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An Investigation of the Relationships among 11th Grade Students' Attitudes toward Chemistry, Metacognition and Chemistry Achievement

11. Sınıf Öğrencilerinin Kimyaya Yönelik Tutumları, Üstbilişleri ve Kimya Başarıları Arasındaki İlişkilerin İncelenmesi

Sevgi KINGIR[1], Nurdane AYDEMİR[2]

[1]Selçuk Üniversitesi, Fen Bilimleri Enstitüsü, Konya/TÜRKİYE, kingirsevgi@gmail.com

[2]Atatürk Üniversitesi, Kazım Karabekir Eğitim Fakültesi, Erzurum/TÜRKİYE, nurdaneyazici@gmail.com

ABSTRACT

The purpose of this study was to investigate the relationships among 11th grade students' metacognition, chemistry achievement and attitudes toward chemistry. A total of 81 high school students at 11th grade participated in this study. Data were collected using Metacognitive Awareness Inventory and Attitude Scale toward Chemistry at the end of the second half of the academic year 2010–2011. Students' report card mean scores in chemistry course for that academic year were used as an indicator of their chemistry achievement. Data were analyzed using descriptive statistics and Pearson correlation analysis. The results revealed that Turkish high school students held more declarative and conditional knowledge than procedural knowledge, and used debugging strategies more than the other strategies (planning, information management, monitoring and evaluating) to regulate their cognition. Significant associations were detected between attitude toward chemistry and chemistry achievement and metacognition, and between knowledge of cognition and regulation of cognition.

Keywords: *Attitude toward chemistry, Chemistry achievement, Metacognition.*

ÖZ

Bu çalışmanın amacı 11. sınıf öğrencilerinin üstbilişleri, kimya başarıları ve kimyaya yönelik tutumları arasındaki ilişkileri incelemektir. Bu çalışmaya 11. sınıf toplam 81 lise öğrencisi katılmıştır. Veriler 2010-2011 akademik yılının ikinci yarısı sonunda Üstbiliş Farkındalık Envanteri ve Kimya Tutum Ölçeği kullanılarak toplanmıştır. Verilerin toplandığı akademik yıla ait öğrencilerin kimya dersi karne not ortalamaları kimya başarılarının bir göstergesi olarak kullanılmıştır. Veriler betimleyici istatistik ve Pearson korelasyon analiz yöntemleri kullanılarak *çözümlenmiştir. Analiz sonucunda öğrencilerinin açıklayıcı bilgiye ve durumsal bilgiye işlemsel bilgiden daha çok sahip oldukları ve öğrencilerin üstbilişlerini düzenlemede hata ayıklama yöntemini diğer yöntemlerden (planlama, izleme, değerlendirme ve bilgi yönetme) daha fazla kullandıkları bulunmuştur. Öğrencilerin kimyaya yönelik tutumları ile kimya başarıları ve üstbilişleri arasında ve üstbiliş bilgileri ile üstbiliş düzenlemeleri arasında anlamlı ilişkiler tespit edilmiştir.*

***Anahtar Kelimeler**: Kimyaya yönelik tutum, Kimya başarısı, Üstbiliş.*

INTRODUCTION

Science educators are continuously seeking ways for improving the quality of science education in today's modern age. There are many variables accounting for the student outcomes in science. Student outcomes can be accounted by cognitive and affective characteristics of the students, and the quality of instruction adopted by the teacher in the classrooms (Abraham, Renner, Grant, &Westbrook, 1982; Duit&Treagust, 2003). Over the last three decades, there is a great emphasis on taking into account cognitive, metacognitive, and affective factors together to increase the quality of science education. Many scholars have been interested in investigating the relations between cognitive, metacognitive, and affective characteristics of the students (*e.g.,*Eshel&Kohavi, 2003; Sungur&Gungoren, 2009; Sungur&Senler, 2009; Topcu&Yilmaz-Tuzun, 2009).

The research on metacognition has begun with John Flavell in the 1970s (Flavell, 1979). Metacognition is a fuzzy concept and there is not unique definition of metacognition. The reason of this confusion might be the fact that there are several terms used to describe the same phenomenon (*e.g.,* meta-memory, meta-learning, self-regulation) and these terms are used interchangeably in the literature (Livingston, 1997). Two examples of definitions of metacognition are: "knowledge and cognition about cognitive phenomena" (Flavell, 1979, p. 906) and "our ability to know what we know and what we don't know" (Costa, 1984, p. 57). Several frameworks have been developed for categorizing metacognition into its components (Papaleontiou-Louca, 2003). Flavell (1979) made distinction between metacognitive knowledge and metacognitive experiences. Metacognitive knowledge refers to acquired knowledge about cognitive processes and consists of knowledge of person, task and strategy variables. The knowledge of person variable refers to knowledge about how people learn and process. This variable includes beliefs about intraindividual differences, interindividual differences, and cognition in general. Knowledge of task variables encompasses beliefs about the nature of the information encountered. Strategy variables are about the knowledge of effective strategies to achieve a certain goal. Metacognitive experiences are the experiences that they have to do with some cognitive or affective endeavor, most frequently a current, ongoing one. Metacognitive experiences can lead somebody to establish new goals and revise old goals; and activate strategies. Metacognitive experiences also affect one’s metacognitive knowledge store by adding to it, deleting from it or revising it (Papaleontiou-Louca, 2003).

Schraw and Dennison (1994) suggested components of metacognition as knowledge of cognition and regulation of cognition. Knowledge of cognition refers to “how much learners understand about their own memories and the way they learn”; regulation of cognition refers to “how well learners can regulate their own memory and learning” (Brown, 1987; cited in Sperling, Howard, Staley, &DuBois, 2004, p.118). The subcomponents of knowledge of cognition are declarative knowledge, procedural knowledge and conditional knowledge. Declarative knowledge is about learner’s intellectual skills and abilities; procedural knowledge is about how to implement learning procedures such as strategies; and conditional knowledge is about when and why to use learning procedures. The subcomponents of regulation of cognition are planning, information management, monitoring, debugging, and evaluation. Planning includes goal setting and allocating resources before learning; information management requires using skills and strategies to process information effectively; monitoring is the assessment of one’s learning or strategy use; debugging is using strategies to correct comprehension and performance errors; and evaluation is the analysis of performance and strategy effectiveness following a learning task. Schraw and Dennison (1994) provided some evidence to suggest that knowledge of cognition is a prerequisite to regulation of cognition. They reported that knowledge of cognition was giving more predictive information about subsequent performance than regulation of cognition.

Previous research on metacognition recognized the non-cognitive components of metacognition (*e.g.*, affective) in addition to its obvious cognitive components (Case &Gunstone, 2006). More broadly, metacognition was defined as “knowledge of one’s knowledge, processes, and cognitive and affective states; and the ability to consciously and deliberately monitor and regulate one’s knowledge, processes, and cognitive and affective states” (Papaleontiou-Louca, 2003, p. 10). Current studies have linked metacognition to a number of other constructs, including epistemological beliefs (*e.g.,*Ozgelen, 2012; Yilmaz-Tuzun&Topcu, 2010), motivational beliefs (*e.g.,*Sungur&Senler, 2009), nature of science (Ozgelen, 2012), and achievement (Sperling, Howard, Miller, & Murphy, 2002; Topcu&Yilmaz-Tuzun, 2009).

The previous literature revealed inconsistent associations between metacognition and achievement: Some studies measured metacognitive processes separate from achievement while some studies assumed that an increase in metacognition should lead to an increase in achievement (Sperling et al., 2002). Based on the second view, metacognitive knowledge of strategies, tasks, and self-knowledge affects how students learn. If students know different strategies, they can select the appropriate ones and use them while solving problems. On the other hand, if students do not know strategies, they will not be able to use them. Effective use of metacognitive knowledge, experiences, and skills is essential for success in science courses because as students become more aware of their own thinking and cognition, they tend to learn better (Bransford, Brown & Cocking, 1999; cited in Pintrich, 2002).

Attitude is also linked with metacognition because it affects the use and development of cognitive and metacognitive skills (Schraw, Crippen, & Hartley, 2006). Attitude can be defined as “a predisposition to respond positively or negatively to things, people, places, events, or ideas” (Simpson, Koballa, Oliver, &Crawley, 1994, p. 212). Attitude is divided into two areas: science attitude and attitude toward subject matter. *Science attitude* means “behaviors associated with critical thinking and typically meant to characterize the thinking processes of scientists” (Koballa, 1988, p. 115), while *attitude toward subject matter* means favorable or unfavorable feelings toward the subject matter (Koballa, 1988). Accordingly, in the context of the present study, attitude toward chemistry refers to feelings, emotions, values and evaluative beliefs that a student has about chemistry as a school subject (*e.g.*, Cheung, 2007; Oliver & Simpson, 1988; Osborne, Simon, & Collins, 2003).

Attitude toward science is an important predictor of student achievement in science, and it explains a significant proportion of the variance in science achievement (Koballa, 1988; Oliver & Simpson, 1988; Papanastasiou&Zembylas, 2004; Salta &Tzougraki, 2000). For example, Hough and Piper (1982) found a significant relationship between students’ attitudes toward science and their science achievement (r = 0.45). Students with high positive attitudes participate in learning activities more than students with low positive attitude. A high relationship between the learning environment and attitudes toward science was detected by Talton and Simpson (1987). Accordingly, students’ feelings about the activities within the classroom, and the interaction between the students are all essential factors contributing to how students feel about science. Kan and Akbas (2006) identified high school students’ attitudes toward chemistry and then determined the relationship between students’ attitudes toward chemistry and their achievement in chemistry. The analyses revealed that students’ attitudes toward chemistry were slightly positive, and there were differences in the chemistry attitudes across the grade levels; 10th grade students’ attitudes toward chemistry were the highest. Moreover, attitude toward chemistry was the significant predictor of chemistry achievement, and explained about 10% of the variation in chemistry achievement.

Building upon the studies mentioned above, the relations among metacognition, attitude toward chemistry and chemistry achievement are worth to investigate because promotion of favorable attitudes toward subject matter, promotion of metacognition, and development of scientific understanding have always been a matter of concern in science education (*e.g.*, Osborne et al., 2003). Rickey and Stacy (2000) asserted that metacognition is important for success in solving non-routine chemistry problems.

However, there is limited study about metacognition in chemistry domain (*e.g.*, Rickey & Stacy, 2000; Thomas & McRobbie, 2001). There is a need to identify the gaps in students' metacognition and teach it in chemistry courses at schools. Furthermore, the relationships between metacognition and achievement (*e.g.*,Sperling et al., 2002; Topcu&Yilmaz-Tuzun, 2009) and between achievement and attitude toward subject matter *(e.g.*,Kan&Akbas, 2006; Salta &Tzougraki, 2000) were studied in the previous literature. There is limited research investigating the relations among metacognition, attitude toward subject matter and achievement, and incorporating those variables of interest in a study. Therefore, this study intended to explore the relationships among metacognition, chemistry achievement, and attitude toward chemistry.

This study seeks to answer the following research questions:

1. What is the relationship between chemistry achievement and attitude toward chemistry?

2. What is the relationship between chemistry achievement and components of metacognition (knowledge of cognition and regulation of cognition)?

3. What is the relationship between attitude toward chemistry and components of metacognition (knowledge of cognition and regulation of cognition)?

4. What is the relationship between knowledge of cognition and regulation of cognition?

METHOD

Participants

Participants of the study were 81 high school students (38 girls and 43 boys) at 11th grade from a public high school located in a larger city in Turkey. The sample was selected by a convenience sampling technique that considered time, cost, transportation, and voluntary participation in study. Students were asked to provide information about their background characteristics through the administration of a questionnaire. The mean age of students was 17.02 years (*SD* = 0.157). Students were from middle to high socioeconomic class families. A summary of the background characteristics of the students were provided in Table 1.

Table 1. Background Characteristics of Students

Variable		*Percent (%)*
Gender	Male	46.9
	Female	53.1
Age	17 years	96.3
	18 years	2.5
Mother Education Level	Primary School	8.6
	Secondary School	4.9
	High School	27.2
	University	53.1
	Graduate degree	3.7
Father Education Level	Primary School	0
	Secondary School	3.7
	High School	17.3
	University	59.3
	Graduate degree	19.8
Mother Work Status	Unemployed	54.3
	Employed	45.7
Father Work Status	Unemployed	8.6
	Employed	91.4
Number of Books	0-25 books	3.7
	26-60 books	13.6
	61-100 books	17.3
	101-200 books	22.2
	More than 200 books	43.2
Presence of Study Desk	Have a study desk	93.8
	Do not have a study desk	6.2

Instrumentation

Student Background Characteristics

A questionnaire comprised of 8 items that investigated background characteristics of students, namely, age, gender, employment status and educational level of parents, number of books and presence of study desk at home. Information about employment status and educational level of parents, number of reading materials at home and presence of a study desk at home were used as indicators of students' socio-economic status.

Metacognition

Students' metacognition was measured using Metacognitive Awareness Inventory (MAI). This inventory was originally developed by Schraw and Dennison (1994), and later it was translated and adapted into Turkish by Sungur and Senler (2009) for measuring high school students' metacognition. For the present study, the Turkish version of the instrument was used to assess 11^{th} grade students' metacognition. MAI is a 5-point Likert-type instrument, and it consists of 52 items in two parts, namely, knowledge of cognition scale and regulation of cognition scale. The subscales of knowledge of cognition are declarative knowledge – DK (*e.g.*, "I am good at remembering information", $n = 8$, $\alpha = 0.79$), procedural knowledge – PK (*e.g.*, "I try to use strategies that have worked in the past", $n = 4$, $\alpha = 0.71$) and conditional knowledge – CK (*e.g.*, "I learn best when I know something about the topic", $n = 5$,$\alpha = 0.71$). Regulation of cognition consists of five subscales: planning – P (*e.g.*, "I think about what I really need to learn before I begin a task", $n = 7$, $\alpha = 0.79$), information management strategy – IMS (*e.g.*, "I consciously focus my attention on important information", $n = 10$, $\alpha = 0.79$), monitoring – M (*e.g.*, "I consider several alternatives to a problem before I answer", $n = 7$, $\alpha = 0.74$), debugging strategy – DS (*e.g.*, "I change strategies when I fail to understand", $n = 5$, $\alpha = 0.60$), and evaluating – E (*e.g.*, "I know how well I did once I finish a test", $n = 6$, $\alpha = 0.75$).

In the present study, students' scores on each subscale or component of metacognition were computed by summing all the items and dividing the sum by the total number of items constituting the subscale or component. Cronbach's alpha reliability coefficients for the subscales of DK, PK, CK, P, IMS, M, DS and E were computed as 0.71, 0.63, 0.75, 0.71, 0.71, 0.72, 0.64 and 0.50, respectively. These subscales were used for describing the participants' metacognition, and two main components of metacognition, namely, knowledge of cognition and regulation of cognition, were used for analyzing the relation of metacognition with chemistry achievement and attitude toward chemistry. Cronbach's alpha reliability coefficients for the knowledge of cognition and regulation of cognition were computed as 0.87 and 0.90, respectively.

Attitude toward Chemistry

Students' attitudes toward chemistry were measured using Attitude Scale toward Chemistry (ASTC). This scale was developed by Geban, Ertepınar, Yılmaz, Altın and Şahbaz (1994) to measure students' attitudes toward chemistry as a school subject. This scale consisted of 15 items (*e.g.,* "I like reading books related to chemistry") in 5-point Likert type scale: fully agree, agree undecided, disagree, and fully disagree. It covers both positive and negative statements. Students' scores on attitude toward chemistry scale were computed by summing all the items and dividing the sum by the total number of items. While lower scores show negative attitudes toward chemistry, higher scores show positive attitudes toward chemistry. The reliability of the original scale was 0.83. For the current study, the Cronbach's alpha reliability coefficient of the scale was computed as 0.89.

Chemistry Achievement

Students' report card grades were obtained from the school administration. Students' chemistry achievement was determined using their report card mean scores in chemistry course for the academic year 2010-2011. The mean of students' chemistry scores was 81.37 out of 100 with standard deviation of 11.2.

Procedure

Student Background Questionnaire, Metacognitive Awareness Inventory (MAI) and Attitude Scale toward Chemistry (ASTC) were administered at the end of the second half of the academic year 2010–2011 to the students in a 30 min period under the supervision of the teachers after getting permission from the administration. Before students responded to the instruments, the purpose of the study was explained and the directions were made clear. It was ensured that no one else except the researcher would have a chance to access the data, and the results of the study would only be used for the research purposes.

Data Analyses

The data were analyzed by using descriptive statistics and correlational analysis using PASW (Predictive Analytics Software) Statistics 18. Pair wise deletion was used for handling missing data, which was under 10%. The assumptions of linearity and homoscedasticity were checked by generating scatterplots before conducting Pearson correlation analysis. The distribution of scores on the scatterplots indicated that the relationship between the variables was roughly linear, and that the scores were evenly spread in a cigar shape. In order to explore the relationships among chemistry achievement, attitude toward chemistry, knowledge of cognition and regulation of cognition, Pearson correlation coefficients were computed. Using the Bonferroni approach to control for Type I error across the 6 correlations, a p value of less than 0.008 (0.05/6 = 0.008) was used for significance (Green & Salkind, 2005). The strength of the association between the variables was determined based on the criteria proposed by Cohen (1988) in which a Pearson correlation (r) value of 0.10 to 0.29 is small, 0.30 to 0.49 is medium, and 0.50 to 1.00 is high.

RESULTS

Descriptive Statistics

Descriptive statistics of students' knowledge of cognition, regulation of cognition, attitude toward chemistry and chemistry achievement were presented in Table 2.

Table 2. Descriptive Statistics of Chemistry Achievement, Attitude Toward Chemistry, and Components of Metacognition

Variables	*N*	*Mean*	*Standard*	*Min.*	*Max.*
Chemistry Achievement	80	81.37	11.22	51.8	97.6
Attitude toward chemistry	76	2.94	0.67	1	5
Knowledge of cognition	75	3.64	0.53	2	5
Declarative knowledge	77	3.77	0.52	2	5
Procedural knowledge	78	3.53	0.60	2	5
Conditional knowledge	80	3.64	0.65	1	5
Regulation of cognition	74	3.52	0.46	3	5
Planning	79	3.28	0.61	2	5
Information management strategy	77	3.49	0.50	2	5
Monitoring	81	3.28	0.59	2	5
Debugging strategy	81	3.72	0.61	2	5
Evaluation	80	3.34	0.53	2	5

In this study, mean scores of students' knowledge of cognition, regulation of cognition, attitudes toward chemistry were above 3, the mid-point of the 5-point Likert scale. This finding implied that participants had reasonable knowledge about themselves as learners, about learning strategies, and about when and how a specific learning strategy will be useful. The mean scores also suggested that participants appeared to regulate and control their learning at a reasonable level. Participants demonstrated favorable attitudes toward chemistry as a school subject, as well. In addition, students' chemistry mean scores on their report card indicated a high level of achievement in chemistry.

Correlational Analysis

The relationships among attitude towards chemistry, chemistry achievement and the components of metacognition (knowledge of cognition and regulation of cognition) were shown in Table 3. There was a high positive association between chemistry achievement and attitude towards chemistry. Knowledge of cognition and regulation of cognition were found to have medium positive associations with attitude toward chemistry. There was a high positive relationship between knowledge of cognition and regulation of cognition. However, the relationships between chemistry achievement and the components of metacognition were not significant for this study.

Table 3. Intercorrelations among Chemistry Achievement, Attitude toward Chemistry, Knowledge of Cognition and Regulation of Cognition.

Variables	*1*	*2*	*3*	*4*
(1) Chemistry achievement	1.000			
(2) Attitude toward chemistry	0.521*	1.000		
(3) Knowledge of cognition	0.217	0.391*	1.000	
(4) Regulation of Cognition	0.249	0.371*	0.755*	1.000

$^{*}p < 0.008$

DISCUSSION

The results suggested that Turkish high school students had more declarative and conditional knowledge than procedural knowledge, and used debugging strategies more than the other strategies (planning, information management, monitoring, and evaluating) to regulate their cognition. This finding is consistent with that of Sungur and Senler (2009). A reason of using debugging strategies more than the others might be related to the classroom learning environment. Although the recently revised high school chemistry curriculum is student-centered (Ministry of National Education [MNE], 2011), there is a tendency towards traditional (teacher-centered) approaches

(Acat, Anilan, &Anagun, 2010). Teacher-centered instruction may not be effective in developing metacognitive strategies; or in such a learning environment, students may not need to use various metacognitive strategies. Students are likely to choose their own strategies and practice them when they experience the need for using strategies (Sternberg & Wagner, 1982; cited in Costa, 1984). In addition, students demonstrated moderately positive attitudes toward chemistry as in the case of many studies consistently resulting in favorable attitudes toward science (*e.g.*, Osborne et al., 2003).

The findings revealed a high positive association between chemistry achievement and attitude toward chemistry. Previous research demonstrated a reciprocal relationship between achievement and attitude toward subject matter: Changing attitudes resulted in improved achievement in science (*e.g.,* Oliver & Simpson, 1988) and an improvement in students' science achievement significantly influenced their attitudes toward science (*e.g.,* Park, Khan, &Petrina, 2009). What is more, the present study revealed that student attitudes toward chemistry were significantly linked with metacognition. This finding is compatible with the previous research emphasizing the role of non-cognitive issues on the use and development of metacognition (Case &Gunstone, 2006; Schraw et al., 2006). A high association between knowledge of cognition and regulation of cognition was also found in this study. This finding is supported by the previous literature (*e.g.,*Schraw& Dennison, 1994) suggesting that knowledge of cognition is a prerequisite to regulation of cognition.

On the other hand, this study demonstrated non-significant associations between chemistry achievement and the components of metacognition. This finding is supported by the literature indicating inconsistent relationships between metacognition and achievement to some extent (*e.g.,*Sperling et al., 2002). However, this finding is not consistent with the studies indicating a significant association between science achievement and metacognition (*e.g.,*Topcu&Yilmaz-Tuzun, 2009). A reason of having a non-significant association between achievement and metacognition might be related with having convenience sampling and limited sample size. Another reason might be related with using high-stakes testing in Turkish educational system. High school students have to take normative examinations implemented nationwide to attend universities. Despite an emphasis on alternative assessment techniques in high school chemistry curriculum (MNE, 2011), teachers continue to assess their students via test items similar to those used in the nationwide exams (Acat et al., 2010). It is worth to note that the chemistry achievement scores used in this study were report card mean scores in chemistry course for the academic year 2010-2011, in which the study was conducted. Therefore, students' chemistry achievement was assessed based on the teacher-made paper and pencil tests. Achievement gains obtained from such a testing may not reflect changes in metacognition (Sperling et al., 2002), or being successful in such a traditional testing may not require having knowledge and regulation of cognition.

The relationships established in the present study among chemistry achievement, attitude toward chemistry and metacognition might provide useful information for curriculum developers and teachers in designing chemistry learning environment. Chemistry is abstract in nature and many chemistry concepts are difficult to understand (Gabel, 1999; Garnett, Garnett, & Hackling, 1995) that may diminish students' favorable attitudes toward chemistry learning (*e.g.*, Osborne et al., 2003). Because this study demonstrated positive association between attitude toward chemistry and metacognition and chemistry achievement, development of students' favorable attitudes does matter in enhancing student metacognition and scientific understanding. Chemistry activities that are fun and personally fulfilling have the potential of leading positive attitudes toward chemistry and conceptual understanding (Koballa& Glynn, 2004). In other words, learning environments facilitating understanding of chemistry concepts supports development of students' favorable attitudes toward chemistry (Freedman, 1997; Uzuntiryaki&Geban, 2005) and in turn students' acquisition of metacognitive knowledge, use of various metacognitive strategies and scientific understanding (Costa, 1984), all of which are necessary for the development of scientifically literate citizens (Hurd, 1998).

Consequently, this study attempted to explore the relationships among metacognition, attitude toward subject matter and achievement in Turkish high school chemistry context. This study has a limited generalizability due to the limited sample size and convenience sampling technique (Fraenkel&Wallen, 2003). Future studies modeling the relationship among those variables of interest using path analysis with larger sample size and random sampling technique are highly recommended. Another limitation of this study is the use of self-report questionnaires for measuring students' attitudes toward chemistry and metacognition (Gay, 2002). Therefore, collection of qualitative data is suggested to complement the quantitative information and to clarify reasons for the observed relationships.

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GENİŞ ÖZET

Bu çalışmada 11. sınıf öğrencilerinin üstbilişleri, kimya başarıları ve kimyaya yönelik tutumları arasındaki ilişkilerin incelenmesi amaçlanmıştır. Çalışmaya Türkiye'nin büyük bir ilinde bulunan bir devlet lisesine devam eden 81 (38 kız, 43 erkek) 11. sınıf lise öğrencisi katılmıştır. Veri toplama araçları olarak Üstbiliş Farkındalık Envanteri ve Kimya Tutum Ölçeği kullanılmıştır. Schraw ve Dennison (1994) tarafından geliştirilen Üstbiliş Farkındalık Envanteri 52 sorudan oluşan 5 dereceli Likert tipi bir ölçektir. Bu envanterin Türkçeye çevrilmesi ve adaptasyonu Sungur ve Şenler (2009) tarafından yapılmıştır. Bu envanter üstbiliş bilgisi ve üstbiliş düzenlemesi temel boyutları altında yer alan sekiz alt boyut içermektedir. Üstbiliş bilgisi, açıklayıcı bilgi, işlemsel bilgi ve durumsal bilgi olmak üzere üç alt boyuttan oluşmaktadır. Üstbiliş düzenlemesi ise planlama, bilgi yönetme, izleme, hata ayıklama ve değerlendirme olmak üzere 5 alt boyuttan oluşmaktadır. Öğrencilerin kimyaya yönelik tutumlarını ölçmek için Geban, Ertepınar, Yılmaz, Altın ve Şahbaz (1994) tarafından geliştirilen Kimya Tutum Ölçeği kullanılmıştır. Bu ölçek, 15 sorudan oluşan 5 dereceli Likert tipi bir *ölçektir. Öğrencilerin kimya başarısı olarak, çalışmanın yapıldığı yıldaki iki döneme ait kimya ders notları ortalamaları kullanılmıştır.*

Veriler betimleyici istatistik ve Pearsonkorelasyon analiz yöntemleri kullanılarak çözümlenmiştir. Betimleyici istatistik bulguları, öğrencilerin hem üstbiliş bilgisi ve düzenlemesi alt boyutlarına hem de kimyaya yönelik tutuma ait ortalama puanların 5'li Likert tipi ölçek için orta değerin üstünde olduğunu göstermiştir. Bu bulgu, öğrencilerin hem öğrenen bireyler olarak kendileri hakkında bilgileri olduğunu hem öğrenme stratejileri hakkında bilgi sahibi olduklarını hem de sahip oldukları öğrenme stratejilerini ne zaman ve nasıl kullanacakları hakkında bilgilerinin olduğunu göstermektedir. Ortalama puanlar ayrıca öğrencilerin yeterli düzeyde öğrenmelerini kontrol ettiklerini ve düzenlediklerini, kimyaya yönelik olumlu tutum sergilediklerini ve kimya başarılarının yüksek olduğunu göstermektedir. Pearsonkorelasyon analizi sonucunda, kimya başarısının kimyaya yönelik tutum ile yüksek düzeyde ilişkili olduğu bulunurken üstbiliş bilgisi ve düzenlemesi ile herhangi bir ilişkisinin olmadığı tespit edilmiştir. Ayrıca, üstbiliş bilgisi ve üstbiliş düzenlemesi arasında yüksek derecede bir ilişki bulunurken bu iki değişkenin kimyaya yönelik tutum ile orta derecede ilişkisinin olduğu tespit edilmiştir.

Çalışma sonucunda 11. sınıf öğrencilerinin açıklayıcı bilgiye ve durumsal bilgiye işlemsel bilgiden daha çok sahip oldukları ve öğrencilerin üstbilişlerini düzenlemede hata ayıklama yöntemlerini diğer yöntemlerden (planlama, izleme, değerlendirme ve bilgi yönetme) daha fazla kullandıkları bulunmuştur. Bu bulgu ilgili alanyazın tarafından da desteklenmektedir (Sungur & Senler, 2009). Ayrıca, öğrenciler kimyaya yönelik olumlu tutum sergiledikçe kimya başarıları artmaktadır. Dahası, öğrencilerin kimyaya yönelik tutumları ile üstbiliş bilgileri ve düzenlemeleri arasında anlamlı bir ilişki bulunmuştur. Öğrenciler kimyaya yönelik olumlu tutum sergiledikçe sahip oldukları üstbiliş bilgisi artmakta ve üstbiliş stratejilerini daha çok kullanmaktadırlar. Bu bulgu üstbilişin bilişsel yönü yanında bilişsel olmayan yönünü de öne çıkaran alanyazın tarafından desteklenmektedir (Case &Gunstone, 2006; Schraw ve ark., 2006). Kimya başarısı ile üstbiliş arasında anlamlı bir ilişkinin olmadığını gösteren araştırma *bulgusu, başarı ile üstbiliş arasındaki tutarlı bir ilişkiden söz edilemeyeceğini savunan alanyazın (Sperling ve ark., 2002) tarafından bir ölçüde desteklenirken; akademik başarı ile üstbiliş arasında anlamlı ilişki ortaya koyan çalışmalarla tutarlılık göstermemektedir (Topçu & Yılmaz-Tüzün, 2010). Sonuç olarak, kimya öğretmenlerinin öğrencilerin kimyaya yönelik olumlu tutum geliştirmelerini ve üstbiliş bilgi ve stratejileri kullanmalarını destekleyen öğrenme ortamları tasarlamaları tavsiye edilmektedir. Ayrıca, kimyaya yönelik tutum, kimya başarısı ve üstbiliş arasındaki ilişkilerin örneklem sayısı artırılarak ve yapısal eşitlik modellemesi kullanılarak* analiz *edilmesi önerilmektedir.*