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DEVELOPMENT OF A SCALE TO MEASURE ORGANIC CHEMISTRY ANXIETY LEVEL OF UNIVERSITY STUDENTS

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Abstract. *University students' achievements in organic chemistry depend on cognitive variables. In addition, non-cognitive variables such as anxiety levels also have an impact on students' organic chemistry achievements. The aim of this study was to develop a measurement tool assessing the anxiety levels of university students in organic chemistry lessons. In this study, the Organic Chemistry Anxiety Scale (O-CAS) consisting of 24 items was developed, its validity and reliability was analysed. All the items are positively worded to indicate increased anxiety. Factor analytic evidence from a sample (n=340) of university organic chemistry students indicated that the O-CAS measured three constructs. Additional analysis with a second sample (n=297) showed that scores on these anxiety constructs were internally consistent, with Cronbach's alphas ranging from 0.87 to 0.92 and were 0.95 for the overall scale. Further, the result of analysis of the third sample (n=195) indicated that there was a statistically significant relationship between organic chemistry anxiety and organic chemistry achievement of students. According to these results, the O-CAS can be used as a valid and reliable instrument in chemistry education.*

Key words: *anxiety, chemistry education, organic chemistry, reliability, and validity.*

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Introduction

Thanks to the great advances in chemistry throughout the 20th century, it has been included in primary and secondary education curriculum as a part of science lesson or in a separate field (Salta & Tzougraki, 2004). Moreover, chemistry has become an essential area in terms of medical sciences, textile technology, agricultural sciences, synthetic industry, printing technology, pharmaceutical, chemical engineering, which have very important place in the fields of science (Jegede, 2007). Whereas, organic chemistry is simply defined as the study of the physical and chemical properties of organic compounds that occur in the chemistry.

Organic chemistry, which affects every aspect of our daily life from life-saving drugs to exciting new materials in technology, is a dynamic field in chemical science. Therefore, organic chemistry is an important course taught in the field of agriculture, biology, health sciences, medical school, veterinary medicine, pharmacy and medical chemistry in many universities.

From viewpoint of many university students' studying in these areas, organic chemistry course seems to be a difficult and also academic achievement of these students is probably low (Mahajan & Singh, 2005). According to Seymour and Hewitt (1997), difficulties of the course and the poor image arising from these difficulties created an important problem for those who were interested in increasing the number of science student. In order to achieve this goal, educators should be aware of factors that affect students' organic chemistry achievements (Turner & Lindsay, 2003).

Students' achievements in organic chemistry depend on general chemistry achievements, high school chemistry course performance, test scores and cognitive variables such as spatial visual performance (Krylova, 1997; Pribyl & Bodner, 1987; Rixse & Pickering, 1985; Sevenair, Carmichael, O'Connor & Hunter, 1987). In addition, students' achievement in organic chemistry was influenced by students' non-cognitive variables such as anxiety levels (Turner & Lindsay, 2003).

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The researchers suggested various definitions for anxiety. According to Levitt (1967), anxiety is "learned a strong impulse that come into action in the face of situations or intensive expectancy of threatening but an uncertain event; feeling of a disturbing doubt expectation" and when faced with a threat that the realization probability is very low, the feeling of caution and being alert exist in the body. (Mallow, 1981, 1986; Rachman, 1998) defined science anxiety as disgust or fear of science concepts, scientists and science related activities. Breslow (1993) and Eddy (2000) described chemistry anxiety as a fear of chemicals and chemical courses (McCarthy & Widanski, 2009). In addition to these definitions, Turner and Lindsay (2003) defined anxiety as students' feelings such as timidity towards chemistry, nervousness and physical manifestations of these emotions.

For the purpose of determining the level of anxiety towards science and mathematics education a limited number of assessment tools have been developed (Alvaro, 1978; Bowen, 1999; Hermes, 1985; Mallow, 1994; Richardon & Suinn, 1972; Spielberger et al., 1970; Udo et al., 2001). Results of the studies, in which these assessment tools were used, revealed that there was anxiety among the students (Berdonosov et al., 1999; Black & Deci, 2000; Chiarelott & Czerniak, 1987; Eddy, 2000), and the relationship between the students' anxiety levels towards courses and attitudes affected the students' achievement. Mallow and Greenburg (1982) stated that "there was a science anxiety among students, whereas it was less understood and rarely addressed case". Moreover, they stated that the anxiety of science, as well as mathematics anxiety, caused students to be afraid of enrolling in science courses, and as a result, to become a part of many areas related with science education and to be successful in these areas were prevented (p. 358). Humpreys and Revelle (1984) developed a model linking individual differences and information process to each other in their study. Although anxiety as a component of this model, they explained that anxiety could increase or decrease the performance depending on the nature of the task (Bowen, 1999). Westerback and Primavera (1992) reported that students who had anxiety towards chemistry course had a low success than students who had not (Mahajan & Singh, 2005). Steiner and Sullivan (1984) pointed out that there was a relationship between students' perceptions and attitudes towards organic chemistry course and their course achievements. Accordingly, they expressed that more successful students defined their approaches towards the lesson like that "relevant", "coordinate", "have confidence", "enthusiastic", and also it was common among these students that chemistry was useful and opens new prospects. In contrast, less successful students in organic chemistry were inclined to feel more anxious, uneasy and chaotic, and also chemistry was defined as a bizarre and confusing by them (Turner & Lindsay, 2003). Mahajan and Singh (2001) stated that the presence of anxiety affects students' understanding related to the subject. In addition, it was stated that teachers conducting classes, laboratory sessions and students' previous knowledge on the subject were factors that contribute to the success of students in organic chemistry course. On the other hand, anxiety, fear, and insufficient time were the factors that reduce the performance in the organic chemistry course. Because of this anxiety, students perceive organic chemistry as a discipline that creates the problem (Mahajan & Singh, 2005).

Organic chemistry is a branch of chemistry that deals with the structure, properties, and reactions of carbon-containing compounds. Furthermore, organic chemistry is the science of designing, synthesizing, characterizing, and developing applications for carbon-containing molecules. Therefore, instruction of organic chemistry is one of the most significant subjects in chemistry education and organic chemistry differs from other chemistry fields in terms of content. In general, textbooks of Organic Chemistry I consist of this content (Kurbanoglu, Taşkesenligil, & Sozbilir, 2006; Libby, 1991):

I. Carbon compounds and chemical bonds;
II. Stereochemistry; Types of isomerism and isomers of organic compounds;
III. Overview of the reaction mechanisms of organic compounds;
IV. Determination of the structure of organic molecules: IR and NMR spectroscopy.

Considering the content of organic chemistry, "anxiety of organic chemistry can be defined as not being able to name the organic compounds, and fear of not being able to learn complex subjects such as isomers of organic compounds and isomeric relationships, and fear of not being able to analyze synthesis reaction problems of the organic compounds efficiently".

Efficiency of learning organic chemistry depends on students' attitudes towards writing hybridization and bond types of carbon atoms, the formulas of organic compounds and naming, abilities to write isomer types of organic compounds, relationships of isomers and skills for analyzing and synthesizing of reaction problems of organic compounds sufficient skills for analyzing. Therefore, students may have different thoughts, attitudes and anxiety level towards learning organic chemistry. Ensuring that students develop positive attitudes towards organic chemistry courses and reducing their levels of anxiety will enhance students' abilities to learn organic chemistry topics. Thus, when tools are developed for measuring the dimensions of the factors affecting the learning of topics in organic chemistry, organic chemistry teaching will reach the intended destination. According to the studies, there is no tool that measures students' levels of anxiety for the organic chemistry course. Thus, the purpose of this study is to develop an assessment tool to measure the anxiety level of college students towards organic chemistry courses.

Methodology of Research

Development of the Instrument

To develop the Organic Chemistry Anxiety Scale (O-CAS) in a Likert format, we started with an extensive review of the literature on psychological theories of anxiety. Literature on students' anxiety toward organic chemistry was also reviewed to identify instruments used in research studies. According to the past studies, there was no tool that measures students' levels of anxiety for the organic chemistry course. Therefore, an assessment tool to measure the anxiety level of university students towards organic chemistry was developed in this study. Analysis of the data was conducted in three ways: (a) determining content validity of scale items, (b) calculating item total correlation estimates for item analysis to identify any faulty items, obtaining internal consistency reliability estimates of the scale scores, and (c) testing the construct validity by exploratory factor analysis.

Instrument

The O-CAS was designed to measure the anxiety students have in university organic chemistry courses. Based on typical organic chemistry course formats, measurement of three dimensions was desirable. These three dimensions included anxieties about (a) writing bond type of organic compounds, formulas and naming them, (b) writing the types of organic compounds and their isomers, and (c) writing the reaction mechanisms of organic compounds. Ten items were written for each scale, for a total of 30 items. The items intended to measure each of the three dimensions were interspersed. Respondents were asked to answer to each item using a 5-point Likert scale ranging from 1 (never makes me anxious) to 5 (always makes me anxious). Items of the final version of the O-CAS are included in Appendix. To make students understand the items in the scale and to increase the reliability, for each dimensions, key molecule structures and reactions mechanisms were designed. The scale was administered in this format. Demographic information including gender, GPA, and department and university information was also requested.

Samples and Data Analysis

The sample was 832 sophomore undergraduate students (436 female and 396 male) who take organic chemistry lessons at science faculties of seven different universities. Sample one were 297 university students (110 male, 187 female) from four universities across the Turkey (Sakarya University, Balikesir University, Agean University, and Kocaeli University), although some students did not respond to all items. This sample was administered the draft instrument for examine item analysis and Cronbach alpha internal consistency coefficients of the scale. Sample two were 340 university students (182 male, 158 female) who enrolled in organic chemistry classes at four universities across the Turkey (Sakarya University, Ataturk University, Marmara University, and Middle East Tech University). This sample was administered the draft instrument to establish construct validity of the instrument by exploratory factor analyses. Sample three were 195 university students (104 male, 91 female) who enrolled in Organic Chemistry I from Sakarya University, Turkey. These students were administered the O-CAS to establish the relationship between organic chemistry anxiety and organic chemistry achievement. Each students' two quiz scores, one hour-exams, and a final exam were used to determine point totals for each student, which were subsequently converted to averages. These averages were used as measures of organic chemistry achievement. All quizzes and exams were constructed by the instructor in charge of the course. At the end of the semester, averages were collected for consenting students. Students that withdrew from the course at any point during the semester were excluded from the study.

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Procedures

Organic chemistry courses in the first and second semesters during the 2010-2011 academic years were selected randomly by the on-site data collector at the four universities. Permission for student participation was obtained from the related chief departments and students voluntarily participated in research. Completion of the questionnaires was anonymous and there was a guarantee of confidentiality. The instruments were administered to the students in groups in the classrooms. Administration typically required 10 to 15 minutes. The measures were counterbalanced in administration. Prior to administration of measures, all participants were told about purposes of the study.

Results of Research

Content Validity

For determining the content validity, a panel of content experts (ten from organic chemistry and five from measurement and evaluation in education departments) judged the content validity of the O-CAS-30. These experts were also potential users of the scale. The content validity was assessed by asking the members to rate each item as a valid measure of the construct using a 5-point Likert scale ("1" strongly disagree, "5" strongly agree). A content validity ratio was calculated for each item and for the overall O-CAS-30. An acceptable content validity ratio should be "3". The overall ratings were high, attaining a ratio of 4.1 (individual item ratings ranged 4.8–3.9). In addition, the panel was asked to make comments on individual items in relation to the accuracy, clarity, style, and cultural relevance of the translation. Minor changes were suggested and a panel-modified version was developed.

Item Analysis

The corrected item-total correlations of the 30 items ranged from 0.33 to 0.78. Table 1 shows means, standard deviations, and the item total correlations of the 30 items for Sample 1.

Table 1. Means, standard deviations, and item–total correlations of the draft Organic Chemistry Anxiety Scale (O-CAS) for Sample 1.

Items	M	SD	Item-total correlation	Items	M	SD	Item-total correlation
1	2.16	1.29	0.33	16	2.80	1.30	0.71
2	1.92	1.22	0.50	17	2.62	1.31	0.63
3	1.92	1.12	0.65	18	2.60	1.22	0.71
4	1.82	1.18	0.69	19	2.63	1.33	0.71
5	1.94	1.14	0.58	20	2.73	1.26	0.69
6	2.19	1.20	0.71	21	2.47	1.21	0.64
7	2.04	1.10	0.72	22	1.98	1.08	0.69
8	2.10	1.12	0.68	23	2.71	1.30	0.78
9	2.16	1.13	0.36	24	2.56	1.24	0.49
10	2.63	1.20	0.35	25	2.60	1.16	0.75
11	2.59	1.19	0.66	26	2.51	1.13	0.78
12	2.66	1.27	0.71	27	2.59	1.23	0.33
13	2.91	1.39	0.76	28	2.65	1.24	0.68
14	2.52	1.21	0.63	29	2.61	1.24	0.39
15	2.16	1.39	0.74	30	2.60	1.22	0.66

Construct Validity

The purpose of the factor analysis was to determine if an empirical factor pattern/structure was similar to the intended scales that guided the item construction. It was hoped that three factors would be identified that had high factor structure coefficients for each of the 10 items designed to measure each of the three initial dimensions.

For the construct validity, exploratory factor analysis was conducted to validate the underlying structure of the model. Prior to the conduct of exploratory factor analysis, Kaiser-Meyer-Olkin (KMO) static and Bartlett's Test of Sphericity were performed. The KMO value (KMO =.921) indicated that the degree of common variance among the three variables was marvelous. The Bartlett's test of sphericity indicated a Chi square 4.905 with an observed significance level of $p<.001$. Based on the results, it was inferred that the relationship between the variables was strong and appropriate for factor analysis. These factors explained 61% of variance.

An initial analysis yielded three factors with eigenvalues greater than 1. Seven of the 30 items had factor structure coefficients exceeding an absolute value of 0.30 on the first extracted factor. All of these items (2, 3, 4, 5, 6, 7, and 8) originally were written to measure students' anxiety about writing bond type of organic compounds, formulas and naming organic compounds. None of these 7 items had high factor structure coefficients with any of the other factors. Because of the high factor structure coefficients on other factors, Items 9 and 10 and Item 1 has no structure coefficient on any of the three factors, all of these three items were deleted from the later version of this scale. This factor is best interpreted as measuring anxiety about writing bond types and formulas of carbon compounds and naming them.

For the second factor, 10 of the items have factor structure coefficients that have an absolute value exceeding 0.30. Examination of these items indicates that they measure anxiety related to writing the types of organic compounds and their isomers (Items 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20). None of these 10 items had high factor structure coefficients with any of the other factors. Therefore, this factor is best interpreted as measuring anxiety about writing the types of carbon compounds isomer. The third extracted factor was originally intended to measure anxiety about writing the reaction mechanisms of carbon compounds. This factor has seven items whose structure coefficients absolute values exceed 0.30 (Items 21, 22, 23, 25, 26, 28, and 30). None of these items have high structure coefficients on any of the other factors. On the other hand, Item 24 has high factor structure coefficients on other two factors and Item 27 and 29 have no structure coefficient on any of the three factors. Thus, they were deleted from the later version of this scale. The best interpretation of this factor is that it measures anxiety about writing the reaction mechanisms of organic compounds.

Table 2. Items, number of respondents, and varimax-rotated factor/structure pattern matrix for the three-factor solution of the draft Organic Chemistry Anxiety Scale (O-CAS) for Sample 2.

				Factors		
		Items	**n**	**I**	**II**	**III**
2	1	Taking organic chemistry course	340	0.60		
3	2	Listening to the organic chemistry course in the classroom	340	0.77		
4	3	Writing the type of carbon atom bond in organic molecules	340	0 .58		
5	4	Writing the type of carbon atom hybridization in organic molecule	340	0.81		
6	5	Writing the formula of organic molecule from its given name	340	0.82		
7	6	Writing the name of an organic molecule from its given formula	340	0.68		
8	7	Writing the type of formula of an organic molecule	340	0.39		
11	8	Writing the type of isomer of an organic molecule	340		-0.80	
12	9	Writing the structural isomers of an organic molecule	340		-0.40	
13	10	Thinking and write three-dimensional structure of an organic molecule	340		-0.73	
14	11	Determining the geometry of an organic molecule	340		-0.57	
15	12	Writing conformational isomers of an organic molecule	340		-0.52	
16	13	Writing the configurational isomers of an organic molecule	340		-0.56	

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				Factors		
		Items	n	I	II	III
17	14	Determining the priority groups at stereoisomerism	340		-0.54	
18	15	Writing the geometric isomers of an organic molecule	340		0 .40	
19	16	Determining chiral and achiral carbons in an organic molecule	340		0 .90	
20	17	Determining the enantiomers of a chiral molecule	340		-0.80	
21	18	Determining the type of nucleophile and solvent for the reaction	340			0.67
22	19	Writing which products can occur in reaction	340			0 .77
23	20	Writing the rate of products of reaction	340			0 .84
25	21	Writing the type of reaction mechanism	340			0.86
26	22	Writing the steps of the reaction mechanism	340			0 .72
28	23	Writing how the mechanism of the reaction occurs	340			0.57
30	24	Determining the structure of organic molecule with Spectroscopic method	340			0 .37

Reliability

Estimated Cronbach's reliabilities was 0.87 for anxiety about writing bond types and formulas of carbon compounds and naming them, 0.92 for anxiety about writing the types of carbon compounds isomers, 0.90 for anxiety about writing the reaction mechanisms of carbon compounds, and 0.95 for the overall scale.

Inter Scale Correlation Estimates

The purpose of examining the correlations among the scale scores was to determine how much overlap there was among the anxiety dimensions. Each scale score was calculated by summarizing responses for each item that comprised the scale. The scale scores were then calculated for each respondent by summing their responses. Students who did not respond to all items for the scales were omitted from the analysis. It was expected that there would be some overlap among the scales because each measures anxiety about different aspects of learning in organic chemistry. Table 3 contains the correlation matrices for the three original scales (comprised of 10 items each) and the six modified scales (7 items for first factor, 10 items for second factor, and 7 items for third factor). Examination of the correlations among the original (ranging from 0.37 to 0.57) and the modified scales scores (ranging from 0.30 to 0.53) shows that they are moderately related.

Table 3. Pearson product-moment correlations among scale scores for the original and modified anxiety scales.

Original Anxiety scales (and item numbers)	I	II	III
I. writing bond types and formulas of carbon compounds and naming them (Items 1 to 10)	1.00		
II. writing the types of carbon compounds isomer (Items 11 to 20)	0.37	1.00	
III. writing the reaction mechanism of carbon compounds (Items 21 to 30)	0.57	0.45	1.00
Modified Anxiety scales (and item numbers)	I	II	III
I. writing bond types and formulas of carbon compounds and naming them (Items 1 to 7)	1.00		
II. writing the types of carbon compounds isomer (Items 8 to 17)	0.53	1.00	
III. writing the reaction mechanism of carbon compounds (Items 18 to 24)	0.50	0.30	1.00

Organic Chemistry Anxiety and Organic Chemistry Achievement

A Pearson moment correlation was used to examine the relationship between organic chemistry anxiety and the organic chemistry achievement.

Table 4. Descriptive statistics and inter-correlations of the variables.

Variables	WBFNOC	WIOC	WRMOC	O-CAS	OCA
WBFNOC[a]	1.00				
WIOC[b]	0.65*	1.00			
WRMOC[c]	0.68**	0.66**	1.00		
O-CAS[d]	0.86**	0.90**	0.88**	1.00	
OCA[e]	-0.48**	-0.39**	-0.39**	-0.47**	1.00
Mean	15.61	30.38	21.50	67.50	45.31
SD	5.82	8.12	6.72	18.19	20.90

Note. [a]WBFNOC = Writing bond type of organic compounds, formulas and naming them, [b]WIOC = Writing the types of organic compounds and their isomers, [c]WRMOC = Writing the reaction mechanism of organic compounds, [d]O-CAS = Total organic chemistry anxiety scores, [e]OCA = Organic Chemistry Achievement.
$^{**}p < .01$

When Table 4 is examined, it is seen that there are significant correlations between organic chemistry achievement and organic chemistry anxiety. Writing bond type of organic compounds, formulas and naming them (r= –0.48), writing the types of organic compounds and their isomers (r= –0.39), writing the reaction mechanism of organic compounds (r= –0.39), and total organic chemistry anxiety scores (r= –0.47) were found to negatively correlate to organic chemistry achievement.

Discussion

Organic chemistry is one of the most important courses for undergraduate students majoring in applied chemistry, polymer chemistry, material chemistry, chemical engineering, life science, and environmental engineering and science. Therefore, in this study an assessment tool was developed to measure the anxiety level of college students towards organic chemistry.

Based on the factor analysis, the scale reliability information, and the inter scale correlations the three-scale O-CAS instrument was constructed. The 24-item Organic Chemistry Anxiety Scale measures the following dimensions of organic chemistry anxiety:

- Writing bond types and formulas of carbon compounds and naming them,
- Writing the types of carbon compounds isomer, and
- Writing the reaction mechanism of carbon compounds

Factor analytic evidence indicates that the items measure three unique dimensions of organic chemistry anxiety. The CFA results showed that the factorial model of the scales of the O-CAS that consists of three is at an acceptable degree of goodness of fit. Reliabilities of the scale scores, ranging from .87 to .92, are sufficiently high for making comparisons among groups of students. Cronbach's alpha values were .95 for the overall scale. In international literature, few scales determining the chemistry anxiety level of students have been developed. For instance, Eddy (1996) has developed a scale in order to determine chemistry anxiety level of students. The reliability of the Turkish version of the scale was found α=.90. Bowen (1999) has developed a chemistry laboratory anxiety scale and conceptualized it as a five dimensional construct. Reliabilities of the scale scores were ranging from .73 to .88. Reliability coefficients ranged between .86 and .88 for Turkish version. The assessments made in the researches (Akin & Kurbanoğlu, 2011; Kurbanoğlu & Akın, 2012; Kurbanoğlu, 2013), the O-CAS showed that the items distinguished the individuals sufficiently in terms of relevant features of the items. The inter scale correlations also support the multi-dimensional nature of the organic chemistry anxiety.

Given the multi-dimensional nature of the organic chemistry anxiety construct, it makes sense to ask this question: Are the anxieties of each dimension experienced to the same degree? This is an important question

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for organic chemistry educators and curriculum developers. For example, if it is found that the anxiety about "writing the types of carbon compounds isomer" is greater than the other two dimensions, then organic chemistry curriculum developers might target their efforts to reducing this dimension of anxiety by designing three-dimensional structure of organic molecules with the help of molecular models and computer-based physical modelling.

Similarly, second subscale, writing the reaction mechanisms of carbon compounds, measures fears of students' toward reaction mechanisms of carbon compounds. Mechanisms are important tools that organic chemists use to explain, predict, understand synthetic products, and problem-solving in organic chemistry. Students who are learning organic chemistry often have difficulty solving mechanistic tasks, and this may stem from both their problem-solving abilities as well as their level of content-specific knowledge. To be able to successfully solve novel mechanisms, it is important to have both cognitive skill sets, and to be able to understand the chemical properties of compounds. Furthermore, it is not known how students evaluate different mechanistic pathways or what basic non-cognitive features and at which level they are, they pay attention to when doing so. Thus, this subscale will provide valuable data for educators and curriculum developers about the anxiety level of students' toward reaction mechanism.

Also, a Pearson moment correlation was used to examine the relationships between organic chemistry anxiety and the organic chemistry achievement. Correlational results proved that there are significant correlations between organic chemistry achievement and organic chemistry anxiety. In other words, if students' organic chemistry anxiety levels increase then their organic chemistry achievement decreases.

Conclusions

As a result it can be said that this scale had high validity and reliability scores. Therefore, the O-CAS could serve as a useful tool for chemistry, agriculture, biology, health sciences, medical school, veterinary medicine, pharmacy and medical chemistry fields to collect information about the organic chemistry anxiety experienced by students. However, further studies that will use the O-CAS are important for its measurement force.

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Appendix: Items of the final version of the O-CAS

Writing bond types and formulas of carbon compounds, and naming them (7 items)	
1	Taking organic chemistry course
2	Listening to the organic chemistry course in the classroom
3	Writing the type of carbon atom bond in organic molecules.
4	Writing the type of carbon atom hybridization in organic molecule
5	Writing the formula of organic molecule from its given name
6	Writing the name of an organic molecule from its given formula.
7	Writing the type of formula of an organic molecule
Writing the types of carbon compounds isomer (10 items)	
8	Writing the type of isomer of an organic molecule
9	Writing the structural isomers of an organic molecule
10	Thinking and write three-dimensional structure of an organic molecule
11	Writing conformational isomers of an organic molecule
12	Determining the geometry of an organic molecule
13	Writing the configurational isomers of an organic molecule
14	Determining the priority groups at stereoisomerism
15	Writing the geometric isomers of an organic molecule
16	Determining chiral and achiral carbons in an organic molecule
17	Determining the enantiomers of a chiral molecule
Writing the reaction mechanism of carbon compounds (7 items)	
18	Determining the type of nucleophile and solvent for the reaction
19	Writing which products can occur in reaction
20	Writing the rate of products of reaction
21	Writing the type of reaction mechanism
22	Writing the steps of the reaction mechanism
23	Writing how the mechanism of the reaction occurs
24	Determining the structure of organic molecule with Spectroscopic method

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