



Abstract. *The aim of this study was to investigate the effects of organic chemistry anxiety on sophomore undergraduate students in relation to chemistry attitude and organic chemistry achievement. The participants were 228 sophomore undergraduate students, enrolled in organic chemistry courses. Anxiety and attitude were measured using O-CAS and CAS, respectively. O-CA was measured by determining a point total for each student, using the results of exams and quizzes from organic chemistry courses. The results of an ANOVA showed a significant difference in the means for O-CA and chemistry attitudes scores between the low, moderate, and high anxiety groups. The findings also revealed a moderate, significant negative correlation between organic chemistry anxiety and achievement, and a small, significant negative correlation between organic chemistry anxiety and chemistry attitudes. In addition, there was a small, significant positive correlation between chemistry attitudes and organic chemistry achievement.*

Key words: *achievement, chemistry attitude, organic chemistry anxiety, undergraduate students.*

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THE EFFECTS OF ORGANIC CHEMISTRY ANXIETY ON UNDERGRADUATE STUDENTS IN RELATION TO CHEMISTRY ATTITUDE AND ORGANIC CHEMISTRY ACHIEVEMENT

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Introduction

Organic chemistry is a branch of chemistry that deals with the structure, properties, and reactions of compounds that contain carbon. It 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, and is a required part of the curriculum in many countries, including Turkey. The primary teaching objectives of organic chemistry are to provide a basic understanding of its principles, introduce the characteristic of some types of organic compounds, instruct students on how to design and synthesize important active compounds, and solve some real-life problems. Therefore, the teaching of organic chemistry is considered one of the most important issues in chemistry education (Kurbanoglu & Akin, 2012).

Many university students studying these subjects, view the organic chemistry course as difficult, and the academic achievement for organic chemistry among such students is probably low (Mahajan & Singh, 2005). The difficulty of this course and the poor image that arises from these difficulties (Seymour & Hewitt, 1997) create an important problem to be resolved by those interested in increasing the number of science students (Turner & Lindsay, 2003).

Many factors influence students during the learning process. Of these, achievement is a major concern for both educators and policy planners. Some research has been carried out in the area of organic chemistry achievement. Existing research indicates that student achievements in organic chemistry depend on their achievements in general chemistry, their high school performance in chemistry courses, their test scores, and cognitive



variables such as spatial visual performance (Krylova, 1997; Pribyl & Bodner, 1987; Rixse & Pickering, 1985; Sevenair, Carmichael, O'Connor & Hunter, 1987). It is also influenced by non-cognitive variables such as attitude and anxiety (Turner & Lindsay, 2003).

Attitude has been conceptually linked to behavior, based on the premise that actions tend to be reflective of feelings (Koballa, 1988). Therefore, the development of a positive attitude toward a given subject is essential. According to Chapman and Neil (1999), a positive attitude provides an emotional state that is useful for dealing with problems. In this state, the individual is not only motivated to solve the problem but is also more tolerant to the problem when he or she is unable to find the ideal solution. In this context, a person with a positive attitude is able to convert any problem into an opportunity. In addition, students that maintain a positive attitude towards a subject are more likely to continue learning, both formally and informally, once the direct influence of a teacher has abated (Sua, 2007).

Attitudes have been studied using several independent methodological approaches, such as description, measurement, polls, theories, and experiments, and different definitions for the concept of attitude have been suggested. Baker (1988) defined attitudes as inferred, conceptual inventions that aid both the description and explanation of behavior. Eagly and Chaiken (1993), considered attitude is an expression of a psychological tendency, which measures the degree of like or dislike of a particular entity. Furthermore, Oskamp and Schultz (2004) defined attitude as a predisposition to respond in a positive or negative manner to a particular object or class of objects. Koballa and Crawley (1985), defined an attitude towards science as the liking or disliking of science, or the negative vs. positive feeling toward science.

The existing literature largely supports the idea that positive attitudes and behavior play a role in improving the academic achievement of students. Moreover, a student's attitude is one of the key factors in learning science, and the development of a positive attitude toward science can motivate a student to be interested in both science education and science-related careers (George, 2006).

Student attitudes toward science have been extensively studied. Schibeci and Riley (1986) indicated that attitudes influence achievement, rather than achievement influencing attitudes. Students with a positive attitude toward science tend to score more highly on measures of achievement (Oliver & Simpson, 1988; Weinburgh, 1994). Findings from previous research also indicate a low to moderate correlation between attitude and achievement (Freedman, 1997; Germann, 1988; Haladyna & Shaughnessy, 1982; Wilson, 1983). According to Yara (2009), attitudes toward chemistry or science indicate a student's interests in or feelings toward its study.

Student attitude toward learning chemistry as a factor has long attracted the attention of both researchers and practitioners, with especial regard to the importance of student attitudes towards chemistry lessons in school (Osborne, Simon & Collins, 2003). The development of a positive attitude toward chemistry lessons in school is considered important, as research shows a link between attitudes and academic achievement. For example, Bennett, Rollnick, Green, and White (2001) found that undergraduate students with a less positive attitude to chemistry almost invariably obtained lower marks in examinations. Moreover, Salta and Tzougraki (2004) reported that the correlation between high school student achievement in chemistry and attitude towards chemistry ranges from 0.24 to 0.41.

Anxiety is another factor that influences a student's achievement in chemistry. The phenomenon called chemistry anxiety exists amongst university students in many countries, including Turkey (Berdonosov et al., 1999; Eddy, 2000; Kurbanoglu & Akin, 2010; Mahajan & Singh, 2005). Eddy (2000) conceptually defined chemistry anxiety as a fear of chemicals and/or chemistry courses (McCarthy & Widanski, 2009). In addition, Turner and Lindsay (2003) defined chemistry anxiety as related to a student's feelings towards chemistry, such as timidity and nervousness, and to the physical manifestations of these emotions. A review of the current research suggests that low achievement in chemistry is frequently accompanied by chemistry anxiety. Students who feel anxiety about learning chemistry frequently lose interest in the sciences (Keeves & Morgenstern, 1992; Jegede, 2007). Students who experience anxiety related to their chemistry course have a lower level of success than students that do not (Westerback & Primavera, 1992; Mahajan & Singh, 2005). Anxiety affects a student's understand-



ing of the subject (Mahajan & Singh, 2001) and is also the primary factor that reduced performance in the organic chemistry course. This anxiety can lead to students perceiving organic chemistry as the discipline that creates the problem (Mahajan & Singh, 2005).

A significant relationship between organic chemistry anxiety and achievement has also been shown. Most importantly, research has shown that highly anxious individuals perform poorly, especially when the task is difficult or when their performance is to be evaluated (Dutke & Stober, 2001; Lee, 1999; Wong, 2010). Steiner and Sullivan (1984) revealed the relationship between a student's perception and attitude towards organic chemistry course and their course achievement. Accordingly, they proposed that less successful students were inclined to feel more anxious, uneasy, and chaotic, and to define chemistry as bizarre and confusing (Turner & Lindsay, 2003). Therefore, it is considered that if negative thoughts can be replaced by positive thoughts, the resultant reduction in anxiety may lead to an improvement in performance.

Organic chemistry is simply defined as the study of the physical and chemical properties of the organic compounds used in chemistry. It differs from the other fields of chemistry fields in terms of content. In general, organic chemistry textbooks contain the following topics (Kurbanoglu, Taşkesenligil & Sozibilir, 2006; Libby, 1991):

- I. Carbon compounds: Hybridization and bonding of carbon atom
- II. Stereochemistry: Types of isomerism and isomers of organic compounds.
- III. Overview of the reaction mechanism of organic compounds.
- IV. Determination of the structure of organic molecules: IR and NMR spectroscopy.

With regard to the content of organic chemistry courses, the "anxiety" of organic chemistry can be defined as fear of an inability to name the organic compounds; learn complex subjects, such as isomers of organic compounds and isomeric relationships; and analyze and synthesis the reaction problems of organic compounds efficiently. In order to learn organic chemistry efficiently, students must have a positive attitude toward writing hybridization and bond types of carbon atoms, the formulas of organic compounds (including naming), the ability to write the isomer types of organic compounds, the relationships of isomers, and the skills required for sufficiently analyzing and synthesizing the reaction problems of organic compounds. Students may have different thoughts, attitudes, and anxiety levels towards organic chemistry while learning the subject. Therefore, organic chemistry anxiety may play a crucial role in both chemistry attitudes and organic chemistry achievement. Although previous studies have typically focused on science and chemistry anxiety (Eddy, 2000; Laukenmann et al., 2003), organic chemistry anxiety has received relatively little attention in science education literature. For this reason, the aim of the present study was to examine the relationship between chemistry attitudes, organic chemistry anxiety, and achievement.

Purpose

The purpose of this study was to investigate whether there was a statistical difference between student chemistry attitude and organic chemistry achievement (classified according to the organic chemistry anxiety levels). Furthermore, this study also sought to examine whether a significant correlation exists between (a) students' organic chemistry anxiety and chemistry attitude, (b) organic chemistry anxiety and achievement, and (c) chemistry attitude and organic chemistry achievement.

Methodology of Research

A survey questionnaire was used to collect data for this study. Participants were asked to complete a survey questionnaire, consisting of a series of questions taken from the Organic Chemistry Anxiety Scale and the Chemistry Attitudes Scale. Permission to use students as participants was obtained from the relevant heads of department. All students participated voluntarily in the research. The completion of scale was anonymous and participants were guaranteed confidentiality. Scales were administered within the classroom. All of the participants were informed as to the purpose of this study prior to completing the survey. All measures were counterbalanced.



Participants

The course under investigation was organic chemistry, the organic chemistry course in Turkey starts in second grade, ordinarily offers two seasons for Organic Chemistry (I and II) per year, one in the fall and the other in the summer. The research participants were 228 sophomore undergraduate students (123 male and 105 female), enrolled in Organic Chemistry I within the Chemistry Department at the University of Sakarya, Turkey. Their ages ranged from 18 to 21 years, with a mean age of 19.5 years. Consequently, all applications were performed at the end of the fall.

Measures

The Organic Chemistry Anxiety Scale (O-CAS; Akin & Kurbanoglu, 2011). This scale is a 24-item self-report measurement that consists of three factors: (1) writing the bond type of carbon compounds and formulas and naming the carbon compounds (seven items, for example, write the type of carbon atom bond in organic molecules); (2) writing the types of carbon compounds and their isomers (ten items, for example, write the type of isomer of an organic molecule); and (3) writing the reaction mechanism of carbon compounds (seven items, for example, write the steps of the reaction mechanism). Each item was rated on a 5-point Likert scale, ranging from 1 (never makes me anxious) to 5 (always makes me anxious). Cronbach's alpha values were 0.87 for writing bond type of carbon compounds, formulas and naming carbon compounds; 0.92 for writing the types of carbon compounds and their isomers; 0.90 for writing the reaction mechanism of carbon compounds; and .95 for the overall scale.

The Chemistry Attitudes Scale (CAS; Geban, Ertepinar, Yilmaz, Altin, & Şahbaz, 1994). This scale contains 15 items, of which 5 are negatively keyed (items 3, 6, 9, 13 and 14). Examples include "during chemistry lessons I am bored" (negatively keyed) and "I like chemistry courses more than the others" (positively keyed). Each item was rated on a 5-point Likert type scale (from 1 = strongly disagree to 5 = strongly agree). Higher scores indicated a higher positive attitude towards chemistry. The Cronbach Alpha internal consistency reliability coefficient of the scale was 0.83.

Organic Chemistry Achievement (O-CA). The course under investigation, Organic Chemistry is the first in a two-course sequence designed for chemistry majors in Turkey. The Chemistry Department at the University of Sakarya, ordinarily offers two seasons for Organic Chemistry (I and II) per year, one in the fall and the other in the summer. Only the fall sections were used in this study. Two quiz scores were used to measure organic chemistry achievement. These were the one-hour exam and the final exam for the course. A points total was calculated for each student, which was subsequently converted into an average. The averages were then used to measure organic chemistry achievement. The course instructor constructed all quizzes and exams. At the end of the semester, averages were collected for each of the consenting students.

Data analysis

Students were assigned to one of three groups according to their organic chemistry anxiety scores (low, moderate, and high). They were also assigned to one of three groups according to their chemistry attitude scores low-attitude (0-35), moderate-attitude (36-49), and high-attitude group (50-75). The percentiles of organic chemistry anxiety and chemistry attitude scores were used to classify students. The moderate group consisted of those students whose score fell between 41% and 76%. The low and high organic chemistry anxiety groups consisted of students whose scores were in the lower 41% and upper 76% of the distribution respectively. In addition, students whose chemistry attitude scores fell between 48% and 65% were considered the moderate group. The low and high chemistry attitude groups consisted of students whose scores were in the lower 48% and upper 65% of the distribution respectively. A one-way ANOVA and Tukey's HSD (Honestly Significant Difference) tests were used to compare means for chemistry attitudes and the O-CA scores for the organic chemistry anxiety groups. A Pearson's product correlation coefficient was calculated for participant chemistry attitudes, and O-CA and organic chemistry anxiety scores, in order to explore potential relationships between these variables.



Results of Research

Total scores for organic chemistry anxiety and chemistry attitude were calculated from items on the organic chemistry anxiety scale (O-CAS) and the CAS. A critical examination was made to determine the common level of organic chemistry anxiety and chemistry attitude.

The number of students in each anxiety group, and the mean scores for each dependent variable are shown in Table 1.

Table 1. Comparisons of mean by level of organic chemistry anxiety.

O-CAS Group	\bar{X} (O-CA)	SD	\bar{X} (CA)	SD	n
High (77-100%)	34.49	21.560	42.65	9.453	75
Moderate (41-76%)	44.68	18.008	46.60	10.521	77
Low (0-40%)	54.85	21.471	48.49	9.957	75
Total	44.67	21.931	45.92	10.239	227

O-CAS: Organic Chemistry Anxiety, CA: Chemistry Attitudes, O-CA: Organic Chemistry Achievement.

The ANOVA results (shown in Table 2) reveal a significant difference in mean scores between the groups (low, moderate, and high) for organic chemistry achievement, $F(2,224)=18.689$, $p<0.01$. Tukey's HSD tests revealed a significant difference in organic chemistry achievement between the low and moderate anxiety group, between the low and high anxiety groups, and between the moderate and high anxiety groups.

Table 2. Results of the ANOVA for organic chemistry anxiety and O-CA scores.

	Sum of Squares	df	Mean Square	F	p	Tukey
Between Groups	15544,860	2	7772,430	18.689	0.00	L-M
Within Groups	93159,016	224	415,888			L-H M-H
Total	108703,877	226				

H: High Anxiety, M: Moderate Anxiety, L: Low Anxiety.

The ANOVA results for chemistry attitudes (Table 3), show a significant difference in mean scores for organic chemistry achievement between the low, moderate, and high chemistry attitudes groups, $F(2,224)=10.933$, $p<0.01$.

Table 3. Results of the ANOVA for chemistry attitudes and O-CA scores.

	Sum of Squares	df	Mean Square	F	p	Tukey
Between Groups	9667,280	2	4833,640			
Within Groups	99036,597	224	442,128	10.933	0.00	L-H M-H
Total	108703,877	226				

H: High Attitudes, M: Moderate Attitudes, L: Low Attitudes.



Tukey's HSD tests revealed a significant difference between the low and high chemistry attitudes groups, and the moderate and high chemistry attitudes groups. However, a comparison of means for the low and moderate chemistry attitudes groups showed no significant difference at the 0.01 level.

Table 4. Results of the correlations between the variables.

Variables	O-CAS	CA	O-CA
O-CAS	1.00		
CA	-.20**	1.00	
O-CA	-.43**	.29**	1.00

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

A significant correlation was observed between chemistry attitudes (CA), organic chemistry anxiety, and organic chemistry achievement (O-CA) (Table 4). The results also revealed a moderate, significant negative correlation between organic chemistry anxiety and O-CA ($r=-0.43$, $p<0.01$), and a small, significant negative correlation between organic chemistry anxiety and CA ($r=-0.20$, $p<0.01$). A small, significant positive correlation between CA and O-CA was also shown ($r=0.29$).

Discussion

The present study was designed to investigate the influence of chemistry attitude and organic chemistry anxiety on the achievement of university students in organic chemistry. Besides, in this study we tried to identify the direct effects these variables have on each other. Pearson's product correlation coefficients for scores relating to chemistry attitudes, organic chemistry achievement, and organic chemistry anxiety scores were calculated in order to examine the possible relationships between these variables.

The results of this study showed significant correlations between chemistry attitudes, organic chemistry anxiety, and achievement. The results also indicated that university students with high organic chemistry anxiety had significantly lower scores for achievement. This shows that there is a small, but significant, negative relationship between organic chemistry anxiety and the achievement of students studying organic chemistry. Numerous authors have suggested that low achievement is linked to both high levels of anxiety and poor learning outcomes in school (Busari & Uwakwe, 2001; Moline & Borkivec, 1994; Olatoye, 2009).

Furthermore, the current findings indicate a significant negative relationship between organic chemistry anxiety and chemistry attitude. This implies that higher levels of organic chemistry anxiety are correlated with low levels of positive chemistry attitude. This is consistent with the research findings of Dory (1989) and Keeves and Morgenstem (1992), who also revealed a negative relationship between these variables. They reported that a student's anxiety levels regarding their learning of chemistry can be attributed to perceptions relating to the difficult nature of chemistry, the involvement of a multitude of facts, and the notion that chemistry is somewhat disconnected from reality. A student's level of anxiety related to the learning of chemistry also leads to loss of interest in the sciences. Unlike chemistry attitude, organic chemistry anxiety appears to be a negative psychological construct. This is because organic chemistry anxiety in students manifests as an inability to think clearly, a fear of failure, negative self-evaluation, and self-blame.

However, the analysis also revealed a significant positive relationship between chemistry attitude and organic chemistry achievement. Thus, higher levels of organic chemistry anxiety correlate with lower organic chemistry achievement and chemistry attitude, and lower organic chemistry anxiety correlates with higher levels of achievement and more positive attitudes towards chemistry. In simple terms, if a student's organic chemistry anxiety levels increase, then either his or her attitude to and achievement in organic chemistry decreases. These results concur with those of Steiner and Sullivan (1984), who found



evidence of a relationship between the attitudes and perceptions pertaining to organic chemistry, and achievement. Moreover, students with a lower achievement level in organic chemistry were more likely to feel worried, anxious, and disorganized and were more likely to describe chemistry as strange and puzzling (Steiner & Sullivan, 1984; Turner & Lindsay, 2003).

Conclusion

In conclusion, this investigation reports that organic chemistry anxiety affects organic chemistry achievement and chemistry attitudes, directly. Students' lows in organic chemistry achievement are more likely to vulnerability to organic chemistry anxiety and negative chemistry attitudes. So, the current findings may increase our understanding of the relationships between organic chemistry achievement, organic chemistry anxiety, and chemistry attitudes. The results of the present study provide evidence that organic chemistry anxiety has an important effect on organic chemistry teaching, one that cannot be ignored.

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Received: October 05, 2012

Accepted: February 05, 2013

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