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THE EFFECT OF LOGICAL THINKING SKILLS AND ATTITUDE TOWARD CHEMISTRY ON ELEMENTARY TEACHERS'S PERFORMANCE ON CONCEPTUAL AND ALGORITHMIC PROBLEMS IN CHEMISTRY

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ÖZET

Bu çalışmanın amacı ilköğretim öğretmen adaylarının bilimsel düşünme yetenekleri ve kimya dersine karşı tutumlarının kimyadaki kavramsal ve algoritmik problem çözme performanslarına etkisinin incelenmesidir. 6 kavramsal ve 6 algoritmik problem içeren test sınıf öğretmenliği anabilim dalında okuyan 173 öğretmen adayına, problemlerle ilgili konular sınıfta anlatıldıktan sonra uygulanmıştır. Ayrıca öğrencilerin bilimsel düşünme yeteneklerini ölçmek için Bilimsel Düşünme Yetenek Testi ve kimya dersine karşı tutumlarını ölçmek için Kimya Tutum Ölçeği öğrencilere uygulanmıştır. Veriler çoklu varyans analizi (MANOVA) ile test edilmiştir. Elde edilen bulgular öğrencilerin bilimsel düşünme yeteneklerinin ve kimya dersine karşı olumlu tutumlarının kimyadaki kavramsal ve algoritmik problemlerdeki performanslarına istatistiksel olarak anlamlı bir etkisinin olduğunu göstermiştir. Öğrencilerin algoritmik problemlerdeki başarıları kavramsal problemlerden daha iyidir. Bunun yanında öğrencilerden kimya dersine karşı tutumları yüksek olanların düşük olanlardan ve soyut düşünme sürecinde olan öğrencilerin somut düşünme sürecinde olan öğrencilere göre kavramsal ve algoritmik problemlerdeki başarıları daha iyidir. Bu çalışmanın bulguları öğrencilerde yüksek düzeyde bilişsel yapının geliştirilmesini ve bu özelliklerin değerlendirilmesi gerektiği sonucunu ortaya çıkarmaktadır.

Anahtar kelimeler: Kavramsal ve algoritmik problem, Bilimsel düşünme yeteneği, Kimya dersine karşı tutum

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ABSTRACT

The purpose of this study were to investigate the effects of logical thinking skills and attitude toward chemistry on elementary teachers' performance in conceptual versus algorithmic problems in chemistry. A test containing six algorithmic and six conceptual questions related to chemistry was administered to 173 pre-service teachers at the Department of Elementary Education. Also, Logical Thinking Skills Test and Attitude Scale toward Chemistry were distributed to the students in order to measure their logical thinking abilities and attitudes toward chemistry as a school subject. The data were analyzed by MANOVA. The results showed that students' logical thinking skills and their attitudes toward chemistry have significant effects on their understanding of algorithmic and conceptual questions. Generally, students scored lower in conceptual questions than algorithmic questions. There was a significant difference in answering algorithmic and conceptual questions correctly among students at the formal, transitional and concrete stage of development. Students at the concrete stage were least successful in algorithmic and conceptual questions. Also, there was a significant difference in answering algorithmic and conceptual questions correctly among students with low, medium and high attitudes toward chemistry. The mean of test scores of students with low attitudes toward chemistry was the lowest for both algorithmic and conceptual questions. This study has implication that science education should favor development of higher order cognitive abilities and use appropriate assessment techniques for this purpose.

Keyword: Conceptual and algorithmic questions, logical thinking skills, attitude toward chemistry

1. INTRODUCTION

One of the aims of chemistry education is to develop higher order cognitive skills in students. These skills include abilities to ask questions and problem solving, decision making, critical and reflective thinking abilities (Zoller, 1993; Zoller, 1999). Traditionally, chemistry instruction focuses on formal, lecture-oriented teaching and presents facts and equations to be memorized (Bandera's cited in Zoller, 1993; Swift, Gooding & Swift, 1989). This type of teaching does not enhance development of higher order cognitive skills instead it promotes lower order cognitive skills which can be defined as abilities to recall information or simple application of known theory to familiar situations by mean of algorithmic processes (Zoller, 1999). Therefore students get the information without processing it; in other words, they cannot apply their higher order cognitive skills. This results in not comprehending the concepts. However, in order to attain the purpose of chemistry instruction, teaching strategies which favor higher order cognitive skills should be implemented in class and proper assessment methods should be used. The development of higher order cognitive skills needs appropriate exam questions which provide useful feedback both to students and teachers. (Zoller, 1993; 1999).

Research studies indicated that there was a little connection between solving a problem algorithmically and understanding the concept behind the problem (Pickering, 1990; Nakhleh, 1992; Sawrey 1990). Although students solve algorithmic problems successfully, they could not explain the chemical concepts exactly and they are often unable to integrate facts and formulas (Yager, 1991). They use the memorized set of procedures for their solutions. On the other hand, students could not answer conceptual questions, which require them to invoke basic theories to answer questions, to apply them to unfamiliar situations, to analyze, synthesize and evaluate the new situation (Zoller et al., 1995). This situation has been observed for several chemistry topics such as gases, stoichiometry and bonding (Nurrenbern & Pickering, 1987; Nakhleh & Mitchell, 1993; Zoller et al., 1995; Mason, Shell & Crawley, 1997). In chemistry learning, students should create a meaningful conceptual framework in order to develop reasoning, critical thinking and problem solving abilities. Therefore, conceptual understanding is important. Science instruction, chemistry instruction in particular, should motivate students to construct a conceptual understanding of the scientific phenomena rather than apply useful algorithms to problems (Gabel & Bunce, 1994). Conceptual understanding is related to meaningful learning, first introduced by Ausubel (1968). Meaningful learning refers to creating connection between what is already known and new potentially meaningful information in a nonarbitrary and substantive way. For meaningful learning to occur, there should be two conditions: new knowledge must have potential meaning, the learner must have relevant concepts to anchor the new ideas and the learner intends to incorporate the new knowledge in a nonarbitrary, nonverbatim way. When one or more of these requirements are not met, rote learning, verbatim memorization, occurs. In rote learning students do not develop hierarchical framework of successively more inclusive concepts instead they accumulate isolated propositions in their cognitive structure. This causes poor retention and retrieval of new knowledge to solve problems.

On the other hand, research studies revealed that students have difficulty in understanding of scientific concepts. Mason, Shell & Crawley (1997) reported that regardless of the students' problem solving ability, students spend more time in completing algorithmic questions than conceptual questions. Students are more successful in solving algorithmic problems than solving conceptual problems. Zoller, Dori & Lubezky (2002) found the same result in their study. In addition, they conclude that solving algorithmic questions correctly does not imply solving a higher order cognitive skills questions. Students find these types of questions difficult to answer. Therefore, more research should be done in this area in order to enhance conceptual understanding.

Students' performance on science is affected by many factors such as prior knowledge (BouJaoude & Giuliano, 1994), formal reasoning (Ingle & Shayer, 1971; Shayer & Adey, 1981; BouJaoude & Giuliano, 1994; Lawson, 1985). The logical thinking skill requires formal operations. The formal operational thinker achieves the highest level of cognitive development and he/she can reason in terms of abstract entities and hypothetical situations. The students at the formal operational level have ability of applying theoretical reasoning, interpreting relationships and observations and controlling some variables. Thus, these students perform significantly better in their thinking process. Many of the abstract concepts in chemistry require the students to function at the aspects of logical thinking ability to attain comprehension (Blake & Norland, 1978).

Besides intellectual competence, attitude is another factor affecting students' performance in science, in particular chemistry. Attitude can be defined as predispositions to respond positively or negatively to objects such as ideas, events, places or people. It covers enjoyment, like-dislike, interest, confidence, perception, value, and competence (Hill & Atwater, 1995). Koballa, et.al., (1990) described attitude toward science as a learned response evaluating our feelings within the environment related to science learning. Recent research studies have indicated that students' attitude toward science is strongly related to their achievement in science. (Harty, et.al., 1985; Simpson & Oliver, 1990; Lee & Burkam, 1996).

Since science education aims development of higher order cognitive skills, such as critical thinking, problem solving and decision-making, science teachers should be informed about the use of teaching strategies focusing on these skills. Science teacher education should focus on activities that help students increase their higher order cognitive skills, which promotes conceptual understanding. The purpose of the present study was to determine the effect of logical thinking skills and attitude toward chemistry on elementary teachers' performance on conceptual versus algorithmic problems in chemistry. Therefore, this study was designed to investigate following research questions:

1. Are there significant differences between students' performance on algorithmic and conceptual problems in chemistry?
2. What is the effect of logical thinking skills on students' performance of algorithmic and conceptual problems in chemistry?
3. What is the effect of attitudes on students' performance of algorithmic and conceptual problems in chemistry?

2. METHOD

2.1 Subjects

One hundred seventy three students attending general chemistry course participated in this study. General chemistry course was designed for elementary teachers at the department of Elementary Education and compulsory for all students to attend 3-hour lecture per-week.

2.2 Instruments

In order to address the research questions asked in this study; Conceptual and Algorithmic Questions Tests, Logical Thinking Skills Test and Attitude Scale Toward Chemistry were used.

Conceptual and Algorithmic Questions Test (CAQT): It included 12-items which were six conceptual questions and six algorithmic questions. All of the test items were taken from the previous studies (Nurrenbern and Pickering , 1987; Nakhleh, and Mitchell, 1993; Niaz, 1995; Sawrey, 1990; Chiu, 2001). All of the test items were multiple-choice except items 6A and 6B. Each of the correct answers were scored 1 point. The Cronbach's alpha reliability coefficient of the test was found to be 0.65 for conceptual questions and 0.75 for algorithmic questions. Two examples is given in Appendix 1.

Test of Logical Thinking (TOLT): It was developed by Tobin and Capie (1981). It is a two-tier multiple-choice instrument designed to assess cognitive development of students. It contains ten items. Students were supposed to respond correctly to the both parts of an item in order to get a credit from it. Students scoring between 0 and 3 were classified as concrete operational, those scoring between 4 and 6 as transitional, and those scoring above 6 as formal operational (Lewicki, 1993; p.57). An item was marked as correct if both the answer and reason were correct. The Cronbach's alpha reliability coefficient of the logical thinking skills test was found to be 0.85 for this study. Two example is given in Appendix 2

Attitude Scale Toward Chemistry (ASTC): This scale was developed by Geban et al. (1994). This scale measures students' attitude toward chemistry as a school subject and contains 15 5-point likert type items (strongly agree, agree, undecided, disagree and strongly disagree). The Cronbach's alpha reliability coefficient of this scale was found to be 0.83. Students' scores between 0 and 42.5 were classified as low attitude, scores between 42.5 and 53.4 as medium attitude, and scores between 53.4 and 75 as high attitude toward chemistry. The upper boundary score for low attitude group was determined as a result of subtracting 0.5*standard deviation from mean attitude score, which gave 42.5. The lower boundary score for high attitude group was determined by adding 0.5*standard deviation to mean attitude score, which resulted 53.4 (Thompson and Soyibo, 2002). The scores between these values were taken as medium attitude group. ASTC is given in Appendix 3

2.3 Procedure

This study was conducted during the 2002-2003 spring semester. 173 students in three general chemistry classes of same instructor at the department of Elementary Education in the study participated in the study. During the instruction, atoms, molecules and ions, nature of the matter, chemical bonds, stoichiometry, types of the reactions, gases and solutions topics were covered as a regular classroom curriculum in the general chemistry course. The classroom instruction was three 50-minute sessions per week. The instructor used lecture and discussion methods and solved algorithmic and conceptual problems to teach these topics. After the instructor's explanations, some concepts were discussed by the instructor directed questions. At the beginning of the study all of the students were administered logical thinking skills test and attitude scale toward chemistry. At the end of the semester, students were given conceptual versus algorithmic questions test.

2.4 Analysis of Data

Paired samples t-test was used to test whether there was a significant mean difference between the students' performance on conceptual and algorithmic questions in chemistry. Multivariate analysis of variance (MANOVA) was used to determine the effects of logical thinking skills and attitude toward chemistry on students performance on conceptual versus algorithmic questions. In this study, there were two dependent variables as students' performance on conceptual and algorithmic questions, and two independent variables as students' logical thinking skills and attitudes toward chemistry as a school subject.

3. RESULTS

Based on the data obtained by Test of Logical Thinking Skills, Attitude Scale toward Chemistry, and Conceptual and Algorithmic Problems Test, the students' mean and standard deviation scores for levels of logical thinking skills and attitudes were found as shown in Table 1 and 2, respectively.

Table 1: Sample sizes, means and standard deviations for algorithmic and conceptual problems scores with respect to attitude levels

Attitudes	N	SD	Mean	
Algorithmic Problems	Low	59	1.752	2.610
	Medium	61	1.654	3.787
	High	53	1.769	4.717
	Total	173	1.914	3.670
Conceptual Problems	Low	59	1.200	1.356
	Medium	61	1.428	2.377
	High	53	1.581	3.000
	Total	173	1.551	2.220

It is seen that performance of the students with high attitude toward chemistry is higher than the students with low and medium attitude toward chemistry for both conceptual and algorithmic questions.

It is seen that performance of the students who are at the formal stage is higher than the students who are at the concrete and transitional stages for both conceptual and algorithmic questions.

Table 2: Sample sizes, means and standard deviations for algorithmic and conceptual problems scores with respect to logical thinking skill levels

Logical Thinking		N	SD	Mean
Algorithmic Problems	Concrete	44	1.954	2.750
	Transitional	66	1.781	3.561
	Formal	63	1.729	4.429
	Total	173	1.914	3.670
Conceptual Problems	Concrete	44	1.519	1.705
	Transitional	66	1.514	2.212
	Formal	63	1.531	2.588
	Total	173	1.551	2.220

Paired samples t-test was used to determine whether there was a significant mean difference between the students' performance on conceptual and algorithmic problems in chemistry. It was found that students' performance on algorithmic problems in chemistry is higher than their performance on conceptual problems in chemistry ($t=14.67$; $df=172$; $p<0.05$). As it can be seen in Table 1 and Table 2, the mean score of the students is 2.220 for conceptual questions whereas it is 3.670 for algorithmic questions.

In order to investigate the effects of students' logical thinking skills and attitude on their conceptual and algorithmic problems in chemistry, MANOVA was run separately for each independent variable. One of the MANOVA assumptions is multivariate normality, which states that all of the individual dependent variables must be distributed normally. In order to check this assumption, scatter diagrams of dependent variables were plotted, since bivariate normality indicates multivariate normality. Also, skewness and kurtosis values were computed. Skewness and kurtosis should be zero for a normal distribution. The skewness values for conceptual and algorithmic questions were found to be 0.054 and –0.486, respectively. The kurtosis values were –1.040 for conceptual questions and –0.787 for algorithmic questions. Generally, these values are around zero and thus, it can be said that there is no violation to this assumption. Another assumption in MANOVA is homogeneity of covariance matrices. In order to test this assumption, Box's Test was used. This analysis revealed that observed covariance matrices of dependent variables are equal across the levels of logical thinking skills (F=0.468, p> 0.05) and attitudes (F=1.523, p> 0.05). Therefore, this assumption was not violated. Levene's Test was used in order to check the assumption that error variance of the dependent variables is equal across logical thinking skills and attitudes. All significance values for dependent variables were greater than 0.05, which means that equality of variances assumption was not violated.

After checking whether assumptions were violated, Wilks Lambda was used in order to test the main effects of students' logical thinking skills and attitudes on their conceptual and algorithmic problems in chemistry. The results of this analysis showed that there were significant effects of the students' logical thinking skills (□ = 0,878 , F= 5.659; df=4; p<0.05) and attitudes (□ = 0,768, F=11.427; df=4; p<0.05) on their performance on the collective dependent variables of conceptual and algorithmic problems in chemistry. Follow up ANOVA was needed to decide which dependent variable was responsible for this significant effect on the performance of the students. The results revealed that students' logical thinking skills made a significant effect on the students' performance on conceptual problems (F=4.363; df=2; p<0.05) and algorithmic problems (F=11.358; df=2; p<0.05) in chemistry. Also, the students' attitudes made a significant effect on the students' performance on conceptual problems (F=19.690; df=2; p<0.05) and algorithmic problems (F=21.073; df=2; p<0.05) in chemistry. In order to investigate the effects of the logical thinking stages and attitude levels on students' performance of conceptual and algorithmic problems in chemistry, Post Hoc Tests were used. The results of this analysis are given Table 3 for stages of logical thinking and Table 4 for levels of attitude.

Table 3: Pairwise comparisons for students' levels of logical thinking, conceptual and algorithmic problems

Dependent Variable	Levels of Logical Thinking		Mean Difference	P values
Algorithmic problems	concrete	transitional	-0.811	0.067
	concrete	formal	-1.679	0.000*
	transitional	formal	-0.868	0.021*
Conceptual problems	concrete	transitional	-0.508	0.265
	concrete	formal	-0.883	0.011*
	transitional	formal	-0.375	0.490

*$p<0.05$

It is seen in Table 3 that there was a significant mean difference between the students at the concrete stage and formal stage and between the students at the transitional stage and formal stage with respect to the students' performance on algorithmic problems in chemistry but there was no significant mean difference between concrete and transitional stages in terms of the students' performance on algorithmic problems in chemistry. In terms of the conceptual problems in chemistry, there was only a significant mean difference between concrete and formal stages but there was not significant mean difference among the other logical thinking stages. Table 2 summarizes the mean scores of the students for conceptual and algorithmic questions in chemistry in terms of three logical thinking skills stages.

Table 4: Pairwise comparisons for students' levels of attitudes, conceptual and algorithmic problems

Dependent Variables	Levels of attitudes		Mean difference	P values
Algorithmic problems	Low	Medium	-1.767	0.001*
	Low	High	-2.106	0.000*
	Medium	High	-0.930	0.014*
Conceptual problems	Low	Medium	-1.021	0.000*
	Low	High	-1.644	0.000*
	Medium	High	-0.623	0.058

*$p<0.05$

It is seen in Table 4 that there was a significant mean difference among the levels of attitudes with respect to conceptual and algorithmic problems in chemistry except between the performance of the students who have low and high attitudes on conceptual problems in chemistry.

4. DISCUSSION

The main purpose of this study was to investigate the effects of students' logical thinking skills and attitudes toward chemistry on conceptual and algorithmic problems in chemistry. Results of this study showed that students' performance on algorithmic problems is better than conceptual problems in chemistry. This result is consistent other research studies (Nakhleh and Mitchell, 1993; Sawrey, 1990; Zoller, Dori and Lubezky, 2002; Chiu, 2001; Niaz, 1995; Nurrenbern and Pickering, 1987) and studies in the literature showing that many students solve chemistry problems using algorithmic strategies but they do not understand behind its chemical concepts (Niaz and Robinson, 1992,1993; Niaz, 1995; Garnett and Treagust, 1992). The findings of this study indicated that logical thinking skills have an influence on students' performance on conceptual and algorithmic problems in chemistry. Students who are at the formal stage have better performance than other stages of logical thinking skills on both conceptual and algorithmic problems in chemistry. The results of this study support the results of other studies in that there is a significant relationship between achievement and cognitive development of students. For example, Sanchez and Betkouski (1986) found that students' cognitive development level affected students' performance in community college general chemistry courses. This result was also confirmed a study of Chandran, Treagust and Tobin (1985) and Haidar and Abraham (1991). They reported that formal reasoning ability was significantly related to chemistry achievement among high school students and strongly associated with their conceptions relating to specific subject-domains.

In the present study, the results indicated that students' attitude toward chemistry affects their performance on conceptual and algorithmic problems in chemistry. Students having high attitude toward chemistry have better performance than other levels of attitudes on conceptual and algorithmic problems in chemistry. The finding of this study is consistent with some other studies (Soyibo and Hudson, 2000; Schibeci and Riley, 1986; Scrinivasan, 1993; Cukrowska, Staskun and Schoeman, 1999). According to these researchers, appropriate perception of science learning environment helps to the development of positive attitude toward science while positive attitude toward science in its own right enhances achievement in science.

As a result, the findings of this study and other studies in literature showed that students' performance on algorithmic problems is better than conceptual problems in chemistry. Also, students' logical thinking skills and attitudes have significant effects on their performance on conceptual and algorithmic problems in chemistry. It is suggested that chemistry instructors need to measure students' logical thinking skills and attitudes and use instructional methods (such as;learning cycle, inquiry, cooperative learning, computer assisted instruction) that improve students' logical thinking skills and their attitudes, which are important for their performance on chemistry subjects.

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APPENDİX 1: Examples of one conceptual and one algorithmic problems

Algorithmic Problems

1 A). For a mixture of 2 mol H_2 and 2 mol O_2 reacting according to the following equation, what is the limiting reagent, and how many moles of the excess reactant would remain after the reaction is completed?

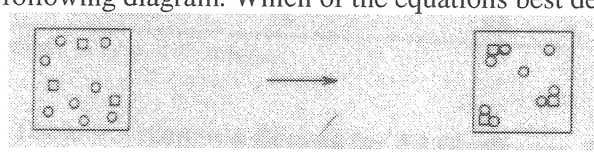
$$2H_2 + O_2 \longrightarrow 2H_2O$$

	Limiting Reagent	Excess Reactant Remaining
A)	O_2	1 mol O_2
B)	O_2	1 mol H_2
C)	H_2	1 mol O_2
D)	H_2	1 mol H_2

E) No reaction occurs since the equation does not balance with 2 mol H_2 and 2 mol O_2 .

Conceptual problems

1B). The reaction of element X (□) with element Y (O) is represented in the following diagram. Which of the equations best describes this reaction?



A) $3X + 8Y \longrightarrow X_3Y_8$

B) $3X + 6Y \longrightarrow X_3Y_8$

C) $X + 2Y \longrightarrow XY_2$

D) $3X + 8Y \longrightarrow 3XY_2 + 2Y$

E) $X + 4Y \longrightarrow XY_2$

APPENDİX 2: Bilimsel Düşünme Yetenek testinden iki örnek

SORU 1: Bir boyacı, aynı büyüklükteki altı odayı boyamak için dört kutu boya kullandığına göre sekiz kutu boya ile aynı büyüklükte kaç oda boyayabilir?

a). 7 oda b) 8 oda c) 9 oda d) 10 oda e) hiç biri

Açıklaması:

1. Oda sayısının boya kutusu sayısına oranı daima 3/2 olacaktır.
2. Daha fazla boya kutusu ile fark azalabilir.
3. Oda sayısı ile boya kutusu sayısı arasındaki fark her zaman iki olacaktır.
4. Dört kutu boya ile fark iki olduğuna göre, altı kutu boya ile fark yine iki olacaktır.
5. Ne kadar çok boyaya ihtiyaç olduğunu tahmin etmek mümkün değildir.

SORU 2 : Üç altın, dört gümüş ve beş bakır para bir torbaya konulduktan sonra, dört altın, iki gümüş ve üç bakır yüzük de aynı torbaya konur. İlk deneme torbadan altın bir nesne çekme olasılığı nedir?

a. 2 de 1 b) 3 de 1 c) 7 de 1 d) 21 de 1 e) Yukarıdakilerin hiçbiri

Açıklaması :

1. Altın, gümüş ve bakır yapılan nesneler arasında bir altın nesne seçilmelidir.
2. Paraların ¼ ' ü ve yüzüklerin 4/9'u altından yapılmıştır.
3. Torbadan çekilen nesnenin para veya yüzük olması önemli olmadığı için, toplam 7 altın nesneden bir tanesinin seçilmesi yeterlidir.
4. Toplam yirmi bir nesneden bir altın nesne seçilmelidir.
5. Torbadaki 21 nesnenin 7' si altından yapılmıştır.

APPENDIX 3: Kimya Tutum Ölçeği
Adı Soyadı:
Cinsiyet:
Öğrenci No:

Açıklama: Bu ölçekte Kimya dersine ilişkin tutumu belirleyici cümleler yer almaktadır. Her cümlenin karşısında TAMAMEN KATILIYORUM, KATILIYORUM, KARARSIZIM, KATILMIYORUM VE HİÇ KATILMIYORUM olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatle okuduktan sonra kendinize uygun seçeneği işaretleyiniz.

		Tamamen Katılıyoru m	Katılıyo rum	Karar sızım	Katılmıyorum	Hiç Katılmıyo rum
1	Kimya çok sevdiğim bir alandır.					
2	Kimya ile ilgili kitapları okumaktan hoşlanırım.					
3	Kimyanın günlük hayatta çok önemli yeri yoktur.					
4	Kimya ile ilgili ders problemlerini çözmekten hoşlanırım.					
5	Kimya konularıyla ilgili daha çok şey öğrenmek isterim.					
6	Kimya dersine girerken sıkıntı duyarım.					
7	Kimya derslerine zevkle girerim.					
8	Kimya dersine ayrılan ders saatinin daha çok olmasını isterim.					
9	Kimya dersine çalışırken canım sıkılır.					
10	Kimya konularını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim.					
11	Düşünce sistemimizi geliştirmede Kimya öğrenimi önemlidir.					
12	Kimya çevremizdeki doğal olayların daha iyi anlaşılmasında önemlidir.					
13	Dersler içinde Kimya dersi sevimsiz gelir.					
14	Kimya konuları ile ilgili tartışmaya katılmak bana cazip gelmez.					
15	Çalışma zamanımın önemli bir kısmını Kimya dersine ayırmak isterim.					