

Summer 8-1-2008

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Recommended Citation

Ozden, Mustafa (2008) "An Investigation of Some Factors Affecting Attitudes toward Chemistry in University Education," *Essays in Education*: Vol. 24 , Article 8.
Available at: <https://openriver.winona.edu/eie/vol24/iss1/8>

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An Investigation of Some Factors Affecting Attitudes toward Chemistry in University Education

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Abstract

This is a study that explores university student attitudes toward chemistry who were taking an introductory chemistry course. Participants included freshmen enrolled in either a science teacher training program, an elementary school teacher training program or a mathematics teacher training program. 627 students were chosen from four different Education Faculties of Adiyaman, İnönü, Anadolu and Gazi University in Turkey. 348 subjects were male and 279 subjects were female students. The research instrument used 20 statements measuring students' attitudes toward chemistry. Gender and study specialization differences in students' attitudes toward chemistry were examined. It was found male students have more positive attitudes toward chemistry than female students and science teacher training program students' attitude is more positive than others.

Introduction

Attitude was defined by Eagly & Chaiken, (1993) as “psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor”. Attitudes toward learning chemistry is very important concept that can be described as the students' views of knowledge, assessment, laboratory activities, and the roles of instructors and students according to Berg (2005).

Many researchers have investigated attitudes by studying variables or by examining its relation to a specific aim such as achievement (Albert, Aschenbrenner, & Schamolhover, 1989). Researches in science and chemistry education show that gender and academic major can affect attitudes toward science and chemistry. Many researchers found that boys exhibited significantly more positive attitudes toward science and chemistry than girls such as Lowery, Browyer and Padilla (1980), Baker (1983), Simpson and Oliver (1985), Pogge (1986), Oliver and Simpson (1990), Eryılmaz, (1992); Özyürek and Eryılmaz, (2001). Some researcher such as Maple & Stage, (1991) and Archer & McDonald, (1991) revealed that females had avoidance of additional science courses. Schibeci (1984) stated that females exhibit more positive attitudes toward biology and males toward physics. The American Association of University Women- AAUW (1992) data shows the need to focus more attention on the development of positive attitudes toward science with females. The females become less confident of their academic skills as they progress through secondary grades, therefore, their career aspirations are narrowed (AAUW, 1992; Linn & Hyde, 1989). National Science Foundation data (NSF, 1994) shows that females consist 46% of the labor force with only 22% of the scientists being female. Besides this, Barrington and Hendricks (1988) have concluded that there was no gender difference with respect to attitudes toward science.

It is known that self-competence level plays important role in attitudes toward chemistry. A positive correlation was found between gender and attitude towards chemistry by Morgil and Seçken (2004). They have also found that self-efficacy belief of male student teachers was higher than female ones supporting the similar studies made by Betz & Hackett (1981), Jones & Wheatley (1990), Brophy (1985) and Aşkar & Dönmez (2006). Smithers and Robinson (1988) also have found a declining interest in chemistry for young people. There is

a widespread scientific ignorance in general populace according to Durant and Bauer (1997); Durant, Evans, and Thomas (1989); Miller, Pardo, and Niwa (1997). On the other hand, House of Lords (2000); Jenkins (1994) and Lepkowska (1996) stated that an increasing recognition of the significance and economic utility of scientific information and its cultural background has become a matter of social concern and debate. In addition, the concept of attitudes toward chemistry is often poorly investigated and not understood well.

University teachers usually mention characteristics like attitude, drive, and actual interest that are the most important student characteristics associated with successful studies. Likewise, questions about the importance of attitude (Dalgety et al., 2003), and of motivation (Covington, 2000) have been investigated by many educational researchers.

University students' attitude towards learning chemistry is the focus of this study. To gain insight in what could influence changes in attitude, 627 first and second year university students, attending an introductory general chemistry course and displaying large changes in attitude toward learning chemistry were determined through questionnaires about attitudes towards chemistry course.

Perry developed a theory of intellectual and ethical development among college students. He represented a developmental process and not static personality traits, and described six stages, or positions, usually condensed into four sequential categories (Fitch et al., 1984; Moore, 1994). Perry's work was later adapted (Fitch, 1984; Finster, 1991), and applied to science education (Mackenzie et al., 2003). Finster adapted the Perry scheme in the context of chemical education and presented examples of how a student's attitude position could affect.

There are many factors affecting attitudes toward chemistry. Gender differences and academic major are some of these factors. The teaching programs should be prepared according to the factors affecting toward chemistry. For this reason, it is very important to determine different factors affecting attitudes toward chemistry. If gender and academic major play important role to taking chemistry course with respect to this study, what are the reasons of this important role? This study is also very important in the following ways:

Firstly, if there is a difference between male and female students' attitudes toward chemistry, which type of processes can be made by the university and educators to change this attitude? Is there any resistance to change this attitude in a positive way? The number of research should be increased about the reasons of different attitudes toward chemistry.

Secondly, if there is a difference between students' academic majors and their attitudes toward chemistry, the reasons should be investigated. The academic staff in the university could change their attitudes toward students to teach chemistry better.

Thirdly, the results of this study can influence the contributors and writers of chemistry programs for the schools.

The purpose of this study was to examine gender differences in students' attitudes toward chemistry and determine any differences between academic major and attitudes toward chemistry. Besides this, it was also aimed to explore the reasons about the existence of attitudes toward chemistry with respect to gender and academic major and to propose solutions.

Research questions

The purpose was to answer the following questions:

1. Are there gender differences in student attitudes toward chemistry?
2. Is there a correlation between attitudes toward chemistry and student's academic major?

Hypothesis

Null Hypothesis to be tested:

1. There is no gender difference between male and female students' attitudes toward chemistry ($H_0: m_f - m_m = 0$; m_f : female students mean; m_m : male students mean),
2. There is no correlation between students' attitudes toward chemistry and their academic major.

Methodology*Population and Subjects*

The target population includes all university freshmen students enrolled in the first year introductory chemistry course in four different Education Faculties of four different Universities in Turkey. The available population is freshmen students in the first year introductory chemistry courses at Education Faculties of different universities in Turkey. The study sample was chosen from accessible population using a sample of convenience.

Instrument

Researcher has developed attitudes toward chemistry instrument consisting of 20 statements in this study because there was limited instruments measuring the same content at university level after a literature review (Perry, 1970; Fraser, 1981; Finster, 1991; Mackenzie et al., 2003; Henderleiter et al., 1999; Berg et al., 2003 and Reid, 2003). The questionnaire was designed to assess the attitudes of students towards chemistry learning.

This instrument is in form of Likert scale with five scales (strongly agree, agree, disagree, etc.), toward chemistry. In the survey there are four validity threats: mortality, location, instrumentation, and instrument weakness. A mortality that arises in longitudinal studies, but in this study there was no longitudinal period or treatment period. Subjects were used only once. The missing data was not important, because the percentage of missing data was lower than five percent. Therefore, there was no mortality problem. The location was students' their normal classroom; therefore, there was no negative effect to responding questionnaire. Questionnaire items can not be efficient if the participants get tired, but in this study survey consists of 20 short statements and would not take much time to get tired or rushed or these kind of negative effects. The internal reliability of the survey was calculated by using Cronbach's Alpha formulae and found 0.94.

Procedures

This instrument was used at Education Faculty freshmen students who were taking first chemistry introductory course. At that time there were about 650 enrolled students could participate this research. Total 627 students took this survey. Table 1 shows the distribution of the students and their academic areas. After collecting data, the results were classified first as male and female to calculate ANOVA test. Second, the data were classified as academic areas (elementary school teacher candidates, primary mathematics teacher candidates, etc.) to calculate ANOVA interactions as detail explanation given below.

Table 1. Students and their Academic Areas

Academic Area	Male	Female	Total
Elementary School Teacher Training	181	128	309
Mathematics Teacher Training	91	84	175
Science Teacher Training	74	69	143
Total	346	281	627

N=627

Data Collection and Analysis

Earlier than making any computation and statistics, the twenty investigation questions were categorized as positive and negative statements. Negative statement (for example in the survey question number seven, eighteen, etc., see Appendix) scores were evaluated separate and then the total scores summed up for each student.

After determining total score for each student from the investigation, first, it was used ANOVA to compare whether there are differences between female and male students' attitudes toward chemistry or not. Secondly, to investigate and show distinction between students' majors and their attitudes toward chemistry, also it was used the ANOVA interactions. So as to test a hypothesis concerning two or more variable means, It is used the analysis of variance (ANOVA) technique. After calculating ANOVA inter-actions among the academic areas and students' attitude toward chemistry, the Scheffe test was used for three academic areas. The Scheffe test uses an F-ratio to test for a significance difference between any two variable conditions. To compare female and male students' responses, the alpha level was considered as a 0.01.

Limitations

There are some resource of surprising variables that might be significant for students to selecting of any academic area and attitudes toward chemistry. These are: social position of family, job of father and mother, chemistry background, GPA, school differences, etc. must be reviewed and essential, but these kinds of extraneous variables can not be controlled at this time in this research.

Results and Discussion

Table 2 shows female and male students mean, standard deviations (SD), degree of freedom (df), and F score. It can be seen that the result of F ratio of the female and male students is $F(1,173) = 28.5$ $p < 0.01$. It means the data support that there is a significance difference male and female students' attitudes toward chemistry. Male students' attitudes are more positive than females. This result is also valid for science teacher training students. The reason offered to explain this finding can be the result of cultural socialization of Turkish people that offers girls considerably less opportunity to face scientific and technological events and instruments. Males can experience scientific activities and skills in their early life compared to females in Turkey. After, to find out if there is any difference between academic areas and students' attitudes toward chemistry, the ANOVA interactions were calculated.

Table2. Number of students (n), mean, Standard deviation, df and F value of the male and female students' attitudes toward chemistry.

Gender	N	mean	SD	df	F
Male	346	163.6	29.7	1.173	28.5
Female	281	112.5	42.1		

* $\alpha=0.01$

The detailed analysis including examination the results of individual questions for science teacher training students are given in the following:

There were significant differences between male and females with some items used in questionnaire. For example, 58 percent of females have agreed (strongly agree and agree) with the item 18 "All chemicals are harmful" and 39 percent of males have agreed with the same item. This result shows that females believe that chemicals are harmful and fear of chemicals more than males. It can be explained with social and cultural role of males and females. Great numbers of the females (56%) do not believe that "chemistry can provide solutions to many of the world's problems". On the other hand, 52 percent of males have agreed this item. This result can be interpreted that males face scientific and technological experiences more than females in their life. While 58 percent of females have agreed with the difficulty of subject material, 41 percent of males have agreed with the item 3 "Chemistry is a very difficult subject." This result can be explained with the past experiences of students, about problem solving skills and making experiments in the laboratory etc. Many of the females (59%) have agreed with the item 20 "Chemistry makes me restless, irritable and impatient." and only 43 percent of males have agreed with this item. This result can be interpreted with the sensitive and emotional structure of females compared to males in the society.

The table 3 shows the results. The results of all academic areas ANOVA interactions show that there is a significance difference every academic areas and students' attitudes toward chemistry with $F(6,114) = 9.27$ $p < 0.01$. Therefore, to find out which academic area shows significance difference from another one we have to use Scheffe test.

Table3. Academic areas and mean, standard deviation and F ratio of the male and female students' attitudes toward chemistry.

Academic area	n	mean	SD
Elementary School Teacher Training	309	2.55	15.96
Mathematics Teacher Training	175	3.14	32.77
Science Teacher Training	143	3.87	36.65
df ratio		F	
All academic areas	6.114	9.27	

* $\alpha=0.01$ N=627

Academic areas of ANOVA interactions show that there is important difference every academic areas and students' attitudes toward chemistry with $F(6,168)=9,34$ $p<0.01$. Scheffe test is used in order to determine which academic area shows important difference from other ones. The Table 4 shows Scheffe's test results.

Table 4. Scheffe's test results

Interactions	df	F ratio
Elementary School Teacher Training& Mathematics Teacher Training	6,168	21,44
Elementary School Teacher Training& Science Teacher Training	6,168	24,85
Science Teacher Training& Mathematics Teacher Training	6,168	32,96

The result shows that male students' attitudes towards chemistry are more positive in comparison to female students. Besides this, there is a significant distinction between students' academic areas and their attitudes toward chemistry. It can be concluded from Table 4 that there are significant differences in every interaction between Science Teacher Training& Mathematics Teacher Training and the other academic area students. Briefly, science Teacher Training& Mathematics Teacher Training program students' attitude toward chemistry is more positive than other academic areas. According to Scheffe test results, Elementary School Teacher Training& Mathematics Teacher Training program students have the most negative attitude toward chemistry.

The results of this study show that male students have shown a more positive attitude towards chemistry than female students and there are distinctions among the students' academic areas and their attitudes toward chemistry. Hart & Robottom, (1990) stated that educational community has realized the need of reform in science education. Besides this, the content of instruction programs and the textbooks need to change to improve female students' attitudes toward chemistry in a positive way. The teachers' attitudes towards chemistry should be also investigated.

It should be investigated that the reason of some academic major's success than others and female students show poor attitudes than others. These differences should be considered during lessons and making a new education program. Besides this, teachers should take in to consideration the effects of the attitudes toward chemistry on their pedagogical formations.

There are some educational implications for educators and further researches:

- There is a need various researches for improving all students' attitudes toward chemistry, especially for female students.
- The prospective teachers' attitudes toward chemistry involving the attitudes of future science teachers are very significant since the teachers play a crucial role in influencing students' attitudes toward science learning and science- related careers.
- This study helps to reflect the involvement of students in teacher education programs and refers to the students pursuing a degree in science related courses.
- The answer of the question "why and when attitudes toward chemistry begin to change" should be investigated.

- All of the factors affecting attitudes toward chemistry especially gender differences need to be studied.
- There is a practical need for different researches examining strategies in the classroom for improving female students' attitudes toward chemistry.
- Instructional designers should address the emotions that are associated with existing attitudes, involve credible, attractive women role models and address the functions of the existing attitudes.

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APPENDIX: ATTITUDES TOWARD CHEMISTRY QUESTIONNAIRE	Strongly agree	Agree	Neither agree nor disagree	Disagree
Gender: Female () Male()				
Grade and Major:				
1. I like chemistry.				
2. Chemistry is very interesting to me.				
3. I don't like chemistry and I am afraid to take it. .				
4. I would be happy to take more chemistry courses...				
5. I have enjoyed studying chemistry.				
6. I participate in chemistry discussions often, and it is enjoyable.				
7. Chemistry lessons are very boring.				
8. I like chemistry because of instructor.				
9. The chemistry textbook is not helpful.				
10. Chemistry is enjoyable and fun.				
11. I have good feelings toward chemistry in general.				
12. Chemistry is not usable in daily life situations, and is not important to learn.				
13. Chemistry knowledge is necessary in my future career.				
14. I am comfortable with chemistry and it is not difficult very much.				
15. I am always under a terrible stress in chemistry class.				
16. It makes me nervous to think about problem solving and making chemistry experiments.				
17. Chemistry concepts and symbols of elements are unfamiliar for me.				
18. I don't want to take role in chemistry experiments.				
19. The chemistry curriculum is not suitable for student teachers.				
20. Chemistry makes me restless, irritable, and impatient.				