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## TURKISH UNIVERSITY STUDENTS' ATTITUDES TOWARD BIOLOGY: THE EFFECTS OF GENDER AND ENROLMENT IN BIOLOGY CLASSES

**Abstract.** *Research on the association between achievement and attitudes belong to fundamental questions in science education research. It is proposed that more positive attitudes are associated with better learning outcomes in science. However, recent research has revealed controversial results either supporting or rejecting the "attitude-achievement hypothesis". Moreover, very little is known about attitudes toward science among university students. In this study undertaken with a large number of university students in Turkey (n= 1301), we examined whether achievement correlates with attitudes toward biology, whether girls have more positive attitudes than boys as observed in previous research and whether those who enrolled in biology classes show more positive attitudes toward biology than those in humanities. The results indicated only weak, although statistically significant, association between attitudes and achievement. Furthermore, both achievement and attitudes toward biology were not influenced by gender or enrolment in biology classes. These results somewhat surprisingly cast doubts on relationships between attitudes and achievement and effects of gender on attitudes toward biology among university students.*

**Key words:** *biology education, attitudes, achievement, gender.*

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### Introduction

Research on the relationship between learners' attitude and achievement is fundamental in science education (Weinburgh, 1995). In general, attitudes, goals and interest have been identified as important for student's understanding, learning and their academic success. Nowadays, biology education has received special attention by educators and researchers because rapid progress in this area influences our everyday lives since today's biology raises a wide range of ethical issues (Reiss, 2006) (i.e. therapeutic cloning, animal experimentation) and environmental issues (i.e., global climate change, conservation). From this perspective, the development of a positive attitude toward biology should be an important goal for the curriculum developer, the teacher, the students and the scholar. So, the importance of attitude investigation becomes more relevant, especially when studies reveal alarmingly low interest of children of all age groups toward science (Ramsden, 1998; Stark & Gray, 1999).

It is generally appreciated that the association between attitude and achievement toward science exist. The findings of earlier studies confirmed that attitude was more or less correlated with academic achievement. For example, one of most powerful meta-analyses in science education concluded that the correlation



between attitudes toward science and achievement was 0.55 for females and 0.50 for males (Weinburgh, 1995). Freedman (1997), using a post test-only control group design, found that the correlation between attitude toward science and achievement was 0.41 in the treatment group. Salta and Tzougraki (2004), who examined the correlation between attitudes and achievement in chemistry, reported a moderate correlation ( $r = 0.41$ ) between students' own perception of difficulty of chemistry and achievement, but correlations between achievement and other dimensions like "usefulness of chemistry", "interest in chemistry" and "importance of chemistry" revealed relatively lower correlations ranging from 0.24 to 0.33. Bennett, Rollnick, Green and White (2001) also reported a linear relationship between attitude and achievement. They indicated that the less the undergraduate students showed attitudes toward chemistry, the less they obtained examination marks.

In addition, attitudes also predict individuals' decision making and action taking (Glasman & Albaracín, 2006; Kraus, 1995). For example, Kelley (1988) reported that British students' liking for a particular science subject was a good predictor of their actual choice of physics, chemistry, or biology.

Furthermore, several studies examined students' attitudes toward science in general (see Osborne et al. 2003 for a review), but, to our best knowledge, in many countries biology is taught separately from other science subjects (e.g. Prokop, Prokop, & Tunnicliffe, 2007; Prokop, Tuncer, & Chudá, 2007). The results of these studies revealed that biology is somewhat more attractive to females compared to males (Jones, Howe, & Rua, 2000; Keeves & Kotte, 1992; Stark & Gray, 1999; Warrington & Younger, 2000; Lamanauskas, Gedrovics, & Raipulis, 2004; Prokop, Lešková, Kubiátko, & Diran, 2007; Prokop et al., 2007, b). Females especially prefer botany and human biology topics (Baram-Tsabari & Yarden, 2005; Dawson, 2000; Hong, Shim, & Chang, 1998; Prokop et al., 2007b, c;). Surprisingly, most of these research studies were undertaken with elementary or high school students, but, to our knowledge, only three of previous studies examined students' attitudes toward biology in university level (Garcia & McFeeley, 1978; Uno, 1988; Rogers & Ford, 1997). For example, Garcia & McFeeley (1978) investigated whether biology major and non-biology major students' attitudes toward biology were changed as a result of one-semester-instruction of biology. They found that many students' attitudes had decreased in the end of the instruction. Uno (1988) surveyed a sample of first college level biology class students in the U.S. and concluded that the students believed that biology was not critical for their lives. On the other hand, Rogers and Ford (1997) investigated the effect of taking biology courses at two universities in the U.S. on changing biology major and non-biology major students' attitudes. They reported a weak correlation between expected grade and attitude change, and also a weak negative correlation between actual grade and attitude change.

As far as the previous research on biology education is concerned, number of the studies focussed on biology attitudes of university students, and the relationship between their attitudes and achievement regarding biology has not been extensively studied. In this regard, the present study undertaken with 1301 university students can partially fill the gap in the literature and can provide a strong base for the future studies in this area.

#### *Purpose of the study*

The purpose of the study was to reveal university students' attitudes toward biology. In addition, the study further examined whether students' attitudes toward biology differ with regard to gender, major and achievement. The following research questions were addressed throughout the study:

1. What are the university students' attitudes toward biology?
2. Are there any gender differences in biology attitudes and biology achievement among Turkish university students?
3. Do biology major students have more positive attitudes and better achievement in biology compared with non-major students?
4. Is there any correlation between achievement and attitudes toward biology?

These questions emerged as a result of lack of research on attitudes towards biology in the context of Turkey. Despite few available studies in Turkey, the present status of how university students perceive



biology is still unclear. It is expected that the results of the study will provide in-depth insight to biology curriculum developers, policy makers and biology teachers in both high school and university levels.

## Methodology of Research

### Sample

The participants of the study consisted of 1301 university students in various grades selected from four different departments in the Faculty of Education of three public universities in Turkey. Our preliminary analyses did not reveal any differences in attitudes or achievement between the three participating universities, so the data were pooled together. Demographic information regarding the participants is given in Table 1. 517 students (300 females and 217 males) already enrolled in biology classes and taking more than one biology class were referred to as major. The remaining students who enrolled in humanities departments (463 females and 321 males) taking at least one biology class were referred to as non-major. 369 students were freshmen, 160 were junior, 388 were sophomore and 378 were senior. 6 students did not indicate their grade. Students were asked to report the score they obtained from biology classes. The students from science and math teaching departments indicated more than one biology score whereas the students from early childhood and classroom teaching departments indicated at least one biology score. Students' scores from biology classes were converted into a single biology score. The average achievement score was calculated for those who reported more than one biology score. Thus, the average of all students' biology scores was found to be 74.22 (SD = 13.93, Range = 40-100). 33 students did not report their biology score.

**Table 1. Demographic characteristics of the sample.**

Demographic Information	Frequency (f)	Percentage (%)
Gender		
Male	538	41.4
Female	763	58.6
Area of Specialization		
Biology major	517	39.7
Non-Biology major	784	60.3
Grade Level		
Freshmen	369	28.4
Junior	160	12.3
Sophomore	388	29.8
Senior	378	30
Missing	6	0.5

### Instrument

The Biology Attitude Questionnaire on five point Likert type scale (1=strongly disagree and 5=strongly agree) developed by Prokop et al. (2007b) was used for data collection. The original form of the instrument was developed in Slovakian and later translated to English by Prokop et al. (2007b) with the comprehensive literature review, and validated with Slovakian students. The initial internal consistency of BAQ based on Slovakian students' scores demonstrated satisfactory results, for whole data (Cronbach's  $\alpha = 0.86$ ). After recoding negative items in reverse order, data from 17 attitude items were subjected to principal component analysis with Varimax rotation. Principal component analysis resulted in three common factors with eigenvalues higher than 1, which all together explain 53.2% of the variance. An examination of the statements associated with each factor allows the identification of



the underlying concept. These three factors were named according to the common characteristics of the items loaded on the same factor. The names of these factors are "Importance of biology", "Interest in biology lessons" and "Understanding of biology processes". Table 2 illustrates these three factors and the items loaded on that factor.

**Table 2. Subscales and the Items of Biology Attitude Questionnaire.**

Subscales	Items
1. Importance of Biology	Biology knowledge is essential for understanding other courses and phenomena The progress of biology improves the quality of our lives Biology is our hope for solving many environmental problems Biology is not important in comparison with other courses Biology is important part of our lives Nobody needs biology knowledge
2. Interest in Biology Lessons	I like biology more than other subjects Nature and biology is strange for me Biology lessons are very difficult for me I would like to have biology lessons more often During biology lessons, I am bored I hate biology lessons Biology is one of the most easiest courses for me
3. Understanding of Biology Processes	Biology helps development of my conceptual skills I make many efforts to understand biology I find biological processes very interesting The work with living organisms in biology lessons is very interesting

For the present study, these instruments were adapted into Turkish language. Firstly, the instrument was independently translated by two researchers who were bilingual and expert on biology education. This translated instrument was reviewed by another researcher to investigate the gaps between the translations. Furthermore, the Turkish items were back translated and were found to be matching with the original items, and thus considered for the last version of the instrument.

#### *Data Collection*

BAQ was administered to the participants in the fall semester of 2008-09 academic year in the classroom environment. The survey was anonymous and confidentiality of the students was ensured. Before administration, the purpose of the study was explained and the students were asked to be as fair as possible while responding to the items. Participation in this survey study was realized in the voluntary basis, and no promotion and/or incentives were given. At the end, students' permission was obtained in order to use their responses for academic purpose.

#### *Data Analysis*

Students' responses were coded as 1 referring lowest level attitude and 5 referring highest level attitude toward biology. Firstly, total score for whole instrument and then for each sub-scale was calculated. Having performed the preliminary analysis for data cleaning (particularly, missing data and outlier analysis), the descriptive analysis (mean, frequency and percentage) and inferential analysis (factor analysis, ANCOVA and Multiple regression) were conducted respectively. For each analysis, assumption test was initially conducted. For example, normality for each analysis, independence of the error, homoscedasticity and linearity for multiple regression, and homogeneity of slopes for ANCOVA were checked. Any problem was not confronted during assumption check and thus, analyses were conducted without any manipulation and correction.



## Results of Research

### *Students' Attitudes toward Biology*

As shown in Table 3, students considered biology as an important subject (highest mean score) and they did not have too much difficulty with understanding of biology processes, accordingly. However, their interests in biology lessons were observed to be rather neutral.

**Table 3. Students' Attitudes toward Biology (n = 1301).**

Sub-scale	M	SE	# of Items	Cronbach's $\alpha$	Range
Importance of biology	4.29	0.02	6	0.81	1 – 5
Interest in biology lessons	3.20	0.03	7	0.83	1 – 5
Understanding of biology processes	3.83	0.02	4	0.61	1 – 5

In agreement with these results, best mean scores were found for items focused on the importance of biology. Especially items such as "Biology is an important part of our lives", "The progress of biology improves the quality of our lives" and "Biology is our hope for solving many environmental problems" had mean scores above 4.2 (i.e., high agreement of participants). In contrast, mean scores of two items such as "Biology lessons are very difficult for me [scored in reverse order]" and "Biology is one of the easiest courses for me" were below 3.0 which suggested that a significant part of the students showed some learning difficulties when learning biology.

### *The Effect of Gender and Study Area on Biology Attitude and Achievement*

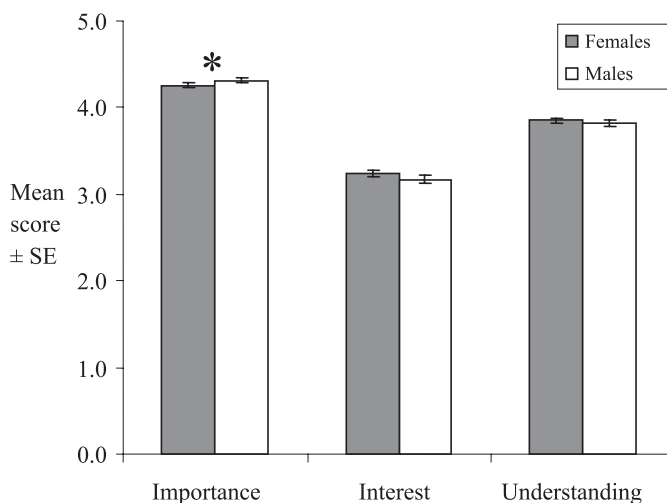
Before starting with further statistical evaluation of students' attitudes toward biology, we tested the assumption that there is no interaction between categorical and continuous predictors with homogeneity-of-slopes GLM. Since several significant interactions emerged, it was clear that our sample was heterogeneous and separate-slopes GLM was used. Mean score of each subscale given in Table 3 and achievement score were defined as dependent variables. Gender and enrolling biology courses (biology majors versus non-majors) were categorical predictors and students' grade was used as covariate.

Both the main effect of gender [ $F(4, 1286) = 2.70, p < 0.05, \text{partial } \eta^2 = 0.008$ ] and the main effect of enrolment in biology courses [ $F(4, 1286) = 18.9, p < 0.001, \text{partial } \eta^2 = 0.055$ ] were observed to be significant on four dependent variables. An interaction between these categorical predictors was not significant [ $F(4, 1286) = 0.95, p > 0.05, \text{partial } \eta^2 = 0.003$ ]. Examining effect sizes however reveals that all these differences are rather artefacts of large sample sizes, but their educational importance is somewhat low. For example, gender differences explain only 0.8 % and enrolment in biology courses only 5.5 % of variability of the results.

Univariate analyses revealed that achievement score was not influenced by gender or enrolment in biology course [ $F(1, 1289) = 3.09$  and  $3.24, p = 0.08$  and  $0.07$ , respectively]. The mean achievement score of biology majors was just slightly higher than the mean score of non-majors (mean score  $\pm$  SE,  $75.40 \pm 0.77$  vs.  $70.84 \pm 0.62$ , respectively) and males had nearly identical mean achievement score compared with females (mean score  $\pm$  SE,  $73.44 \pm 0.76$  vs.  $72.80 \pm 0.65$ , respectively).

Univariate analysis of gender differences revealed that males had similar attitudes towards biology than females. The only significant gender difference was observed for the sub-scale of "Importance of Biology" suggesting that when compared with females, male students considered biology as being more important, but, as shown in Figure 1, the difference in mean scores is very little.





**Figure 1. Gender differences towards biology. Asterisk (\*) denotes statistically significant difference between males and females ( $p < 0.05$ ). Other differences were not significant.**

#### *Association between Attitudes and Achievement regarding Biology*

To examine relationship between achievement and attitudes, forward stepwise linear regression analysis was performed according to Salta and Tzougraki (2004). The multiple regression results are given in Table 4. In this analysis, all variables were controlled for confounding factors like gender, grade and enrolment in biology courses. Achievement score was defined as the dependent variable and the score from three attitude dimensions were independent predictors. All variables entered the multiple regression model ( $R^2 = 0.025$ ,  $F(3, 1293) = 10.85$ ,  $p < 0.001$ ). The result suggested that 2.5 % of the variance on biology achievement can be explained by the linear relation of understanding of biology ( $\beta=3.14$ ), interest in biology ( $\beta=1.50$ ) and importance of biology ( $\beta=-1.44$ ). Put another way, this model accounts for 2.5 % of variance indicating that there is low dependency between "Understanding of biology processes" and "Interest in biology" and achievement score. The "Importance of biology" dimension showed lowest association with achievement score.

**Table 4. Multiple Regression of Achievement in Biology with Attitudes.**

	B	SE	Beta	t(1293)	p
Intercept			61.97	20.43	<0.001
Understanding	0.14	0.03	3.14	4.21	<0.001
Interest	0.08	0.03	1.50	2.65	0.01
Importance	-0.06	0.03	-1.44	-1.89	0.06

#### **Discussion**

This study examined associations between attitudes toward biology and achievement in biology among male and female students in three universities in Turkey. The findings of the present study are important to note its two features. First, review of research on biology education revealed that there are no comprehensive studies of students' biology attitudes in Turkey and other countries. From



this view point, the present study revealed students' attitudes toward biology with a large sample of university students. Second, unlike to the previous studies (Garcia & McFeeley, 1978; Uno, 1988; Rogers & Ford, 1997), the association between attitude toward biology and biology achievement were firstly examined together.

Overall, the findings of the present study, contrary to general expectations, do not support the idea that females prefer biology more than males (Keeves & Kotte, 1992; Hong et al., 1998; Prokop et al., 2007b,c) or that biology majors have more positive attitudes and better achievement regarding biology than non-majors (for similar examples see Prokop et al., 2007a, 2009). Moreover, we also found only a weak relationship between attitudes and achievement which also contradicts results from previous work (e.g. Weinburgh, 1995; Freedman, 1997; Dhindsa & Chung, 2003). As can be seen from these findings, the present study shows that there are complex results between attitude and achievement.

In general, the results reported here have indicated that attitudes toward biology among Turkish university students can be considered as rather positive. Turkish students respect the importance of biology for our lives and express a desire to understand biology processes in a detailed way. These positive responses on two attitude dimensions are important considering that after finishing university most of students (especially non-majors) will never learned biology systematically. However, interest in biology was generally lower indicating neutral attitudes toward biology. Considering that interest showed moderate association with attitudes (see Table 1) one would expect that improving students' interest in biology would result in better learning outcomes. In summary, one of the main implications of this study is that although the relationship between attitudes and achievement among university students is weak, there is a reasonable suggestion that increasing interest in biology would be more associated with learning outcomes in biology.

Perhaps surprisingly, neither achievement nor attitudes toward biology differed between biology majors and non-majors. Similar research in this field (Prokop et al., 2007a) would imply that some differences were expected, it must be highlighted that there were no other works comparing university student attitudes toward biology in general. Especially the "neutral" score in the "interest in biology" dimension suggests that biology majors appeared not to be sufficiently motivated to learn biology.

The absence of gender differences can be explained in various ways. For example, previous research revealed that there are gender  $\times$  grade associations in attitudes towards biology (Prokop et al., 2007b, c). Similar interactions were found in the study examining students' attitudes toward chemistry (Cheung, 2009). This means that females showed more positive attitudes toward biology only in some grades, especially when learning botany and human biology (Prokop et al., 2007c). However, university programmes obviously involve teaching more than one topic during one year or even semester, thus potential gender differences would easily disappear. Another mechanism for low gender differences detected in this study is age of students. Previous cross-age research in biology (Spall et al., 2004; Prokop et al., 2007b,c;) was focused mainly on high school or elementary school children leaving university students unexamined. It may be that females' interest in biology decreased and males' interest remained unchanged which would result in non-significant gender differences. Unfortunately, we do not have additional information which would help us to resolve this question. Further research should therefore involve research instruments with preferences of variety of biological topics (for example, preferences for botany, human biology, zoology, genetics etc.) which would uncover whether gender differences really disappeared or not at university level.





## Conclusion

Relationships between attitudes and achievement in biology received little attention, especially among university students. We found that student interest in biology is "neutral" which means that in depth research examining causes of this phenomenon is needed. Identification of students' perception of biology and biology courses at university will help us with planning effective teaching strategies which will contribute to greater preferences for biology. Our results reveal that there is a potential that increasing students' interest will result in better learning outcomes in biology.

## References

- Allport, G. W. (1935). Attitudes. In C. M. Murchison (Ed.), *Handbook of social psychology* (pp. 798-844). London: Oxford University Press.
- Bagozzi, R. P., & Burnkrant, R. E. (1979). Attitude organisation and the attitude-behaviour relationship. *Journal of Personality and Social Psychology*, 37, 913-929.
- Baram-Tsabari, A. & Yarden, A. (2005). Characterizing children's spontaneous interests in science and technology. *International Journal of Science Education*, 27(3), 803-826.
- Bennett, J., Rollnick, M., Green, G., & White, M. (2001). The development and use of an instrument to assess students' attitude to the study of chemistry. *International Journal of Science Education*, 23(8), 833-845.
- Cheung, D. (2009). Students' attitudes toward chemistry lessons: the interaction effect between grade level and gender. *Research in Science Education*, 39(1), 75-91.
- Dawson, C. (2000). Upper primary boys' and girls' interests in science: have they changed since 1980? *International Journal of Science Education*, 22(6), 557-570.
- Dhinda, H. S., & Chung, G. (2003). Attitudes and achievement of Bruneian science students. *International Journal of Science Education*, 25(8), 907-922.
- Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth, TX: Harcourt Brace Jovanovich.
- Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research in Science Teaching*, 34(4), 343-357.
- Garcia, R. A., & McFeeley, J. C. (1978). Attitude modification among biology and non-biology majors. Paper presented at the national association of biology teachers conference Denver, Colorado, USA.
- 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.
- Hong, J. L., Shim, K. C., & Chang, N. K. (1998). A study of Korean middle school students' interests in biology and their implications for biology education. *International Journal of Science Education*, 20(8), 989-999.
- Jones, M. G., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education*, 84(2), 180-192.
- Keeves, J., & Kotte, D. (1992). Disparities between the sexes in science education: 1970-84. In: *The IEA study of science III*, ed Keeves J pp141-164. New York: Pergamon.
- Kelly, A. (1988). The customer is always right: Girls' and boys' reactions to science lessons. *School Science Review*, 69(249), 662-676.
- Kraus, S. J. (1995). Attitudes and the prediction of behaviour: a meta-analysis of the empirical literature. *Personality and Social Psychology Bulletin*, 21(1), 58-75.
- Lamanauskas, V., Gedrovics, J., & Raipulis, J. (2004). Senior pupils' views and approach to natural science education in Lithuania and Latvia. *Journal of Baltic Science Education*, 5(1), 13-23.
- Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education*, 25(9), 1049-1079.
- Prokop, P., Fančovičová, J., & Kubiátko, M. (2009). Vampires are still alive: Slovakian students' attitudes toward bats. *Anthrozoös*, 22(1), 19-30.
- Prokop, P., Lešková, A., Kubiátko, M., & Diran, C. (2007a). Slovakian students knowledge of and attitudes toward biotechnology. *International Journal of Science Education*, 29(7), 895-907.
- Prokop, P., Prokop, M., & Tunnicliffe, S.D. (2007b). Is biology boring? Student attitudes toward biology. *Journal of Biological Education*, 42(1), 36-39.
- Prokop, P., Tuncer, G., & Chudá, J. (2007c). Slovakian students' attitudes toward biology. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(4), 287-295.
- Ramsden, J. M. (1998). Mission impossible?: Can anything be done about attitudes to science? *International Journal of Science Education*, 20(2), 125-137.
- Reiss, M. J. (2006). Teacher education and the new biology. *Teaching Education*, 17(2), 121-131.





- Rogers, W. D., & Ford, R. (1997). Factors that affect student attitude toward Biology. *Bioscene*, 23(2), 3-5.
- Salta, K., & Tzougraki, C. (2004). Attitudes toward chemistry among 11th grade students in high schools in Greece. *Science Education*, 88(4), 535-547.
- Spall, K., Stanisstreet, M., Dickson, D., & Boyes, E. (2004). Development of school students' constructions of biology and physics. *International Journal of Science Education*, 26(7), 787-803.
- Stark, R., & Gray, D. (1999). Gender preferences in learning science. *International Journal of Science Education*, 21(6), 633-643.
- Uno, G. E. (1988). Teaching college and college-bound biology students. *The American Biology Teacher*, 50(4), 213-216.
- Warrington, M., & Younger, M. (2000). The other side of the gender gap. *Gender and Education*, 12(4), 493-508.
- 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(4), 387-398.

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