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A CROSS-AGE STUDY ON HIGH SCHOOL STUDENTS' ATTITUDES TOWARD CHEMISTRY

Hatice BELGE CAN
Middle East Technical University
Sec. Science & Math. Education
Ankara, TURKEY

Assoc. Prof. Dr. Yezdan BOZ
Middle East Technical University
Sec. Science & Math. Education
Ankara, TURKEY

ABSTRACT

The purpose of this study is to investigate the effect of grade level on high school students' attitudes toward chemistry as a school subject. Attitude Scale Toward Chemistry developed by Geban & Ertepınar (1994) was administered to collect data. The sample of the study was composed of 197 high school students from different grades that ranged from Grade 9 to 11. Principal component analyses revealed two dimensions of the scale for this data set and these dimensions were labeled as "enjoyment" and "importance". Cronbach Alpha reliability coefficient of the scale was computed as .93. MANOVA results indicated that grade level had significant effects on high school students' attitudes toward chemistry as a school subject in terms of both enjoyment and importance dimensions. Post Hoc analyses revealed that there is significant mean differences between Grade 9 and Grade 10 students' attitudes toward chemistry as a school subject on both dimensions.

Key Words: Attitude toward chemistry, grade level, high school students.

INTRODUCTION

Attitudes, one of the constructs of the affective domain, have been searched deeply for more than 40 years (Aiken & Aiken, 1969; Koballa & Crawley, 1985; Koballa, 1988). The main reasons of conducting studies related to attitude are its potential to predict future behaviors like subject and career preferences of students (Koballa, 1988; Osborne, Simon & Collins, 2003), and due to the correlation that exists between attitude and academic achievement (Shrigley, 1990; Weinburgh, 1995; Osborne & Collins, 2000).

Accumulation of knowledge related to the importance of attitudes caused science programs to include science-related attitudes. One of the aims of Turkish secondary school science program, for instance, is to develop positive attitudes toward science (Ministry of National Education [MNE], 2007). Then, what is meant by apparently simple term "attitudes toward science"? Actually, the literature had scene of a debate related to the meaning of "attitudes toward science" and "scientific attitudes or attributes". Gardner (1975a) made a distinction between these two concerns as 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 paper.

Attitudes toward science is related to positive or negative feelings about scientific objects and enables to predict scientific attitudes (Koballa & Crawley, 1985). Schibeci (1983) argued that various objects can be related to attitudes like science lessons, scientists, science in real life, chemistry as a school subject, and etc. For example, students' attitudes toward chemistry as a branch of science and as a school subject may be different in nature and level. Moreover, some of the studies (Havard, 1996; Spall, Dickson & Boyes, 2004) pointed out that treating different branches of science lessons under the general heading (i.e. science) may cause deviated

results; that is, students may have varied attitudes toward chemistry and physics or any other branches of science.

Since attitudes are not the same for different objects and studies confirmed that attitude is a multidimensional variable (i.e. includes various constructs like importance and enjoyment) (Gardner, 1995), it is crucial to define the scope of the study, explicitly. The focus of the current study is on high school students' attitudes toward chemistry as a school subject in Turkey (Grades 9-11).

Besides defining and measuring attitudes, the attitude 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, Kind & Jones, 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 mostly investigated factors affecting high school students' attitudes toward science. Results of the studies that dealt with attitude changes among students of different age groups are not in exact consistency as a result of various factors. Examining different constructs of attitudes may be one of the possible factor (Osborne et al., 2003). George (2006), for instance, showed that students' attitudes toward science declined whereas attitudes toward utility of science increased during secondary years. Nevertheless, Francis & Greer (1999) did not find any significant differences among 13-16 years students' attitudes about the importance of science. Apart from attitudes about the importance of science lessons, the attitude literature introduced also studies related to students' enjoyment of science lessons (Whitfield, 1979; Stables, 1990; Havard, 1996). Actually, enjoyment of chemistry, physics or biology was associated with gender differences in most of the studies. Stables (1990) found that girls have a tendency to biological sciences and males to physical sciences. Havard (1996) pointed out advanced level students in the UK and stated that the least enjoyable lesson is physics according to the students. On the other hand, Whitfield (1979) reported chemistry and physics as the least enjoyable subjects for post-14 English students.

The purpose of the present study is to examine students attitudes toward chemistry as a school subject over the Grade 9-11, in Turkey. The research question was addressed as follows:

- How do attitudes toward chemistry as a school subject change during Grade 9 through 11 of Turkish students?

METHODOLOGY

Sample

The sample of the study was assigned through convenience sampling method. The sample was composed of 197 high school students from different grades that ranged from Grade 9 to 11 (Years 16-18), from a public high school in Isparta, Turkey. 116 of the students were female and the remaining 81 of them were male. Table 1 indicates number of students with regard to their grade levels.

Table 1: Number of Students within each Grade Level

	Grade 9	Grade 10	Grade 11
Number of Students	83	36	65

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 in 5-point Likert type that 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. Lower scores show negative attitudes but higher scores, on the contrary, show positive

attitudes toward chemistry as a school subject. 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

First of all, the items that are negative in nature were recoded. 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 (details of the dimensions reported in the "Findings" section). Reliability analysis of both of the dimensions was computed. Finally, One-Way Multivariate Analysis of Variance (One-Way MANOVA) was conducted to test the research question. All of the mentioned analyses were performed by the use of SPSS.

FINDINGS

The results of the study were reported in two parts namely, findings from descriptive statistics and inferential statistics, respectively.

Findings from Descriptive Statistics

Results driven from descriptive statistics involves the Principal Component Analysis and the reliability analysis which were stated respectively. 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 2, the items were loaded on two factors; that is, the ASTC involves two dimensions for the present data. The first dimension is made up of 8 items which are all above .638. The second dimension consists of 7 items that are above .454. However, the fifth, second, and fourteenth items were loaded on both dimensions. As a result, the contents of the mentioned items were checked and categorized in such a way that two of them were assigned to the first dimension (2nd and 14th items) and one of them was handled under the second dimension (5th item). The dimensions were named with regard to their contents and on the basis of the literature as "enjoyment of chemistry" and "importance of chemistry" (e.g. Dhindsa & Chung, 1999). Table 3 summarizes items that belong to one of the two dimensions.

Table 2: Rotation Component Matrix [a]

Items	Component	
	1	2
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

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Table 3: The Items of the Dimensions of the ASTC

	Enjoyment of Chemistry	Importance of Chemistry
Items	7, 4, 13, 9, 1, 6, 15, 8, 2, 14	10, 12, 3, 11, 5

The Cronbach Alpha internal consistency coefficient is a useful statistics for deducing that students did not respond items of the scale randomly (Fraenkel & Wallen, 2006). The reliability coefficients were computed for each dimensions and the whole scale as general. The Alpha values are found as .92 for the "enjoyment of chemistry" , .81 for the "importance of chemistry", and .93 for the whole scale. George & Mallery (2003) declared that Alpha values greater than .9 is excellent and greater than .8 is good. The "importance of chemistry" dimension has a good internal consistency, on the other hand, the "enjoyment of chemistry" and the whole scale have excellent internal consistencies. The number of items in the "importance of chemistry" is less than the other dimension which may be the cause of smaller Alpha value whereas it is also above the acceptable level.

Findings from Inferential Statistics

In order to test the effect of grade level on enjoyment and importance dimensions of attitudes toward chemistry as a school subject, One-Way MANOVA was performed after meeting assumptions that were normality, homogeneity of variance-covariance matrices and independence of observations. The hypothesis tested was introduced in its null form, as follows:

H_{o1}: There is not a significant mean difference on the enjoyment and importance dimensions of the attitudes toward chemistry as a school subject over the Grade 9 to 11 students in Turkey.

The results of the One-Way MANOVA indicated a significant mean difference on the overall enjoyment and importance dimensions of the attitudes toward chemistry as a school subject across Grade 9 to 11 (Wilks' Lambda=0.948, F (4, 360)=2.44, $p<0.05$). Table 4 involves data necessary to comprehend the effect of grade level on the enjoyment and importance dimensions of the attitude separately.

Table 4: Relationships Between Dimension Means and Grade Level

Dimensions	Grade Level			*F*	Sig.	*η2*
	Grade 9 Mean	Grade 10 Mean	Grade 11 Mean			
Enjoyment of Chemistry	33,843	29.111	32.138	3.950	.021	.042
Importance of Chemistry	17.325	15.694	16.708	3.874	.023	.041

The significance value for the enjoyment dimension (.021) is smaller than .05 which means that there is a significant mean difference on the enjoyment dimension. Similarly, the significance value for the importance dimension (.023) is smaller than .05 that means there is a significant mean difference on the importance dimension of the attitudes toward chemistry as a school subject across Grade 9 to 11.

Furthermore, Table 4 can be used to deduce important information related to the means of each grades on both of the enjoyment and importance dimensions of attitude towards chemistry as a school subject. The highest mean score belongs to Grade 9 students (33.843) and the lowest one belongs to Grade 10 students (29.111) in terms of the enjoyment of chemistry. Similarly, the highest mean score belongs to Grade 9 students (17.325) and the lowest one belongs to Grade 10 students (15.694) with respect to the importance of chemistry.

Table 5: Post Hoc Tests (Bonferroni)

Dimensions	(I) Grade Level	(J) Grade Level	Sig.
Enjoyment of Chemistry	Grade 9	Grade 10	.017
		Grade 11	.676
	Grade 10	Grade 9	.017
		Grade 11	.260
	Grade 11	Grade 9	.676
		Grade 10	.260
Importance of Chemistry	Grade 9	Grade 10	.019
		Grade 11	.624
	Grade 10	Grade 9	.019
		Grade 11	.300
	Grade 11	Grade 9	.624
		Grade 10	.300

Table 5 shows significance values among grade levels on both of the enjoyment and importance dimensions which gives results related to the separate grade levels. As can be seen from Post Hoc analyses, there is significant mean differences between Grade 9 and Grade 10 students' attitudes toward chemistry as a school subject on both enjoyment and importance dimensions.

DISCUSSION AND CONCLUSION

The present study has marked a significant mean difference on attitudes toward chemistry as a school subject across Grade 9 to 11. More specifically, students' attitudes changes across grade levels in terms of both "enjoyment of chemistry" and "importance of chemistry" constructs. Furthermore, in-depth analysis indicated that there is significant mean differences between Grade 9 and Grade 10 students' attitudes toward chemistry as a school subject on both enjoyment and importance dimensions. The noteworthy point of this study is its taking the dimensionality of the scale into account; that is, students' "attitudes toward chemistry as a school subject" was analyzed with respect to two constructs which enables more accurate results about the whole picture.

The findings of the present study cannot be directly compared with the findings of the previous studies since the literature does not provide a study that deals only with the effect of grade level on the enjoyment and importance constructs of attitude toward chemistry as a school subject. However, there are informative studies related to the effect of grade level, gender, and the interaction of grade level and gender (Cheung, 2009) on various constructs of attitude towards chemistry (such as Hofstein, Ben-Zvi & Samuel, 1976; Dhindsa & Chung, 1999). Dhindsa & Chung (1999), for example, reported that females enjoy chemistry laboratory work more than males. Cheung (2009), on the other hand, found that males like chemistry theory lessons more than females in secondary 4 and secondary 5 grades.

According to the findings of the study, the mean scores of Grade 9 students is the highest and Grade 10 students is the lowest. Actually, finding of the highest scores at Grade 9 is in agreement with the findings of the previous studies whereas literature reports a decline across secondary years (such as Barmby et al., 2008). Finding of the lowest mean scores at Grade 10 may be the result of students' extensive exposure to learning in that subject specialist (students select subject specialist at the end of Grade 9 and 10^{th} grade is the first year in the preferred field in Turkish context) and /or the scope of the chemistry contents at 10^{th} grade. Moreover, as students spend time and experience solely the contents of the selected field their attitudes increase again at Grade 11.

Overall, the findings of this study offer that the educational objective of developing positive attitudes toward chemistry lesson is not fully accomplished in Turkey. The highest mean score of students is about 33 (see Table 4) out of 50 in terms of enjoyment of chemistry and about 17 (see Table 4) out of 25 with regard to importance of chemistry dimensions, which can be treated as just above average. To conclude, students of the present study have moderate attitudes toward chemistry as a school subject. This is a causal-comparative study and cross-sectional in nature. A longitudinal research design can be designed in order to evaluate the effect of grade level on attitudes toward chemistry for further research.

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BIODATA AND CONTACT ADDRESSES OF AUTHORS

Hatice BELGE-CAN is PhD Candidate at the department of Secondary Science & Mathematics Education in Middle East Technical University.

Her research interests are science education; chemistry education; cooperative learning; misconceptions; conceptual change; motivation; and attitudes of students.

PhD Candidate Hatice BELGE-CAN
Middle East Technical University
Department of Secondary Science & Mathematics Education
Chemistry Education
Ankara, TURKEY
E. Mail: e128456@metu.edu.tr

Yezdan BOZ is an associate professor at the Secondary Science and Mathematics Education Department in Middle East Technical University.

Her research interests are chemistry education; and teacher education, specifically alternative conceptions in chemistry, evaluation of effectiveness of teaching methods on students' chemistry achievement, and pedagogical content knowledge

Assoc. Prof. Dr. Yezdan BOZ
Middle East Technical University
Department of Secondary Science & Mathematics Education
Chemistry Education
Ankara, TURKEY
E. Mail: yezdan@metu.edu.tr

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.

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.

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.

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. (1976). The measurement of the interest in, and attitudes to, laboratory work among Israeli high school chemistry students. *Science Education, 60* (3), 401-411.

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.

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.

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.

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.

Stables, A. (1990). Differences between pupils from mixed and single-sex schools in their enjoyment of school subjects and in their attitudes to science and to school. *Educational Review, 42,* 221-230.

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

Whitfield, R. C. (1979). Educational research and science teaching. *School Science Review, 60*, 411-430.

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.