

## A Study of the Prediction of Academic Achievement in the Chemistry Course

Mehmet YÜKSEL<sup>1</sup>

Yenimahalle Alparslan Anatolian High School

Ömer GEBAN<sup>2</sup>

Middle East Technical University

### *Abstract*

The present research examines chemistry course achievement in relation to the academic self-concept, attitudes towards the chemistry course and logical thinking skills. The study sample consisted of 252 students in a vocational high school in Ankara who voluntarily participated with convenience sampling method. In the research, the academic self-concept and logical thinking were found to be significant predictors on academic achievement. As a result of discriminant analysis, the academic self-concept and logical thinking were determined to be the variables which distinguish successful from unsuccessful students. The classification of successful and unsuccessful students by distinctive variables was found to be successful at 69.4%.

*Keywords:* chemistry academic achievement, academic self-concept, attitudes toward chemistry course, logical thinking skills.

### **Introduction**

Continuing the existence of human kind in the planet and improving their quality of life depends on many factors and the basic factor is the ability of human kind as a thinking creature to develop attitude and behavior skills in harmony with environment. Such a characteristic exists in only human kind who has thinking and learning skills. Human type deprived of this characteristic can only maintain their life with the abilities they have in the form of their first existence in the planet. Beyond these abilities bestowed by the nature, they could not have had any of the acquisitions obtained and attained today. Science and history of humanity shows that material and spiritual acquisitions obtained by human kind could be achieved through thinking and learning concept. Thus, since other living species are deprived of thinking and learning ability, their behaviors are limited with abilities bestowed by nature. On the other hand, human kind used learning and teaching concept as a primary and indispensable tool in order to provide their continuances in the planet they live, facilitate their lives and improve their quality of life thanks to their thinking ability.

Learning and teaching concepts have stylistically changed and differentiated throughout time. In addition, learning and teaching concepts have become to be perceived as a primary need of societies rather than an individual problem throughout historical process. The basic role in meeting this need have also changes in this process and been undertaken by common and formal educational institutions. In addition, in this process, it is known that researches regarding the content and method of education and training have been densely conducted (Akçay, Tüysüz, Feyzioğlu, & Uçar, 2007; Atasoy, Genç, Kadayıfçı, & Akkuş, 2007; Bayrak, 2007; Temel & Morgil, 2007; Başbay, 2008). One of the research topics of the present study is determining the variables affecting academic achievement (Yanpar, 1998; Tural, 2002; Ünal & Ergin, 2006; Ceylan & Berberoğlu, 2007; Nazlıççek, 2007; Alaz, 2009). In the most general sense, academic achievement means the level of attaining aims predicted in a certain educational process. Academic achievement is generally determined through examinations conducted for measuring knowledge and skills obtained in courses given in educational institutions (Sünbül & Gürsel, 2001). Determining the variables affecting academic achievement is regarded

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<sup>1</sup> Dr. Mehmet Yüksel, Yenimahalle Alparslan Anatolian High School, m06yüksel@hotmail.com

<sup>2</sup> Prof. Dr. Ömer Geban, Middle East Technical University, Faculty of Education, Department of Secondary science and Mathematics Education, geban@metu.edu.tr

important in terms of making regulations regarding increasing learning level and therefore realizing effectiveness and efficiency in education (Senemoğlu, 1990). Literature includes studies explaining, predicting and controlling academic achievement concept with different parameter and variables (Akçay, Tüysüz, & Feyzioğlu, 2003; Akçay et al., 2007; Bayrak, 2007; Ceylan & Berberoğlu, 2007; Güneri & Apaydın, 2004; Kan & Akbaş, 2006; Senemoğlu, 1990; Tural, 2002; Yanpar, 1994; Yanpar, 1998). One of these perceptions is explaining and predicting academic achievement with cognitive and affective variables.

One of the affective variables examined in studies on academic achievement is the attitude of students towards course (Pehlivan & Köseoğlu, 2011). In the most general sense, attitude concept is the predisposition of individuals in cognitive, affective and behavioral integrity which are organized according to the experiences and knowledge of individuals towards themselves, and objects and events around them (Güney, 2000). Another definition (Başaran, 2000) describes attitude as the inclination of individuals which they develop towards adapting to the situations they encounter. In literature, attitude concept is tried to be explained and defined according to approach styles adopted and argued by behavioral scientists (Güney, 2000). However, main characteristic of attitudes is the fact that they are phenomenon adopted through learning (Başaran, 2000). Thus, attitudes are not innate, but acquired later. Therefore, like all intellectual activities, the forming of attitudes has the characteristics of activities realized as a result of learning process (Güney, 2000). In this regard, attitude concept is a variable accepted significant in the explanation of academic achievement.

Another affective variable used in explaining academic achievement is academic self-concept (Saracaloğlu & Varol, 2007; Başbay, 2008; Pehlivan & Köseoğlu, 2011). Self-concept is defined as the organized, consistent and settled perception, view and belief of humans regarding themselves (Başaran, 2000). Another definition is that self-concept is the whole of humans' opinions regarding their personality and the way they know and evaluate themselves (Güney, 2000). Self-concept has psychological characteristics as a compound of the development of human personality (Sanchez & Roda, 2003). Self-concept is suggested to have multi-structure (Byrne, 1984). Thus, it can be observed in the literature that self-concept is categorized as social self, material self, spiritual self, professional self, actual self, ideal self and academic self. Academic self is a self-perception covering defining and evaluating dimensions. This perception is related with the perception of behaviors by persons themselves rather than senses (Başokçu & Doğan, 2005). Academic self-concept is an important variable affecting learning process and its output, academic achievement (Pehlivan & Köseoğlu, 2010). However, literature has different approaches regarding bilateral relationship and causality between academic self-concept and academic achievement. The basic problem encountered in this subject is the opinion regarding which one is the other's cause. The causality from academic self-concept to academic achievement is defined as self-enhancement model, while the causality from academic achievement to academic self-concept is defined as skill development model. Contrary to these two models, reciprocal effects model argues that academic self-concept and academic achievement have bilateral relationship and interaction. According to this model, developed academic self-concept leads to higher academic achievement and higher academic achievement leads to the development of academic self-concept (Marsh, Hau, & Kong, 2002). One of the affective characteristics, academic self-concept is an important factor affecting learning processes and therefore achievement (Saracaloğlu & Varol, 2007).

Another variable examined as related with academic achievement in theoretical and experimental studies is logical thinking skills which has cognitive characteristics (Sökmen & Bayram, 1999; Tekbiyık & İpek, 2007; Nazlıççek, 2007). Logic defines a thinking style called as "correct thinking, "logical thinking" as etymological roots (Özlem, 2004). In literature, logic can be observed to be defined in different ways. Logic -rational or mystical- is the most abstract and general one among all thinking styles (Yıldırım, 2004). In the most general sense, logic is defined as accurate thinking rules and the knowledge of styles. Accepted as the science of thinking laws, logic is related with reasoning relations between thoughts, independently from the forming and content of thinking

(Özlem, 2004). It also examines reasoning in terms of validity in itself and tries to attain the knowledge regarding the styles of reasoning (Özlem, 2004). In other words, logic is related with the validity of thinking (Çubukçu, 2004). The important thing for logic is not the accuracy of judgments but the accuracy of the relationships between judgments (Çubukçu, 2004). Thus, John Dewey defines logical thinking as evaluating a belief or knowledge actively and attentively depending on their basis and the results that can be concluded from them (Nazlıççek, 2007). Logical thinking is a skill that can be obtained from cognitive development stages of Piaget in tangible and abstract processes. Logical thinking process is that an individual solves a problem through logical processes or reaches principles and laws through a series of abstractions or generalizations (Yaman & Karamustafaoğlu, 2006). Logic has become an indispensable tool of thinking. Each field of science aims to determine and explain the phenomenon and the relationship between phenomena regarding their field. Scientific studies use observation and experiment methods in determining phenomenon. Explaining determined phenomenon is a logical process. Controlling the reliability of results reached without the use of logical rules is impossible most times. Thus, logic is an indispensable tool in explanation, prediction and verification processes consisting the basic elements of scientific method (Yıldırım, 2004).

Literature includes studies examining academic achievement within the context of attitude towards course (Ekici & Hevedanlı, 2010; Karaer, 2007; Saracaloğlu & Varol, 2007), academic self-concept (Damrongpanit, 2009; Guay, Marsh, & Boivin, 2003; Nazlıççek, 2007; Pehlivan & Köseoğlu, 2010; Sanchez, & Roda, 2003; Saracaloğlu & Varol, 2007; Senemoğlu, 1990; Yanpar, 1994; Yanpar, 1998;) and logical thinking skill (Nazlıççek, 2007) according to different scientific fields and educational level. Conducted studies determined that academic achievement is related with attitude, academic self-concept and logical thinking skill variables, which predict academic achievement. Some studies found different results regarding attitude variable. For instance, Pehlivan & Köseoğlu (2010) conducted a study on the students of Ankara Science High School and concluded that attitude towards biology class did not change according to success level.

As mentioned above, researches in different scientific fields have tried to explain academic achievement through different affective and cognitive variables. Even though each field of science has difficulties in teaching and learning features, students of physical sciences encounters problems in learning and perceiving difficulties and therefore one of the fields for which methods and techniques facilitating academic achievement (Atasoy et al., 2007; Kurbanoğlu & Akim, 2010) are examined is chemistry science. Literature includes studies about predicting academic achievement of students regarding chemistry science and course through attitude (Bassey, Umoren, & Udida, 2007; Kan & Akbaş, 2006; Pehlivan & Köseoğlu, 2011), academic self-concept (Pehlivan & Köseoğlu, 2011) and logical thinking skill (Sökmen & Bayram, 1999; Ünal, Bayram, & Sökmen, 2002; Temel & Morgil, 2007). These studies also determined that academic achievement is related with academic self-concept, attitude towards course and logical thinking skill. However, conducted studies did not include some issues in research studies, one of which is the simultaneous effect of three variables on academic achievement. The studies in literature generally examine the issue through one variable. Examining the effect of variables on academic achievement one by one does not give information about relative responsibilities of attitude, academic self-concept and logical thinking skill. Even though literature includes studies multi-dimensionally examining the subject (Alcı, Erden, & Baykal, 2010; Atan, Göksel, & Karpat, 2002; Flitman, 1997; Hardgrave, Wilson, & Walstrom, 1994; Güneri & Apaydın, 2004), those are not within the context of variables constituting the subject of the present study. Another issue which is not subjected in the studies in literature is the absence of the determination of cognitive and affective variables distinguishing successful and unsuccessful students. Another issue is the absence of a study enabling to predict students that may be successful or unsuccessful from academic point depending on distinguishing variables. The present study aims to answer those three issues not subjected in studies, which is the distinctive contribution of the present study to literature. Under the light of aforementioned information, the present study basically aims to explain and predict academic achievement of chemistry course depending on the variables of attitude towards chemistry

course, academic self-concept and logical thinking skill. This basic of the present study includes following analyses:

1. Determine the relationship between academic achievement of chemistry course and academic self-concept and between attitude towards chemistry course and logical thinking skill.
2. Determine the effect of the variables of academic self-concept, attitude towards chemistry course and logical thinking skill on academic achievement of chemistry course.
3. Determine the differences between the averages of academic self-concept, attitude towards chemistry course and logical thinking skill tests of successful and unsuccessful students.
4. Determine the variables distinguishing successful and unsuccessful students.
5. Predicting successful and unsuccessful students depending on distinguishing variables.

### Method

The study was conducted in a vocational high school in Ankara in 2010-2011 educational year. The study used convenience sampling method. Within this frame, the study universe consisted of 252 students (19 female and 233 male) among 697 students who were taking chemistry course. Given the study universe, the study sample constituted 36% of the universe. The reason why the students in that school were taken in the scope of the present study is the assumption that students may show homogeneous characteristics in terms of academic enrollment measures to vocational high school. Another reason is their statement to voluntarily participate in the study.

The study used scales present in the literature in order to measure attitude towards chemistry course, academic self-concept and logical thinking skills. The scale of attitude towards chemistry course, which was used in the present study, was developed by Geban, Ertepinar, Yılmaz, Altın, & Şahbaz (1994). The scale consisted of 15 items and each item is answered with Likert type five rating. Geban et al. (1994) determined the alpha reliability coefficient of the scale as 0.81. Academic self-concept scale was developed by Brookover et al. in 1967 (Nazlıçipek, 2007). The first use of the scale in Turkey and its Turkish adaptation studies were made by Senemoğlu in 1989. The scale consisted of 8 items which are rated as five Likert type. In the study by Senemoğlu (1990), the reliability coefficient of the scale was determined to range between 0.80 and 0.89 according to the groups within the scope of the study. The present study also calculated the reliability coefficient of the scale and Cronbach alpha coefficient was found 0.91. The third scale used in the present study is logical thinking skill test consisting of 10 items. The original form of the scale was developed by Tobin and Capie in 1981 and its adaptation studies to Turkish Language were conducted by Geban, Askar, & Özkan (1992). The reliability coefficient was found 0.77 in the study by Geban et al. (1992).

Cronbach reliability coefficient of the scale was found 0.80 in the present study. Another variable of the present study, academic achievement was determined according to statistical analysis techniques used in the study. Chemistry course scores of the students in their school report of the first term were taken as academic achievement in correlation and regression analyses, since the scores in the first term are more objective and the opinions of teachers generally reflect to the scores in the second term. In "t" test and discriminant analysis conducted in the study, academic achievement was classified as successful and unsuccessful according to success and failure state of the students in chemistry courses in the final school records. In data analysis, the study used correlation analysis, multiple regression, stepwise regression analysis, "t" test and discriminant analysis. SPSS 18.0 software was used in statistical analyses.

### Results

This part of the study analyzes study data basing on the aims mentioned in the introduction part of the present study. Primarily, the study examined the relationships between variables. Correlation analysis (Table 1) determined a positive significant relationship between academic achievement and academic self-concept, attitude towards chemistry course and logical thinking skill ( $p < 0.01$ ).

Table 1.  
*Pearson Correlation Coefficients between Variables*

Variable	ASC	ACC	LTS	GPA
Academic Self-Concept (ASC)	1	0.728**	0.150*	0.595**
Attitudes toward Chemistry Course (ACC)		1	0.086	0.437*
Logical Thinking Skills (LTS)			1	0.300*
Grade Point Averages of First Semester (GPA)				1

Note: \*\* $p < 0.01$  and \*  $p < 0.05$  significance

The study determined the effect of academic self-concept, attitude towards chemistry course and logical thinking skill on academic achievement through stepwise regression analysis. The results of analysis determined that academic self-concept and logical thinking skills are variables effective on academic achievement in chemistry (Table 2). The capacity of significant variables in explaining dependent variables was found 0.399 ( $F_{(2,249)} = 82.788$ ,  $p < 0.001$ ,  $R^2 = 0.399$ , Corrected  $R^2 = 0.395$ ).

Table 2.  
*Variables Affecting Academic Achievement According to the Results of Stepwise Regression Analysis*

Variable	Unstandardized Coefficient B	Standard Error	$\beta$	t	Significance (p)
(Constant)	0.638	4.108		0.155	0.877
Academic Self-Concept (ASC)	1.724	0.152	0.562	11.324	0.001
Logical Thinking Skills (LTS)	1.443	0.332	0.216	4.349	0.001

The attitude towards chemistry was not included in regression model since it was not found significant ( $p > 0.05$ ), which was caused by the presence of relationship that can be considered high (0.728) between academic self-concept and attitude towards chemistry course, which can be seen in results of correlation analysis (Table 1). When attitude towards chemistry course and academic self-concept with affective characteristics that shows high correlation between themselves were taken in stepwise regression analysis together, attitude towards chemistry course, which has relatively low effect on academic achievement, was not found statistically significant and not involved in the model. Academic self-concept which has higher effect on academic achievement was involved in the model as a significant variable. Indeed, academic self-concept prevented the effect of attitude towards chemistry course on academic success. Therefore, a second regression analysis was needed and in this analysis, academic self-concept was not used but the variable of attitude towards chemistry was taken.

The results of the analysis determined that the variables of attitude towards chemistry course ( $\beta = 0.414$ ;  $p < 0.001$ ) and logical thinking skill ( $\beta = 0.265$ ;  $p < 0.001$ ), together, explained academic achievement at 26% rate ( $R^2 = 0.26$ ; Corrected  $R^2 = 0.254$ ;  $F = 43.745$ ;  $p < 0.001$ ). As shown in Table 3, the analysis found that attitude towards chemistry course was statistically significant when academic self-concept is excluded from the model.

Table 3.  
*The Variables Affecting Academic Achievement According to the Results of Multiple Regression Analysis*

Variable	Unstandardized Coefficient B	Standard Error	$\beta$	t	Significance (p)
(Constant)	19.327	3.665		5.274	0.001
Attitudes toward Chemistry Course (ACC)	0.559	0.074	0.414	7.562	0.001
Logical Thinking Skills (LTS)	1.767	0.366	0.265	4.835	0.001

The study also analyzed academic achievement through single variable approach. The students were categorized as successful and unsuccessful according to their passing score of chemistry course at the end of educational year. 92 of 252 students within the scope of the study were found unsuccessful and 160 students were found successful. Based on this two student group, "t" test was used in order to examine the difference of variables according to academic achievement, in other

words to examine whether academic self-concept, attitude towards chemistry course and logical thinking skill levels changed according to the success levels of students. While academic self-concept averages of unsuccessful students in chemistry course was 23.84, the average of successful students was 28.34 ( $t=6.729$ ,  $SD=250$ ,  $P<0.001$ ). Academic self-concept of successful students was found statistically better than unsuccessful students. In addition, "t" test determined that the average of attitude towards chemistry course of unsuccessful students was 43.85 and the average of successful students was 49.58 ( $t=3.563$ ,  $SD=250$ ,  $P<0.001$ ). Attitude towards chemistry course of successful students was found statistically better than unsuccessful students. The average of logical thinking skill variable was determined as 1.71 for unsuccessful students and 2.8 for successful students ( $t=3.321$ ,  $SD=250$ ,  $P<0.001$ ). As in other variables, logical thinking skill of successful students was found higher than unsuccessful students.

In the present study, stepwise discriminant analysis was used in order to determine the variables distinguishing successful and unsuccessful students and predict successful and unsuccessful students according to distinguishing variables. At first, the variables of academic self-concept, attitude towards chemistry course and logical thinking skill were included in discriminant analysis. Since the study had two groups (successful and unsuccessful), only one function was found in discriminant analysis. Eigenvalue of this function was 0.213 and the function explained 100% of the total variance. Canonic correlation coefficient was 0.419. Wilks' Lamda value of the discriminant function was 0.825 and chi-square value was 48.027 ( $SD=2$ ), and the model was found statistically significant ( $p<0.001$ ). At the result of stepwise process, academic self-concept (ASC) and logical thinking skill (LTS) variable at 0.01 significance level was included in the model. The variable of attitude towards chemistry could not be included in the discriminant function since it was not found statistically significant (Table 4). According to the standardized discriminate function coefficients showing the relative effect of distinguishing variables on dependent variable, the variables having most distinguishing effect between the groups were academic self-concept and logical thinking skill, respectively. According to structure matrix, the correlation between discriminant function and academic self-concept was 0.923 and between discriminant function and logical thinking skill as 0.847.

Table 4.

*Variables and Their Coefficients Included in Discriminant Function Model*

Variable	Wilks' Lamda	Significance (p)	Structure Matrix Fonction 1	Canonical Discriminant Function Unstandardized Coefficient	Standardized Canonical Discriminant Function Coefficient	Fisher's Discriminant Functions and Classification Function Coefficients	
						Successful Students Function	Unsuccessful Students Function
						1	2
ASC	0.958	0.001	0.923	0.175	0.893	1.076	0.909
LTS	0.847	0.010	0.455	0.155	0.387	0.282	0.134
(Constant)				-5.042		-16.340	-11.652

According analysis results, unstandardized canonic discriminant function is as follows:

$$\hat{Y} = -5.042 + 0.175 (\text{ASC}) + 0.155 (\text{LTS}).$$

In the present study, the values of unstandardized canonic function group centers are -0.606 for unsuccessful students and 0.348 for successful students. According to discriminant analysis findings, 64 (69.6%) of 92 unsuccessful students and 111 (69.4%) of 160 successful students in the original group were classified accurately. The possibility of discriminant analysis to accurately classify successful and unsuccessful students as a whole was found 69.4 % (Table 5).

Table 5.  
*Classification Matrix of Successful and Unsuccessful Students<sup>a</sup>*

Academic Achievement		Predicted Group Membership		Total
		Unsuccessful Students	Successful Students	
Original Group Membership	Unsuccessful Students	64 (69.6 %)	28 (30.4 %)	92 (100 %)
	Successful Students	49 (30.6 %)	111 (69.4 %)	160 (100 %)

a. Accurate classification possibility: 69.4%

### Conclusion and Discussion

This study tries to examine academic achievement in chemistry course depending on the variables of academic self-concept, attitude towards chemistry course and logical thinking skill. The study examined academic achievement in chemistry course from five different points: the first one is to determine the relationship between academic achievement in chemistry course and academic self-concept, attitude towards chemistry course and logical thinking skill. The second one is to determine the effect of academic self-concept, attitude towards chemistry course and logical thinking skill on academic achievement in chemistry course. The third one is to examine the presence or the absence of a difference between the scores of academic self-concept, attitude towards chemistry course and logical thinking skill of successful and unsuccessful students. And the fourth one is to determine the variables distinguishing successful and unsuccessful students. Finally, the study aimed to predict successful and unsuccessful students depending on distinguishing variables.

The study determined a relationship between academic achievement in chemistry course and academic self-concept, attitude towards chemistry course and logical thinking skill with the same direction. Academic achievement in chemistry course was observed to be related with variables with cognitive and affective characteristics that constitute the nature of students. This result of the present study is found consistent with other studies in literature (Bassey et al., 2007; Guay et al., 2003; Damrongpanit, 2009; Nazlıççek, 2007; Sanchez & Roda, 2003; Saracaloğlu & Varol, 2007; Yanpar, 1994). The attitudes of students towards chemistry course and high academic self-concept and logical thinking skills increase academic achievement. Therefore, developing academic self-concept, attitude towards the course and logical thinking skills of students in educational process can be said to be important in terms of academic achievement.

The second result of the present study is the determination of the effect of academic self-concept, attitude towards the course and logical thinking skills on academic achievement. Stepwise regression analysis found that academic self-concept and logical thinking skills are variables positively effective on academic achievement in chemistry. Academic self-concept and logical thinking skill are variables increasing academic achievement. However, the relative importance of academic self-concept was found higher than logical thinking skill in terms of their effects on academic achievement in chemistry. This finding indicates that affective characteristics are more effective on academic achievement of students within the scope of the study. It can be said that academic achievement of students within the scope of the study were mostly affected by academic self-concept including perception and experience obtained mostly within the frame of learning history (Başbay & Senemoğlu, 2009). The capacity of academic self-concept and logical thinking skill to explain academic achievement was found 39.9%. This explaining capacity can be said to be in acceptable level since the whole of total change in academic achievement cannot possibly be explained academic self-concept and logical thinking skill. The explanation of academic achievement is related with other variables in educational process and different characteristics of students (Ceylan & Berberoğlu, 2007). Given the variables included in stepwise regression analysis, the obtained results are observed to be consisted with the findings in literature. Thus conducted studies reported positive effect of logical thinking skill on achievement (Sökmen & Bayram, 1999; Ünal et al. , 2002; Temel & Morgil, 2007). However, in the

study by Nazlıççek (2007), the effect of logical thinking skill on academic achievement was not found statistically significant. Again, the results of the studies in literature regarding the effect of academic self-concept on academic achievement (Saracaloğlu & Varol, 2007; Sanchez et al., 2003; Senemoğlu, 1990; Nazlıççek, 2007; Yanpar, 1998) were found to be consistent with the findings of the present study. However, the present study determined in stepwise regression analysis that attitude towards chemistry course was not a statistically significant variable in explaining academic achievement. Saracaloğlu & Varol (2007) had similar results in their study. Not only the finding determined in the study of Saracaloğlu & Varol (2007), but also the results of the present study do not indicate that the attitude of students towards the course is not theoretically related with academic achievement. Moreover, according to the results of correlation analysis of the present study, attitude towards chemistry course is a variable related with academic achievement. The reason why attitude towards chemistry course is not found statistically significant in stepwise regression analysis can be said to result from the high correlation between academic self-concept and attitude towards chemistry. As can be observed from correlation analysis findings, there is a high relationship (0.728) between academic self-concept and attitude towards chemistry course. However, the highness of the relationship between academic self-concept and attitude towards chemistry course is expected since from conceptual view, each variable has affective structure. Thus, the relationship between logical thinking skill with cognitive characteristics, and academic self-concept and attitude towards chemistry course with affective structure was found very low. Therefore, when variables with affective characteristics which show high correlations between themselves were included in stepwise regression analysis together, the variable with highest effect on academic achievement remained in the model as significant variable. Attitude towards chemistry course which has relatively low relationship with academic achievement was not found statistically significant and therefore not included in the model. The reason why academic self-concept remained in regression model and attitude towards chemistry course was not included in the model can be explained through the possession level of these two variables by the students within the scope of the study. This state indicates that the students within the scope of the study could not obtain or develop their attitude towards chemistry course compared to academic self-concept and their interest and demand for the course could not be created. Given the aforementioned issue as a whole, the absence of a high correlation between independent variables used in explaining academic achievement is important.

Another result of the study is that averages of academic self-concept, attitude towards chemistry course and logical thinking skill tests of students who were unsuccessful in the chemistry course were found lower than the averages of successful students. This result indicates that students with developed academic self-concept and attitude towards the course and high logical thinking skill are more successful in chemistry course. In addition, these results also indicate that students with clearly different level of academic self-concept, attitude towards the course and logical thinking skills, in other words inhomogeneous students may encounter learning and perceiving difficulties in educational process. The studies in literature (Karaer, 2007; Ekici & Hevedanlı, 2010; Pehlivan & Köseoğlu, 2010; 2011) have similar results. However, a recent study (Pehlivan & Köseoğlu, 2010) reported that achievement level did not change according to attitude towards course.

Another question the present study tried to answer is the determination of variables distinguishing successful and unsuccessful students in chemistry course and predicting successful and unsuccessful students. Stepwise discriminant analysis determined that academic self-concept and logical thinking skills are the variables that distinguish, in other words best categorize and predict successful and unsuccessful students. As in stepwise regression analysis, attitude towards chemistry course was not found statistically significant in stepwise discriminant analysis. According to standardized discriminant function coefficients showing the relative effect of distinguishing variables on academic achievement, the variables with highest distinguishing effect between groups were academic self-concept and logical thinking skill, respectively. In discriminant analysis, attitude towards chemistry course could not be involved in the model as a distinguishing variable and academic self-concept had the highest relative effect as distinguishing variable, which was similar

with the findings of stepwise regression analysis. 69.6% of unsuccessful students and 69.4% of successful students in original group membership according to discriminant analysis function were accurately classified. As a whole, successful and unsuccessful students are possible to be predicted at level of 69.4% through discriminant analysis. The results of discriminant analysis were not compared with the studies in literature due to the absence of discriminant analysis studies examining academic achievement through the variables of attitude, academic self-concept and logical thinking skill. However, discriminant analysis findings of the present study were found acceptable when finally evaluated in itself. Again, even though the predictions of discriminant analysis showed differences, the results were consistent with the results of stepwise regression analysis.

Evaluating the aforementioned research results as a whole, the findings can be said to be consistent and significant. However, the generalization of these results is not possible. A generalizable result can be possible only through increasing the scope and samples of studies and conducting longitudinal studies. Therefore, it can be suggested to conduct studies in different scientific fields and different educational levels in order to reach generalizable results in future. Future studies may also examine the functional structure of the relationship between academic achievement and academic self-concept, attitude and logical thinking skills. The present study is based on the assumption that academic self-concept, attitude and logical thinking skills affect academic achievement. However, as stated in literature survey, the cause – effect relationships between these phenomenon can be examined through different approaches. Future studies may use an approach examining the effect of academic achievement on variables.

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