Students' attitudes toward school chemistry: The effect of interaction between gender and grade level

Hatice BELGE CAN
Middle East Technical University, Secondary Science & Mathematics Education
Ankara-TURKEY
E-mail: e128456@metu.edu.tr

Received 16 Mar., 2012
Revised 27 Jun., 2012

Contents

Abstract

The purpose of the study is to investigate the effect of interaction between gender and grade level on secondary school students' attitudes toward chemistry as a school subject. The sample is composed of 197 students across Grades 9 to 11. The Attitude Scale Toward Chemistry, developed by Geban & Ertepinar (1994), is used to collect data. Principal Component Analysis revealed two dimensions of the scale

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

which were labelled as "enjoyment of chemistry" and "importance of chemistry". The Cronbach Alpha reliability coefficient of the whole scale was computed as .93. Two-way MANOVA results indicated that the interaction effect between gender and grade level on students' attitudes toward school chemistry in terms of both enjoyment and importance dimensions was statistically significant. Overall, the findings of this study offer that the educational objective of developing positive attitudes toward chemistry lesson is not fully achieved in Turkey.

Keywords: Attitude Toward Chemistry; Gender; Grade Level; Interaction Between Gender and Grade Level; Secondary School Students

Introduction

Being one of the constructs of the affective domain, attitudes have been researched deeply for more than 40 years (Aiken & Aiken, 1969; Koballa & Crawley, 1985; Koballa, 1988). The need for conducting studies, related to attitude, was undertaken for two main reasons; namely the attitudes' feasible power to predict future behaviors like subject and career preferences of students (Koballa, 1988; Osborne, Simon & Collins, 2003), and the correlation existing between attitude and academic achievement (Schibeci, 1984; Shrigley, 1990; Weinburgh, 1995; Osborne & Collins, 2000). In their meta-analysis of attitude related factors that predict future behaviors, Glasman & Albarracín (2006) concluded that there is a correlation between attitudes and future behaviors; that is, attitudes are a potential for predicting future preferences, especially if there is a direct interaction between participants and the attitude object (i.e. objects that related to attitude like science lessons). Actually, studies that examined the correlation between attitude and academic achievement did not provide consistent results. Schibeci (1984), for instance, found a strong relationship between attitude and achievement. Shrigley (1990), on the other hand, argued that there is only moderate relationship between attitudes toward science and science achievement.

The attitude literature has concentrated on a range of aspects (Osborne et al., 2003) such as defining attitude and making a distinction among similar terms (Koballa, 1988), defining attitude objects (Spall, Dickson & Boyes, 2004), and developing attitude constructs (Kind, Jones & Barmby, 2007). Since these concerns are necessary for deeper understanding of the theory of attitudes, all three aspects have been documented here.

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Accumulation of information related to the importance of attitudes in education required science programs to include science-related attitudes. One of the aims of the Turkish secondary school science program, for instance, was to develop positive attitudes toward science (Ministry of National Education [MNE], 2007). This led to a consideration of what is meant by the apparently simple term "attitudes toward science" and also "scientific attitudes". Gardner (1975a) made a distinction between these two concerns, describing the latter as a scientific thinking and questioning strategy that can be treated under the cognitive domain (Osborne et al., 2003), whereas describing "attitudes toward science" as a learned tendency to evaluate in certain ways, which is the aspect within the scope of the present study.

The attitudes toward science is related to positive or negative feelings about scientific objects and enables prediction of scientific attitudes (Koballa & Crawley, 1985). Schibeci (1983) argued that various objects can be related to attitudes like science lessons, scientists, science in real life, and etc. This leads to the question-do students differ in their attitudes toward science and chemistry? This critique question has already been the subject of research by studies (Havard, 1996; Spall et al., 2004) pointing out that treating different branches of science lessons under the general heading (i.e. science) may cause deviated results; that is, students' attitudes toward chemistry and physics or any other branches of science may vary. In fact, subject preference studies (Havard, 1996; Osborne & Collins, 2000) are not very common due to the objectiveness problems related to the measurement; that is, students give answers to the items within the scale in a relative manner (Osborne et al., 2003) which may not indicate the real situation. Among limited studies, Osborne & Collins (2000) investigated 16-year-old students' attitudes toward science lessons and found that chemistry is the least favorite branch of school science.

"Attitudes toward science" is a term that is treated most of the time as a unique concept, but analyses are needed to check whether the scale is unidimensional as this is important for both reliability and validity concerns (Osborne et al., 2003). The attitude literature confirmed that there are constructs that contribute in varying proportions to the attitudes of students (Osborne et al., 2003) which are formed with respect to contexts (Barmby, Kind & Jones, 2008). Overall, both the nature of sampled individuals and attitude itself require controlling for dimensionality of the scale used to collect data. Kind et al. (2007) developed a set of constructs in order to solve the problems related to the dimensionality of scales which are importance of science, learning science in school, practical work in science, science outside of

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

school, self-concept in science, and future participation in science. Eccles & Wigfield (1995) combined the constructs "interest, importance, and utility" under the term "task value" which can be defined as the degree to which an individual trusts a task for accomplishing an individual's needs or goals.

Since attitudes are not the same for different objects and studies confirmed that attitude, in most cases, is a multidimensional variable (Gardner, 1995), it is thus crucial to define the scope of the study, explicitly. The focus of the current study is on secondary school students' attitudes toward chemistry as a school subject in Turkey (Grades 9-11).

Besides defining attitudes and dimensions of attitude, the literature deals widely with the factors affecting attitude toward science. Grade levels (Hofstein, Ben-Zvi, Samuel & Tamir, 1977; Yager & Yager, 1985; Simpson & Oliver, 1990; Francis & Greer, 1999; George, 2006; Barmby et al., 2008), gender (Hofstein et al., 1977; Harvey & Stables, 1986; Francis & Greer, 1999; Barmby et al., 2008), achievement (Weinburgh, 1995; Salta & Tzougraki, 2004) are some of the most investigated factors affecting secondary school students' attitudes toward science. However, this paper will discuss solely the studies that focused on the effects of gender, grade level, and interaction of them (i.e. gender and grade level) on attitudes toward chemistry as a school subject. Actually, results of the studies that dealt with attitude changes among students of different age groups or gender are not consistent. Hofstein et al. (1977), for instance, examined Grades 11 and 12 Israeli students' attitudes toward chemistry over time and they concluded that there is a decline in students' attitudes toward school chemistry as they progress from Grade 11 to 12. Kan & Akbaş (2006) surveyed 1000 students studying at the 1st, 2nd, and 3rd grades of high schools in Turkey. Contrary to Hofstein et al., they found that attitude scores toward chemistry courses are a maximum at the 2nd grade of high schools.

The attitude literature includes various studies that investigated gender differences in students' attitudes toward chemistry courses. Some of the studies reported that female students' attiudes toward chemistry lessons are higher than male students (Hofstein et al., 1977; Dhindsa & Chung, 1999). Some of the studies, on the other hand, found the opposite situation in their cases; that is, boys have more positive attitudes to chemistry lessons than girls (Harvey & Stables, 1986).

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Inconsistent results of the studies may arise from various factors such as examining different constructs of attitudes (Osborne et al., 2003), not considering dimensionality of data (Rennie & Parker, 1987), and not analyzing the interaction between grade level and gender (George, 2006; Cheung, 2009). The literature confirms that gender and grade level can interact with each other (George, 2006); that is, female or male students may have different attitudes toward chemistry as time passes. However, the number of studies that investigated the interaction effect on attitude are very scarce. Cheung's (2009) study is an informative one which explored the interaction effect between grade level and gender on secondary school students' attitudes toward chemistry lessons in Hong Kong. Attitude toward chemistry lessons was evaluated using four dimensions that were liking for chemistry theory lessons, liking for chemistry laboratory work, evaluative beliefs about school chemistry, and behavioral tendencies to learn chemistry. According to the results of the study there was a significant interaction effect between grade level and gender on secondary school students' attitudes toward chemistry lessons.

Having mentioned significant concerns within the attitude literature, the purpose of the present study is to investigate the effect of interaction between gender and grade level on secondary school students' attitudes toward chemistry as a school subject across Grade 9-11, in Turkey.

Methodology

Sample

The sample of the study was assigned through a convenience sampling method. The sample was composed of 197 high school students from different grades that ranged from Grades 9 to 11 (Years 16-18), from a public high school in Isparta, Turkey. There were 184 valid cases and among them 111 of the students were female and the remaining 73 of them were male. 83 of the students were attending to Grade 9, 36 of them to Grade 10, and 65 of them to Grade 11.

Instrument

The Attitude Scale toward Chemistry (ASTC), developed by Geban, Ertepınar, Yılmaz, Altın & Şahbaz in 1994, was administered by the instructor during regular chemistry lessons. The scale consists of 15 items of the 5-point Likert type that

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

ranges from "Completely Disagree" to "Completely Agree". The items of the scale involve both positive (10 items) and negative sentences (5 items) in nature. The possible minimum score of a student is 15 and the maximum is 75. The reliability of the scale was found as .83 by the developers. However, the researchers computed the Cronbach Alpha internal consistency coefficient of the general scale as .93 for the present data.

Data Analysis

The negatively worded items were recoded before performing statistical analyses which enables researchers to comment on the results, smoothly; that is, lower scores show negative attitudes and higher scores, on the contrary, show positive attitudes toward chemistry as a school subject. In order to check dimensionality of the scale, as suggested by Rennie & Parker (1987) and Gardner (1995), the Principal Component Analysis was used. The analysis pointed out two dimensions of the scale for the present data (detailed information related to the dimensions reported in the "Results and Discussion" section). Moreover, reliability analyses were computed for both of these dimensions. Two-Way Multivariate Analysis of Variance (Two-Way MANOVA) was conducted to test whether there is an interaction between gender and grade levels on the two dimensions of attitudes toward chemistry lessons. Finally, in-depth analyses was carried out to locate where the interaction effect was significant if there was a significant interaction effect according to the results of MANOVA. All of the mentioned analyses were performed by SPSS.

Results

Results of the study were reported under two sub-headings namely descriptive statistics and inferential statistics, respectively.

Results of Descriptive Statistics

Results derived from descriptive statistics involves the Principal Component Analysis and the reliability analysis which were stated sequentially.

According to Stevens (2002), items that load on more than .40 are reliable as long as the sample size is above 150. As can be seen from Table I, the items were loaded on two factors; that is, the ASTC involves two dimensions for the present data. The

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

first dimension is made up of 8 items and the second dimension consists of 7 items. However, the fifth, second, and fourteenth items load on both dimensions. As a result, the contents of the mentioned items are checked and categorized in such a way that two of them are assigned to the first dimension (2nd and 14th items) and one under the second dimension (5th item). In other words, there are ten items in the "enjoyment of chemistry" dimension and five items in the "importance of chemistry" dimension. The dimensions were named with regard to their content and on the basis of the literature as "enjoyment of chemistry" and "importance of chemistry" (e.g. Dhindsa & Chung, 1999).

Table I. *Rotation Component Matrix*[a]

Items	Dimensions	
	Enjoyment of Chemistry	Importance of Chemistry
7	.855	
4	.848	
13*	.799	
9*	.796	
1	.788	
6*	.763	
15	.724	
8	.638	
10		.803
12		.778
3*		.691
11		.667
5**	.459	.622
2	.430	.551
14*	.403	.454

[a]: Rotation converged in 3 iterations.

*: Recoded items.

**: The item that loaded on both dimensions but located later in "importance of chemistry" dimension.

The Cronbach Alpha internal consistency coefficient is a useful statistics for deducing whether students responded to items of the scale randomly (Fraenkel & Wallen, 2006). The reliability coefficients were computed for each dimensions and for the whole scale. The Alpha values were found to be .92 for the "enjoyment of chemistry", .81 for the "importance of chemistry", and .93 for the whole scale (see Table II). George & Mallery (2003) declared that an Alpha values greater than .9 is excellent and greater than .8 is good. According to the literature, the "importance of chemistry" dimension has a good internal consistency on the other hand, the

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

"enjoyment of chemistry" and the whole scale have excellent internal consistencies. The number of items in the "importance of chemistry" dimension is less than the other dimension which may be the cause of a smaller Alpha value although it is above the acceptable level.

Table II. *The Cronbach Alpha Values of the Dimensions and the ASTC*

	Cronbach's Alpha
Enjoyment of Chemistry	.92
Importance of Chemistry	.81
The ASTC	.93

Results of Inferential Statistics

After meeting assumptions (i.e. normality, equality of covariance matrices, equality of error variances, and independence of observations), two-way MANOVA was performed in order to test the effect of interaction between gender and grade level on enjoyment and importance of dimensions of attitudes toward school chemistry. Two-way MANOVA results pointed out that gender has a significant effect (Wilks' Lambda=.948, $p<.05$), grade level has a significant effect (Wilks' Lambda=.943, $p<.05$), and interaction between gender and grade level has a significant effect (Wilks' Lambda=.881, $p<.05$) on secondary school students attitudes toward chemistry as a school subject. Table III summarizes the results of the two-way MANOVA.

Table III. *The Results of Two-way MANOVA*

		Value	*F*	Sig.
Gender	Wilks' Lambda	.948	4,902	.008
Grade Level	Wilks' Lambda	.943	2,627	.034
Gender*Grade Level	Wilks' Lambda	.881	5,786	.000

*: The interaction between gender and grade level

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Finding the interaction effect as significant means that reporting gender and grade level effects as significant may not reflect the actual result although the values were found as significant. Instead of simply stating separate effects of gender and grade level, one should examine where the interaction effect is significant. Further analyses were performed in order to be able to see the location of the interaction effect which is the concern within the scope of the present study. Table IV indicates significance values of the interaction between gender and grade level on both of the dimensions.

Table IV. *Tests of Between-Subjects Effects*

	Dimensions	*F*	Sig.
Gender*Grade Level	Enjoyment of Chemistry	11.339	.000
	Importance of Chemistry	3.726	.026

*: The interaction between gender and grade level

As can be seen from Table IV, there is a significant mean difference on the enjoyment of chemistry in terms of the interaction between gender and grade level ($p<.05$). Similar results were also valid for the importance of chemistry dimension; that is, the interaction between gender and grade level has significant effect on the importance of the chemistry dimension of attitude toward school chemistry ($p<.05$). If there is a significant interaction effect on both of the dimensions of attitudes toward chemistry, then there is a need to determine whether the results favor female or male students? And then, female or male students of which grade level? To answer these type of questions, overall student means by gender (see Table V), and females' and males' scores across each grade level were analyzed separately. Table VI and Table VII show relationships between means and grade level for female students and male students, respectively.

Table V. *Overall Scores of Student Means by Gender*

Dimension	Female Mean (SD)	Male Mean (SD)
Enjoyment of Chemistry	33.43 (7.65)	30.62 (9.67)
Importance of Chemistry	17.03 (2.73)	16.42 (3.35)

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Table V points out that female students enjoyed learning chemistry more than male students. Furthermore, female students' scores related to the importance of learning chemistry are slightly higher than male students' scores. Actually, two-way MANOVA results indicate that gender is significant on the enjoyment of chemistry ($p=.002<.05$) but not significant on the importance of chemistry ($p=.081>.05$) dimension of attitudes toward school chemistry.

As mentioned above, since there is an interaction between gender and grade levels of students on enjoyment and importance of chemistry dimensions, stating that female students enjoyed learning chemistry more than male students may not be valid across each grade level. Table VI summarizes female students' attitude scores through Grades 9 to 11. According to Table VI, female students have their highest attitude mean scores at Grade 10 in terms of both of the enjoyment and importance of chemistry dimensions, but as a matter of fact the latter dimension varies slightly.

Table VI. *Dimension Mean Scores of Female Students Across Grade Levels*

Dimension	Grade Level		
	Grade 9 Mean (SD)	Grade 10 Mean (SD)	Grade 11 Mean (SD)
Enjoyment of Chemistry	32.40 (7.95)	35.00 (7.63)	34.13 (7.30)
Importance of Chemistry	17.06 (2.81)	17.21 (2.05)	16.93 (2.86)

On the contrary, male students have their highest mean scores at Grade 9 on both of the enjoyment and importance of chemistry dimensions. However, there is not a smooth decline from Grades 9 to 11 as the literature points out most of the time. Male students' mean scores fluctuate and have the lowest scores at Grade 10 instead of Grade 11 in terms of both enjoyment and importance of chemistry (see Table VII).

Table VII. *Dimension Mean Scores of Male Students Across Grade Levels*

Dimension	Grade Level		
	Grade 9 Mean (SD)	Grade 10 Mean (SD)	Grade 11 Mean (SD)
Enjoyment of Chemistry	36.26 (6.58)	25.36 (10.13)	27.65 (8.92)
Importance of Chemistry	17.77 (2.38)	14.73 (4.15)	16.20 (2.88)

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Table VIII marks significance values for understanding which grade levels have significant effects on dimensions of the attitudes toward chemistry as a school subject. As can be seen in Table VIII, only Grade 9 and 10 have significant effects on both the enjoyment and importance of chemistry (p= .010 for enjoyment of chemistry and p= .017 for importance of chemistry).

Table VIII. *Post Hoc Tests (Bonferroni) Across Grade Levels*

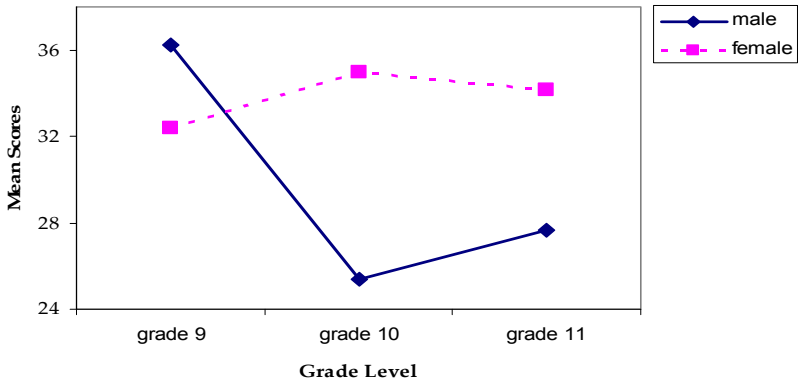
Dimensions	(I) Grade Level	(J) Grade Level	Sig.
Enjoyment of Chemistry	Grade 9	Grade 10	.010
		Grade 11	.594
	Grade 10	Grade 9	.010
		Grade 11	.207
	Grade 11	Grade 9	.594
		Grade 10	.207
Importance of Chemistry	Grade 9	Grade 10	.017
		Grade 11	.604
	Grade 10	Grade 9	.017
		Grade 11	.286
	Grade 11	Grade 9	.604
		Grade 10	.286

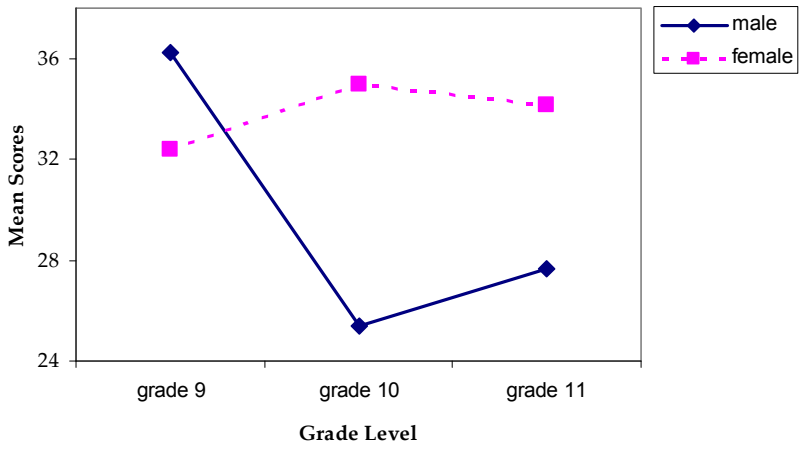
A graphic display of the interactions between gender and grade level for the two dimensions is shown in Figure 1. However, interpretations have been made at Grades 9 and 10 since only the difference between Grades 9 and 10 were found to be significant on both of the dimensions. For the enjoyment of chemistry dimension (Fig. 1a), males have the highest mean scores at Grade 9, but there is a sharp decline through Grade 10. Females, on the other hand, have lower mean scores at Grade 9 as compared to their male counterparts, whereas their attitude mean scores increase across Grade 10. When mean scores of two sexes were compared at each grade levels, females enjoy chemistry at Grade 10 more than males and males enjoy chemistry at Grade 9 more than females.

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

For the importance of chemistry dimension (Fig. 1b), similar results were found with the enjoyment of chemistry dimension; that is, male students' mean scores declined from Grade 9 to 10 and female students' mean scores increased as they progressed to Grade 10. However, the overall mean scores were lower on the importance of chemistry dimension for both females and males which could be the result of number of items that belonged to importance of chemistry dimension (i.e. enjoyment of chemistry involved 10, but importance of chemistry involved 5 items). When the mean scores of the two sexes were compared at each grade level females gave importance to chemistry more than males at Grade 10 and males perceived chemistry as important more than females at Grade 9. Overall, there was a sex difference across Grade 9 and 10 on both enjoyment and importance dimensions of attitudes toward school chemistry.

Figure I. *Changes in Female and Male Students' Attitudes by Grade Level on a. The Enjoyment of Chemistry Dimension, b. The Importance of Chemistry Dimension*





Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Discussion and Conclusion

The purpose of the present study is to investigate the effect of interaction between gender and grade level on secondary school students' attitudes toward chemistry as a school subject across Grades 9-11, in Turkey. There are two features of this study that make it noteworthy. First, students' attitudes toward chemistry as a school subject were measured by the means of a multidimensional scale (enjoyment and importance of chemistry) with excellent reliability coefficient which enables more accurate results related to the whole picture. Second, instead of treating gender and grade level as separate variables, the present study investigated the interaction between gender and grade level through two-way MANOVA. In this way, the study provided more accurate results, since literature confirmed that gender and grade level can interact with each other (George, 2006); that is, female or male students may have different attitudes toward chemistry as time passes.

The findings of the present study cannot be compared directly with the findings of previous studies since the number of researchers who deal with the effect of interaction between gender and grade level is very scarce. From the literature reviewed, only the study of Cheung (2009) introduced information related to the effects of interaction between gender and grade level on secondary school students' attitudes toward chemistry. Cheung (2009) found gender differences were limited only to the theory lessons subscale for Secondary 4 and 5. Hong Kong data also revealed that not all of the male students' scores on the chemistry laboratory work subscale showed decline from junior grades to senior grades. The results of the present study are in harmony with Cheung's findings in such a way that males' scores on the enjoyment and importance of chemistry dimensions followed a decline from Grades 9 to 10. On the enjoyment and importance of chemistry dimensions, female scores, on the other hand, showed growth from Grades 9 to 10. To conclude, this study points out that there is a sex difference across Grades 9 to 10 on the enjoyment and importance dimensions of attitudes toward chemistry as a school subject.

Overall, the findings of this study suggest that the educational objective of developing positive attitudes toward chemistry lesson is not fully achieved in Turkey. The average mean scores of females is about 33 and males is approximately 31 (see Table 6) out of 50 in terms of the enjoyment of chemistry. Moreover, the average mean scores of females is about 17 and males is

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

approximately 16 (see Table 6) out of 25 with respect to the importance of chemistry thus both can be treated as just above average.

According to the findings of this study, it can be implied that Turkish secondary school science program should take gender differences into account. Accordingly, chemistry teachers should organize classroom activities on the basis of gender differences; that is, each student in the classroom should have a chance to develop positive attitudes toward learning chemistry. This was a causal-comparative study and cross-sectional in nature. A longitudinal research can be designed in order to evaluate the interaction effect between gender and grade level on attitudes toward chemistry for further research. Moreover, further research can be conducted related to the interaction effect between gender and grade level on other branches of science to internalize the situation in science. The sampling method (that is, convenience sampling) and the nature of the attitude scale (that is, Likert type) are the limitations of the paper and further research can be performed through random samples and other types of measurement scales.

References

Aiken, L. R., & Aiken, D. R. (1969). Recent research on attitudes concerning science. *Science Education, 53*, 295-305.

Barmby, P., Kind, P. M., & Jones, K. (2008). Examining changing attitudes in secondary school science. *International Journal of Science Education, 30* (8), 1075-1093.

Cheung, D. (2009). Students' attitudes toward chemistry lessons: The interaction effect between grade level and gender. *Research in Science Education, 39,* 75-91.

Dhindsa, H. S., & Chung, G. (1999). *Motivation, anxiety, enjoyment and values associated with chemistry learning among Form 5 Bruneian students.* Paper presented at the MERA-ERA joint conference, Malacca, Malaysia.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin, 21,* 215-225.

Fraenkel, J. R. & Wallen, N. E. (2006). *How to design and evaluate research in education.* New York: Mc Graw-Hill.

Francis, L. J. & Greer, J. E. (1999). Measuring attitude toward science among secondary school students: The affective domain. *Research in Science & Technological Education, 17* (2), 219-226.

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Gardner, P. L. (1975a). Attitudes to science: A review. *Studies in Science Education, 2*, 1-41.
Gardner, P. L. (1995). Measuring attitudes to science: Unidimensionality and internal consistency revisited. *Research in Science Education, 25*, 283-289.

Geban, Ö., Ertepınar, H., Yılmaz, G., Altın, A., ve Şahbaz, F. (1994). Bilgisayar destekli eğitimin öğrencilerin fen bilgisi başarılarına ve fen bilgisi ilgilerine etkisi. *I. Ulusal Fen Bilimleri Eğitimi Sempozyumu: Bildiri Özetleri Kitabı,* Dokuz Eylül Üniversitesi, İzmir, 1-2.

George, R. (2006). A cross-domain analysis of change in students' attitudes toward science and attitudes about the utility of science. *International Journal of Science Education, 28* (6), 571-589.

George, D., & Mallery, P. (2003). *SPSS for windows step by step 11.0 update* (4th ed.). New York: Allyn & Bacon.

Glasman, L. R. & Albarracín, D. (2006). Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. *Psychological Bulletin, 132* (5), 778-822.

Harvey, T. J., & Stables, A. (1986). Gender differences in attitudes to science for third year pupils: An argument for single-sex teaching groups in mixed schools. *Research in Science and Technological Education, 4* (2), 163-170.

Havard, N. (1996). Student attitudes to studying A-level sciences. *Public Understanding of Science, 5* (4), 321-330.

Hofstein, A., Ben-zvi, R., Samuel, D., & Tamir, P. (1977). Attitudes of Israeli high-school students toward chemistry and physics: A comparative study. *Science Education, 61* (2), 259-268.

Kan, A., & Akbaş, A. (2006). Affective factors that influence chemistry achievement and the power of these factors to predict chemistry achievement-I. *Journal of Turkish Science Education, 3* (1), 76-85.

Kind, P. M., Jones, K., & Barmby, P. (2007). Developing attitudes towards science measures. *International Journal of Science Education, 29* (7), 871-893.

Koballa, T. R., & Crawley, F. E. (1985). The influence of attitude on science teaching and learning. *School Science and Mathematics, 85* (3), 222-232.

Koballa, T. R. (1988). Attitude and related concepts in science education. *Science Education, 72*, 115-126.

Ministry of National Education (2007). *Ortaöğretim kimya dersi öğretim programı.* Ankara: Devlet Kitapları Müdürlüğü Basımevi.

Osborne, J., & Collins, S. (2000). *Pupils' and parents' views of the school science curriculum.* London: King's College London.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes toward science: A review of the literature and its implications. *International Journal of Science Education, 25* (9), 1049-1079.

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.

Rennie, L. J., & Parker, L. H. (1987). Scale dimensionality and population heterogeneity: Potential problems in the interpretation of attitude data. *Journal of Research in Science Teaching, 24* (6), 567-577.

Salta, K., & Tzougraki, C. (2004). Attitudes toward chemistry among 11th grade students in high schools in Greece. *Science Education, 88*, 535-547.

Schibeci, R. A. (1983). Selecting appropriate attitudinal objectives for school science. *Science Education, 67,* 595-603.

Schibeci, R. A. (1984). Attitudes to science: An update. *Studies in Science Education, 11,* 26-59.

Shrigley, R. L. (1990). Attitude and behaviour are correlates. *Journal of Research in Science Teaching, 27*, 97-113.

Simpson, R. D., & Oliver, J. S. (1990). A summary of the major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*, 1-18.

Spall, K., Dickson, D., & Boyes, E. (2004). Development of school students' constructions of biology and physics. *International Journal of Science Education, 26* (7), 787-803.

Stevens, J. P. (2002). *Applied multivariate statistics for the social sciences* (4th ed.).Mahwah, New Jersey: Lawrence Erlbaum Associates.

Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32*, 387-398.

Yager, R. E., & Yager, S. O. (1985). Changes in perceptions of science for third, seventh, and eleventh grade students. *Journal of Research in Science Teaching, 22* (4), 347-358.

Copyright (C) 2012 HKIEd APFSLT. Volume 13, Issue 1, Article 16 (Jun., 2012). All Rights Reserved.