007), however, it was found through multiple linear regression analysis that task value, time and study environment management were significantly correlated with students' achievement in the biology course.

Conclusions

This current research found consequently that task value, performance-approach goals and time and study environment management had direct effects on achievement in electrochemistry. The variable with the greatest effect was task value ($\beta=.36$). Performance approach goals, time and study environment management, and task value accounted for 40% of the variance in achievement in electrochemistry scores. The variable having the greatest indirect effect on achievement in electrochemistry was control of learning beliefs ($\beta=.12$). This result demonstrates that achievement is not dependent only on cognitive factors. Students' self-regulatory skills should be developed in order to raise their achievement. Students who are successful in classroom setting employ their self-regulated learning skills more than those who are unsuccessful because self-regulated learners orientate their learning, and they assess their own learning output. Students who take on the responsibility for their own learning in this way can inquire each stage of their learning and thus can attain success at the desired level.

In this study, a structural equation model was used to examine the relationships among Turkish high school students' achievement, task value, control of learning beliefs, performance-approach goals, mastery-approach goals, self-efficacy for learning and performance, metacognitive learning strategies, time and study environment management, and effort regulation. The results of the study showed that students who had high task value, time and study environment management and performance approach goals obtained the highest grades in electrochemistry concept test. Students' self-efficacy beliefs and metacognitive learning strategies were indirectly and positively correlated with their achievements. Because students who had high self-efficacy and metacognition engaged in more effective self-regulated learning strategies. In addition, it was found that students' mastery approach goals affected achievement in electrochemistry through time and study environment management. Students who had mastery-approach goals tended to perform better to achieve task mastery and improvement.

It was found in consequence, that such motivational variables as task value, control of learning beliefs, goal orientations (mastery and performance approach goals) and self-efficacy had direct and indirect effects. Therefore, teachers should motivate students in the classroom in order to raise their achievement. Teachers can do this by



providing students with options for their learning in the classroom and in learning environments and by providing opportunities to control their learning. They can attain success at the desired level in this way.

Students' achievement was limited to the subject of electrochemistry in this study. For this reason, achievement levels for different subjects should also be determined in order to analyze the correlations between students' achievement in chemistry and their self-regulated learning skills. In total 481 students were included in this study. Both the number of participants in the study group can be increased and different study groups such as university students, primary school students can be selected for prospective studies. It was found in this study that 40% of the variance in students' achievement was explained by the variables considered in this study. Thus, 60% of the variance in students' achievement is explained by different variables. For this reason, different variables can also be included in structural equation models to be formed in studies to be performed in the future.

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