



## Secondary School Students' Self-Efficacy Beliefs toward Chemistry Lessons

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### ABSTRACT

The purpose of this study was to investigate secondary school students' self-efficacy beliefs toward chemistry lessons and to determine how their self-efficacy beliefs change across grade levels and gender. The participants were 114 secondary school students (42 males and 72 females) enrolled at a medical vocational high school. High School Chemistry Self-Efficacy Scale for Cognitive Skills (CSCS), a unidimensional instrument, was used for assessing secondary school students' self-efficacy beliefs toward chemistry lessons. Two-way ANOVA was used to determine the effect of gender and grade level of the students on chemistry self-efficacy for cognitive skills. The results showed that secondary school students had a medium level self-efficacy toward chemistry lessons and there was not any significant difference between boys and girls in terms of their chemistry self-efficacy for cognitive skills. The results also showed that the 9th graders have higher self-efficacy beliefs toward chemistry lessons than 10th and 12th graders.

**Keywords:** Self-Efficacy, Chemistry Education, Affective Variables.

### EXTENDED ABSTRACT

Self-efficacy is a very important construct and has a great importance in the field of educational researches. It has a significant effect and impact on students' learning and achievement (Bandura, 1997). Being one of the most important constructs that affects students' behaviors, a lot of studies conducted which present the close relationship between self-efficacy and students' performance levels on academic tasks such as examinations and final grade (eg. Scherer, 2013).

The purpose of this study was to investigate secondary school students' self-efficacy beliefs toward chemistry lessons and to determine how their self-efficacy beliefs change across grade levels and gender. The scope of the current study was limited with secondary school students' self-efficacy beliefs toward chemistry lessons and the effect of gender, and grade level on this affective factor. This study aimed to evaluate the self-efficacy beliefs of secondary school students' in terms of their grade level and gender. The specific research questions that guide this study are as follows:

- What are the differences, if any, between 9th, 10th, 11th, and 12th grade students' self-efficacy beliefs toward chemistry lessons?
- What are the differences, if any, between male and female secondary school students' self-efficacy beliefs toward chemistry lessons?

The participants were 114 secondary school students (42 males and 72 females) enrolled at vocational high school in Etimesgut district in Ankara. 41 participants were 9th grader, 24 participants were 10th grader, 14 participants were 11th grader, and 35 participants were 12th grader. Data were collected during 2013-2014 fall semester.

Çapa Aydın and Uzuntiryaki (2009) developed a self-report questionnaire whose name is High School Chemistry Self-efficacy Scale (HCSS). This instrument assesses secondary school students' self-efficacy beliefs related with chemistry. The scale has two dimensions which are chemistry self-efficacy for cognitive skills and self-efficacy for chemistry laboratory. In this study, having high reliability and validity High School Chemistry Self-Efficacy Scale for Cognitive Skills (CSCS) was used which is suitable for Turkish culture for assessing secondary school students' self-

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efficacy beliefs toward chemistry lessons (see Appendix A ). The type of scale in this instrument is five point Likert type from “poorly” to “very well”. In the current study, the Cronbach’s alpha reliability value of the scale was .947. Furthermore, factor analysis is conducted for providing evidence for construct related validity. Only one factor which is self-efficacy for cognitive skills in chemistry domain was expected to be obtained. Fortunately, the factor analysis yielded one factor which explains 68% of the total variance.

Descriptive statistics was used to give information about the sample such as the means and the standard deviations. Inferential statistics was used to make generalization based on findings of the sample. Two-way analysis of variance (ANOVA) was used to determine the effect of gender and grade level of the students on chemistry self-efficacy for cognitive skills. The results of two-way ANOVA analyses showed that grade level difference was significant ( $F(3,106) = 8.073, p < .05$ ). The analyses also showed that there were significant differences between 9th grade students and 10th grade students, and there were also significant differences between 9th grade students and 12th grade students. The effect of interaction between grade level and gender ( $F(3,106) = 1.625, p > .05$ ) was not significant. Besides, the statistical analyses showed that there was not any significant difference between boys and girls with respect to the scores that they gained from CSCS scores ( $F(1,106) = .072, p > .05$ ).

One of the reasons for decrease in self-efficacy might be the chemistry curriculum. Although the chemistry curriculum includes a lot of subjects, there are not enough lesson hours for teachers to teach these subjects. Therefore, the most probable reason for decrease in self-efficacy toward chemistry lessons may be due to the high burden of curriculum and the teachers’ obligation to finish the subjects. The reasons for decrease in self-efficacy beliefs toward chemistry lessons should be a research topic for future researches and detailed qualitative and quantitative studies should be conducted on this area.

# Lise Öğrencilerinin Kimya Dersine Yönelik Özyeterlik İnançları

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## ÖZET

Bu çalışmanın amacı ortaöğretim öğrencilerinin kimya derslerine yönelik özyeterlik inançlarını araştırmak ve sınıf düzeyi ve cinsiyete göre nasıl değiştiğini belirlemektir. Araştırmaya bir Sağlık Meslek Lisesinden 114 öğrenci (42 erkek, 72 kız) katılmıştır. Lise öğrencilerinin kimya derslerine yönelik özyeterlik inançlarını ölçmek için tek boyutlu bir ölçek olan Bilişsel Beceriler için Lise Kimya Özyeterlik Ölçeği (CSCS) kullanılmıştır. Öğrencilerin sınıf düzeyleri ve cinsiyetlerinin kimya derslerine yönelik özyeterlik inançlarına etkisini belirlemek için iki yönlü varyans analizi kullanılmıştır. Sonuçlar lise öğrencilerinin kimya dersine yönelik orta düzeyde özyeterliğe sahip olduklarını ve bilişsel beceriler için kimya özyeterlikleri açısından kız ve erkek öğrenciler arasında anlamlı bir fark olmadığını göstermiştir. Bununla beraber, sonuçlar dokuzuncu sınıf öğrencilerinin on ve onikinci sınıf öğrencilerinden daha yüksek düzeyde kimya derslerine yönelik özyeterlik inançlarına sahip olduğunu göstermiştir.

**Anahtar Kelimeler:** Özyeterlik, Kimya Eğitimi, Duyuşsal Değişkenler.

## 1. Introduction

Self-efficacy is defined as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3). Bandura, the founder of social cognitive theory (1986), was the first to introduce the construct of self-efficacy to the literature. In social cognitive theory, human functioning is determined by the dynamic interaction of personal, behavioral and environmental factors. In this regard, self-efficacy affects behaviors and environments, and so is influenced by them (Bandura, 1997), and outcomes of behaviors and inputs from the environment and feedback from other people can influence self-efficacy (Schunk & Pajares, 2009). Therefore, it can be inferred that people’s beliefs in their capabilities can be mostly predicted by the way they behave rather than what they are able to do indeed. An important characteristic of self-efficacy is that it is context-specific (Bandura, 1997). Therefore, an individual’s performance on a specific task or a range of tasks in a given domain can be assessed. Another important characteristic of self-efficacy is that it depends on individual’s perception (Bandura, 1997).

Self-efficacy is a very important construct and has a great importance in the field of educational researches. It has a significant effect and impact on students’ learning and achievement (Bandura, 1997). Especially, it is very clear that self-efficacy is strongly related with students’ science learning and science achievement as well as students’ persistence on science related tasks (Bandura, 2001). Therefore, improving this construct is also noteworthy and should be one of the key factors in designing curriculum and in designing effective science instruction.

Science education does not only consist of teaching some cognitive concepts, but also it should consist of improving students’ affective domains like developing positive self-efficacy beliefs toward science. Therefore, one of the major priorities of science educators should be to aid students for developing their science learning by the identification of variables such as self-efficacy. This study can provide a framework for identifying one of the most important affective variables which is self-efficacy.

Being one of the most important constructs that affects students’ behaviors, self-efficacy beliefs have been very popular among education researchers in the last two decades due to the increasing awareness on its importance. A lot of studies conducted which present the close relationship between self-efficacy and students’ performance levels on academic tasks such as examinations and final grade (eg. Scherer, 2013). Besides, several studies showed that self-efficacy beliefs toward chemistry lessons were significant predictors in explaining chemistry achievement and were also positively correlated with chemistry achievement (eg. Lavonen and Laaksonen, 2009). Moreover, self-efficacy has a domain-specific

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characteristic and is specific to subject areas and display very little generalization across areas (Pajares, 1996; Smith & Fouad, 1999). Hence, in the current study, students' self-efficacy beliefs were studied in chemistry as a specific domain.

The purpose of this study was to investigate secondary school students' self-efficacy beliefs toward chemistry lessons and to determine how their self-efficacy beliefs change across grade levels and gender. The scope of the current study was limited with secondary school students' self-efficacy beliefs toward chemistry lessons and the effect of gender, and grade level on this affective factor.

This study aimed to evaluate the self-efficacy beliefs of secondary school students' in terms of their grade level and gender. The specific research questions that guide this study are as follows:

- What are the differences, if any, between 9th, 10th, 11th, and 12th grade students' self-efficacy beliefs toward chemistry lessons?
- What are the differences, if any, between male and female secondary school students' self-efficacy beliefs toward chemistry lessons?

## 2. Literature Review

After Bandura's introduction of this affective construct, researchers have conducted a lot of studies on self-efficacy and its relationships with several educational outcomes including learning and achievement in the last two decades (Pintrich, 1999; Usher & Pajares, 2008). For example, Pintrich (1999) found that students' self-efficacy beliefs were closely related to their academic performance including final grades, lab reports, examinations and papers.

In the field of science education, several studies on students' science self-efficacy were conducted (Britner & Pajares, 2006; Liu, Hsieh, Cho, & Schallert, 2006; Chiou & Liang, 2012; Tsai, Ho, Liang, & Lin, 2011). In the previous studies, researchers have found that there is a close relationship between students' science self-efficacy and their approaches to learning science (Chiou & Liang, 2012), as well as their academic achievements in science (Multon et al., 1991; Pajares, 1996; Hampton & Mason, 2003; Pajares & Miller, 1994; Shell et al., 1995; Kupermintz, 2002; Lau & Roeser, 2002; Lavonen and Laaksonen, 2009). For example, in the study of Lau and Roeser (2002), they found that 10th and 11th grader US secondary school students' science self-efficacy beliefs are significant positive predictors on both standard science test scores whose items are selected from the National Assessment of Educational Progress and the Trends in International Mathematics and Science Studies (TIMSS) and school science grades. Similarly, Lavonen and Laaksonen (2009) found that secondary school students' science related efficacy beliefs are strong predictor of students' science achievement which was indicated by the Program for International Student Assessment (PISA).

Researchers have also been interested in the gender issue in science education. Traditionally, girls have been known to show more anxiety and apprehension than boys about science and science learning which is entitled as gender gap. It has been reported that males have higher self-efficacy than females toward science (Anderman & Young, 1994; Pajares, 1996; Pintrich & De Groot, 1990; Zimmermen & Martinez-Pons, 1990). However, Lau and Roeser (2002) found that female students had higher science grades and self-efficacy than males. On the other hand, Britner (2008) found that for life sciences, achievement of girls is greater than that of boys but boys had higher self-efficacy than girls. For the physical sciences, there are no gender differences in achievement and self-efficacy.

Due to the task and domain specific characteristics of self-efficacy, some researchers focused on specific areas of science like chemistry, biology and physics. In the previous studies, researchers reported that students' self-efficacy beliefs toward chemistry lessons are closely related to their chemistry achievement (Uzuntiryaki & Çapa Aydın, 2007; Taasobshirazi & Glynn, 2009; Şenay, 2010; Kadioğlu & Uzuntiryaki, 2008; Kan & Akbaş, 2006). For example, in the study of Uzuntiryaki and Çapa Aydın (2007), the sample was 150 10th grade public high school students and they investigated the relationship between secondary school students' chemistry self-efficacy beliefs and their chemistry achievement. A chemistry achievement test was used in order to measure students' chemistry achievement and Chemistry Self-Efficacy Scale including two subscales which are self-efficacy for cognitive skills and self-efficacy for laboratory skills in chemistry class was used to measure students' self-efficacy beliefs. The

results of correlational analysis showed that there was a significant correlation between chemistry achievement and chemistry self-efficacy beliefs in cognitive skills. On the other hand, the correlation between students' chemistry achievement and their self-efficacy for laboratory skills was not significant.

Furthermore, Kan and Akbaş (2006) conducted a study with 819 students including 1st, 2nd, and 3rd grades from 10 secondary schools. They found that self-efficacy toward chemistry is a significant predictor of chemistry achievement. They also found that boys have higher self-efficacy beliefs toward chemistry lessons than girls. The statistical analyses also showed that there are significant differences in secondary school students' self-efficacy beliefs toward chemistry lessons across grade levels. 2nd grade students showed higher self-efficacy beliefs toward chemistry lessons than other grades. However, in the research of Demirdöğen, Uzuntiryaki and Çapa Aydın (2009) different results are obtained. They did not find a significant correlation between chemistry self-efficacy and GPA of students who took general chemistry course in public universities.

### 3. Methods

#### 3.1. Participants

The participants were 114 secondary school students (42 males and 72 females) enrolled at vocational high school in Etimesgut district in Ankara. The type of the vocational school is a medical vocational high school where there are more girls than boys in general. 41 participants were 9th grader, 24 participants were 10th grader, 14 participants were 11th grader, and 35 participants were 12th grader. The age of the participants was changing from 15 to 18. After taking necessary permissions from school administration and teachers, data were collected by way of one instrument, as described below during 2013-2014 fall semester. Students participated to the study voluntarily.

#### 3.2. Instrument

A high level of profession and a careful study is required in order to develop an instrument which assesses affective factors such as self-efficacy. For assessing self-efficacy beliefs toward science and chemistry, researchers have developed several instruments. Çapa Aydın and Uzuntiryaki (2009) developed a self-report questionnaire whose name is High School Chemistry Self-efficacy Scale (HCSS). This instrument assesses secondary school students' self-efficacy beliefs related with chemistry. The scale has two dimensions which are chemistry self-efficacy for cognitive skills and self-efficacy for chemistry laboratory. In this study, having high reliability and validity High School Chemistry Self-Efficacy Scale for Cognitive Skills (CSCS) was used which is suitable for Turkish culture for assessing secondary school students' self-efficacy beliefs toward chemistry lessons (see Appendix A ). The type of scale in this instrument is five point Likert type from "poorly" to "very well". In the current study, the Cronbach's alpha reliability value of the scale was .947.

Furthermore, factor analysis is conducted for providing evidence for construct related validity. In order to test sampling adequacy the Kaiser-Meyer-Olkin (KMO) value was calculated and found .932. This value indicates that the sample is enough to conduct factor analysis (Keiser, 1970, 1974). Besides, Bartlett's test of sphericity (Bartlett, 1954) has a significance level of .00 which supports the factorability of correlation matrix. Hence, it can be concluded that factor analysis can be conducted. Only one factor which is self-efficacy for cognitive skills in chemistry domain was expected to be obtained. Fortunately, the factor analysis yielded one factor which explains 68% of the total variance.

#### 3.3. Data Analysis and Procedures

The data were transferred to computer environment as a PASW (Predictive Analytics Soft Ware) data file. Both descriptive and inferential statistics were used to analyze the data. Descriptive statistics was used to give information about the sample such as the means and the standard deviations. Inferential statistics was used to make generalization based on findings of the sample. Two-way analysis of variance (ANOVA) was used to determine the effect of gender and grade level of the students on chemistry self-efficacy for cognitive skills.

## 4. Results

### 4.1. Grade Level Differences

Table 1 presents the means and standard deviations of High School Chemistry Self-Efficacy Scale for Cognitive Skills (CSCS) scores for grade levels.

**Table1**  
Means and standard deviations of CSCS scores for grade levels

Grade Level	Mean	SD
9 <sup>th</sup> Grade	34,7561	10,56594
10 <sup>th</sup> Grade	23,2500	8,61369
11 <sup>th</sup> Grade	28,0000	6,48074
12 <sup>th</sup> Grade	27,6571	12,25691

The first research question was about the differences between 9th, 10th, 11th, and 12th grade students' self-efficacy beliefs toward chemistry lessons. Two-way ANOVA results with respect to the dependent variable of chemistry self-efficacy for cognitive skills are showed in Table 2. The statistical analyses showed that grade level difference was significant ( $F(3,106) = 8.073, p < .05$ ). In order to determine which grades significantly differ from the other ones, multiple comparisons was conducted. The results are presented in Table 3. The analyses showed that there were significant differences between 9th grade students and 10th grade students, and there were also significant differences between 9th grade students and 12th grade students.

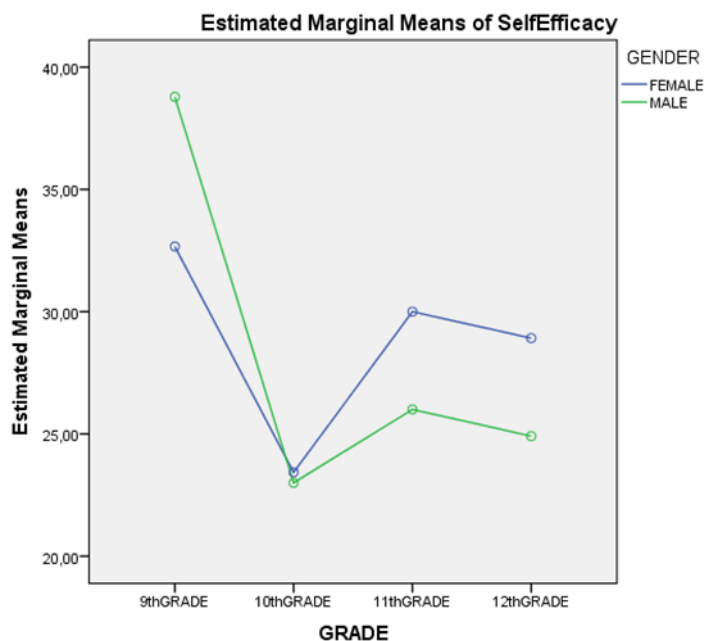
**Table 2**  
Tests of between-subjects effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
GRADE	2582,455	3	860,818	8,073	,000	,186
GENDER	7,690	1	7,690	,072	,789	,001
GRADE * GENDER	519,823	3	173,274	1,625	,188	,044
Error	11302,528	106	106,628			
Total	112075,000	114				
Corrected Total	14042,991	113				

The Table 3 shows that 9th grade students have higher CSCS scores than the other three grade levels. Moreover, Figure 1 illustrates the changes of students CSCS scores with respect to grade level and gender.

**Table 3**  
Multiple comparisons for grade level variable

(I) GRADE	(J) GRADE	Mean Difference (I-J)	Std. Error	Sig.
9th Grade	10th Grade	11,5061*	2,65396	,000
	11th Grade	6,7561	3,19639	,155
	12th Grade	7,0990*	2,37638	,018
10th Grade	9th Grade	-11,5061*	2,65396	,000
	11th Grade	-4,7500	3,47262	,522
	12th Grade	-4,4071	2,73666	,377
11th Grade	9th Grade	-6,7561	3,19639	,155
	10th Grade	4,7500	3,47262	,522
	12th Grade	,3429	3,26539	1,000
12th Grade	9th Grade	-7,0990*	2,37638	,018
	10th Grade	4,4071	2,73666	,377
	11th Grade	-,3429	3,26539	1,000



**Figure 1.** CSCS scores with respect to grade level and gender

Furthermore, related with the significant effect of interactions, Table 2 indicates that the effect of interaction between grade level and gender ( $F(3,106) = 1.625, p > .05$ ) was not significant.

#### 4.2. Gender Differences

The second research question was about the differences between male and female secondary school students' self-efficacy beliefs toward chemistry lessons. As presented in Table 2, the statistical analyses showed that there was not any significant difference between boys and girls with respect to the scores that they gained from CSCS scores ( $F(1,106) = .072, p > .05$ ).

## 5. Discussion and Implications

In the current study, the results showed that among secondary school students, the 9th graders who are the beginners of the secondary schools have higher self-efficacy beliefs toward chemistry lessons than 10th and 12th graders. This finding is not similar to the study of Kan and Akbaş (2006), in their study the 2nd graders of a high school had higher self-efficacy beliefs toward chemistry lessons than 1st and 3rd graders. In this study, the differences among grade levels means that although at the beginning of high schools the students have medium level of self-efficacy beliefs toward chemistry lessons, they have lower self-efficacy beliefs at the end of the secondary school. Thus, the point that should be focused on is what happens during the high school years. One of the reasons for decrease in self-efficacy might be the chemistry curriculum. Although the chemistry curriculum includes a lot of subjects, there are not enough lesson hours for teachers to teach these subjects. Therefore, the most probable reason for decrease in self-efficacy toward chemistry lessons may be due to the high burden of curriculum and the teachers' obligation to finish the subjects. The reasons for decrease in self-efficacy beliefs toward chemistry lessons should be a research topic for future researches and detailed qualitative and quantitative studies should be conducted on this area.

However, the results showed that there is not a significant difference between 9th graders and 11th graders in terms of self-efficacy beliefs toward chemistry lessons. This finding might be due to the limited number of 11th grade participants which was just 14. If the number were greater, it seems likely that there would be a significant difference between 9th and 11th graders which is similar to those of 10th and 12th graders.

Furthermore, the result of the current study can be evaluated in a positive manner from the point that the level of students' self-efficacy belief are at a medium level when their SCSC mean scores are considered. If the education system in secondary school gives more importance on affective variables like self-efficacy in the following years, we may expect that there will be a rapid increase in students' self-efficacy beliefs.

In the current study, the differences between boys and girls with respect to their self-efficacy beliefs toward chemistry lessons were insignificant. This finding is not similar to the previous findings in which significant differences between boys and girls were reported (Britner, 2008; Anderman & Young, 1994; Pajares, 1996; Pintrich & De Groot, 1990; Zimmermen & Martinez-Pons, 1990; Kan & Akbaş, 2006; Lau & Roeser, 2002; Glynn et al., 2011). However, the finding of this study is similar to the findings of Chen and Usher (2013), and Louis and Mistele (2012). They found that self-efficacy toward science were not affected by gender. In order to explain this contradiction, future research should be conducted by utilizing measurement models that explains the effects of gender on affective constructs such as self-efficacy (Velayutham et al., 2012).

Every education system comprises a lot of aspects such as curriculum, school administration, teacher training, and the budget allocated for education etc. Therefore, there are a lot of things to do for increasing students' self-efficacy beliefs toward chemistry lessons due to its importance, in that, self-efficacy have a great effect on students' academic achievement.

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## Appendix

### High School Chemistry Self-Efficacy Scale For Cognitive Skills (CSCS)

	yetersiz	çok az yeterli	biraz yeterli	oldukça yeterli	çok yeterli
1. Kimya kanun ve teorilerini ne derecede açıklayabilirsiniz?	1	2	3	4	5
2. Kimya problemlerini çözerken uygun formül kullanmada ne kadar iyisiniz?	1	2	3	4	5
3. Kimya ve diğer bilimler arasında ilişki kurmada ne kadar iyisiniz?	1	2	3	4	5
4. Atomun yapısını tasvir etmede ne kadar iyisiniz?	1	2	3	4	5
5. Periyodik tabloyu kullanarak elementlerin özelliklerini tanımlamada ne kadar iyisiniz?	1	2	3	4	5
6. Element ve bileşiklerin formüllerini okumada ne kadar iyisiniz?	1	2	3	4	5
7. Kimyasal denklemleri yorumlamada ne kadar iyisiniz?	1	2	3	4	5
8. Maddenin tanecikli yapısını açıklamada ne kadar iyisiniz?	1	2	3	4	5
9. Kimyadaki temel kavramları tanımlamada ne kadar iyisiniz?	1	2	3	4	5
10. Kimya ile ilgili grafik ve çizelgeleri yorumlamada ne kadar iyisiniz?	1	2	3	4	5