

Prospective Biology and Chemistry Teachers' Satisfaction with Laboratory and Laboratory Facilities: The Effect of Gender and University

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ABSTRACT

The purpose of the study was to investigate last year prospective biology and chemistry teachers' satisfaction level with laboratory and laboratory facilities offered by their department and faculty with regard to gender and university. 60 senior prospective Biology Teachers and 101 senior prospective Chemistry Teachers participated in the study. Prospective Science Teacher Satisfaction Scale (PSTSS) was used for obtaining relevant data. PSTSS consists of five sub-scales. For this study, we used "laboratory and its facilities" subscale consisting of 14 items. The alpha (α) level of this subscale was .93. The results pointed out that last year prospective Biology and Chemistry Teachers had a tendency towards satisfaction on biology and chemistry laboratories but not at the desired level. Significant difference was not observed between male and female participants. Most of variance of dependent variable was accounted by the effect of school (university) which suggests that school facilities greatly influence student satisfaction.

Keywords: Satisfaction; Laboratory and Laboratory Facilities; Prospective Biology and Chemistry Teachers.

INTRODUCTION

Over the past 10 years, a substantial number of studies have examined the impacts of college on students' motivation, success and satisfaction. Many of these aimed at exploring the relationships between students' college experiences and learning, development, and satisfaction. Some of those revealed that colleges and universities had a great role for shaping students' overall satisfaction (e.g. Wiers-Jenssen, Stensaker & Groggaards, 2002). Further, some others investigated the impact of academic department on students' motivation and success (Cameron & Ettington, 1988; Hartnett & Centra, 1977). Similarly, it was found that academic departments had a significant impact on student satisfaction and student performance (Elliott & Shin, 2002). Umbach and Porter (2002) examined the effects of different departments and their characteristics on students' satisfaction. They found that department characteristics significantly contributed to

students' satisfaction. Several similar studies indicate that not only campus environment (e.g. campus setting, campus life, academic department, administration, and academic staff) (Gatfield, Barker, & Graham, 1999; Erdoğan & Usak, 2007) and its facilities (e.g. guidance) (Erdoğan, Uşak & Aydın, 2008), but also student background characteristics (GPA and gender) (Erdoğan & Uşak, 2004) shaped and influenced students' satisfaction with their faculty and department overall. Thus, it is clear to say that student satisfaction is affected by many variables. One of those variables is gender. It is apparent that a student's gender significantly contributed to student satisfaction (Adelman 1991; Karemera, et al., 2003; Rienzi, Allen, Sarmiento, & McMillin, 1993; Umbach & Porter, 2002). Particularly, male students show more satisfaction with the overall department than the females do (Adelman, 1991; Carilli, 2000; Rienzi et al., 1993; Unbach & Porter, 2002). On the other hand, a series of research studies done in the context of Turkey indicated that gender did not influence university student satisfaction with academic department (Erdoğan & Uşak, 2007), with social facilities (Erdoğan, Uşak & Aydın, 2008), and curriculum/program (Erdoğan & Uşak, 2006). The other factor strongly contributing to student satisfaction is university in which they are enrolled (Erdoğan & Uşak, 2004).

Gender differences in science have been widely investigated, and, as a conclusion, females are found to be less interested in science as opposed to males (e.g. Osborne, Simon & Collins, 2003). However, there are some subject areas in science that are more interested by females such as human biology and human health (Elster, 2007; Jones, Howe & Rua, 2000, Uitto, Juuti, Lavonen & Meislo 2006), botany, (Hong, Shim & Chang, 1998; Prokop, Prokop & Tunnicliffe 2007). It is observed in the professional literature that female students are less active in laboratory practices (Tobin & Garnett, 1987), using laboratory tools and appliances than male students are (Burkam, Lee & Smerdon, 1997; Jones 1989; Jones & Wheatly 1990, Kahle, Anderson & Damnjanovic, 1991; Martinez, 1992), and male students show more success in laboratory classes (Hamilton, Nussbaum, Kupermintz, Kerkhoven, & Snow, 1995; Lee & Burkam, 1996; Martinez, 1992). Most of gender-related studies were carried out with secondary science groups, but how gender differences persist in university students remains unclear.

The use of the laboratory for science education aims at learning basic information on science (especially biology, chemistry and physics) by giving students the chance to design and conduct experiments. Laboratory instruction that makes science more exciting has a positive impact on developing students' positive attitudes toward science (Freedman, 1997), higher order thinking skills (Miri, David & Uri, 2007; Orbay, Özdoğan, Öner, Kara & Gümüş, 2003; Yehudith & Anat, 2000) and increasing students' successes (Çepni, Akdeniz & Ayas, 1995; Demirci, 1993). In laboratories, the students have opportunities to examine the development of the research studies, and process and findings of these studies. In addition, laboratory instructions and experiments help students develop scientific understanding (Ayaş, Çepni, & Akdeniz, 1994). For example, science laboratories are the places in which scientific knowledge regarding as biology, chemistry and physics are deeply understood, perceived and applied in the most influential way. In this regard, working in laboratories is an important part of science education. Students work both individually and together with their peers in laboratories for testing hypotheses and solving problems. During experiments, they are given opportunities to construct their own knowledge by means of scientific processes and of related materials. The most important difference between learning in the class and in the laboratory is that the activities carried out in the laboratories are mainly students-centered and these activities enable the students to develop their creativity (minds-on skills) and hands-on skills (NABT, 1994).

Today, the research studies related to biology and chemistry mainly depends on laboratory studies. There are two main purposes underlying laboratory studies. As claimed by Erten (1991), one of them is to apply the theoretical information gathered through science education into practice, and support this information with the experiments, and the other is to promote students' scientific skills. In the 1997-1998 educational years, the education faculties in Turkish Universities experienced the accreditation process (YOK, 1998a). Accreditation of the universities was based upon determined standard and was necessary for these faculties since there were many problems (theory-practice gap, inadequacy of infrastructure, insufficient courses, need for new curricula...etc.) faced in faculties of education (Orbay et al., 2003; YOK, 1998a, 1998b). Overcoming the problems regarding regular outer and inner control of faculties, and improving the quality of the teacher candidates and assuring the quality of the teacher education were the main focuses of accreditation (YOK, 2004). Reconstruction of the educational faculties based upon accreditation has entailed many changes in department curricula, infrastructures of the classes, laboratories, departments and faculties.

Despite all these attempts in re-designing laboratory instructions and facilities, the existing literature in Turkey indicates very few studies aiming to investigate students' opinions and satisfactions with the laboratories and their facilities. There are some available studies (Cem, 2002; Ceylan & Demirkaya, 2006; Erten, 1991; Gezer & Köse, 1999; Gezer, Köse & Sürücü, 1998; Orbay et al, 2003), but the number of these studies does not seem enough because these studies did not directly examine students' satisfactions with the laboratories and their facilities. With this study, how the last year students in the biology and chemistry education programs were satisfied with the laboratories and their facilities that were designed / improved in line with accreditation carried out in 1997-98 was investigated. Thus, it is believed that this study will contribute insights to the science educators, science teachers and decision makers who are dealing with and/or designing laboratory instruction and practices.

This survey study aimed at investigating the satisfaction level of last year prospective biology and chemistry teachers with the laboratories and their facilities provided by their department and faculty. In addition, whether their satisfaction level differed with regard to their gender and the universities in which they enrolled were also investigated. It is hypothesized that students' satisfaction level does not differ with regard to male and female students, and universities.

METHODOLOGY

a) Participants

The participants of the study included 60 (37 female, 23 male) final year prospective biology teachers and 101 (49 female, 52 male) final year prospective chemistry teachers. Thirty two of the prospective biology teachers were from Dokuz Eylül University and the remaining were from Gazi University. The average age of prospective biology teachers was 22 and grade point average of the students was 2.74. On the other hand, 13 of the prospective chemistry teachers were from the Middle East Technical University, 23 were from Dokuz Eylül University, 32 were from the Gazi University and the remaining were from the Karadeniz Technical University. The average age of the prospective chemistry teachers was 22 and grade point average of the students was 2.64. Table 1 summarizes the characteristics of the participants.

Table 1. Demographic Profile Of The Participants

| | Fifth Grade Prospective Biology Teachers (<i>n</i> =60) | | Fifth Grade Prospective Chemistry Teachers (<i>n</i> =101) | |
|--------------------------|--|-----------|---|-----------|
| | Number of Students | Percent % | Number of Students | Percent % |
| <i>University</i> | | | | |
| METU | -- | -- | 13 | 12.9 |
| Dokuz Eylül Unv. | 32 | 53.3 | 23 | 22.8 |
| Gazi Unviversity | 28 | 46.7 | 32 | 31.7 |
| Karadeniz Technical Unv. | -- | -- | 33 | 32.7 |
| <i>Gender</i> | | | | |
| Male | 23 | 61.7 | 52 | 48.5 |
| Female | 37 | 38.3 | 49 | 51.5 |

This study was carried out with last year students since it was assumed that they had taken all the laboratory classes offered by their departments.

b) Instrument

In this study, the data was gathered from the participants through the use of Prospective Science Teachers Satisfaction Scale (PSTSS), developed for Turkish prospective science, biology, chemistry and physics teachers (Erdoğan & Uşak, 2005). The reliability analysis indicated that Cronbach's Alpha of the Scale (α) was .98. PSTSS mainly consists of two parts. The first part comprises 4 demographic questions; gender, university, G.P.A, and age of participants, and there are 72 closed items in second part. The items in the second part are Likert-type on a five-point scale ranging from 5-strongly agree referring to strongly satisfied and 1-strongly disagree referring to strongly dissatisfied.

The instrument includes five sub-scales; (1) Administration, Facilities, and Information Source – 26 items, (2) Academic Staff – 17 items, (3) Laboratory and its Facilities – 14 items, (4) Classroom Environment – 6 items and (5) Skill Development – 8 items.

In the questionnaire, students were asked to rate their overall satisfaction level of biology and chemistry education program offered by faculty of education in different universities in Turkey. A greater mean value for each domain suggests a greater satisfaction level, and a smaller mean value refers to a smaller satisfaction level.

This study is a part of the big project. For the present study, the sub-scale of *laboratory and its facilities* with 14 items were taken into account. The results stated here were in line with the data obtained through this sub-scale. Why the students' responses to this sub-scale was considered in the present study is due to the fact that the laboratory is one of the basic parts of science education and many of the available research reported several problems encountered in the laboratory instructions (i.e. Cem, 2002; Orbay et al, 2003; Erten, 1991). Parallel to the pervious research, this sub-scale of PSTSS provided students' satisfactions and dissatisfactions with the dimensions of laboratory instructions (i.e. methods and equipments used, qualification of the instructor(s), number of the working staff and lab hours).

c) Survey Data Collection

In Turkey, there are 68 educational faculties (Higher Education Council - YOK, 2005). These faculties are located all around Turkey. A few, but not all, have biology and chemistry education programs offered under Secondary Science and Math Education Department. Because of the impracticality and infeasibility of studying all the students in the biology and chemistry education programs in the faculties, the researchers selected samples from these faculties. Thus, the target programs in four universities were sampled due to ease of accessibility. For this reason, the generalizability of the results can only be drawn for the students in these universities, not for others.

This study aimed at reaching all last year prospective biology and chemistry teachers in selected universities. At the very beginning, approximately 80 students were selected from the biology education program and 160 students from the chemistry education program. The data collection instrument was administered to the initial sample ($n=240$). Among the participants, only 60 students in biology education and 101 students in chemistry education completed the questionnaire. The return rate of the questionnaire for biology education students was 75% and for chemistry education students was 63.1%.

d) Analysis

The data collected through the PSTSS from the participants were analyzed by means of descriptive statistics (mean, percentages and standard deviation) and inferential statistics (two-way-ANOVA). In order to determine general satisfaction level of participants with the laboratories and their facilities, descriptive statistics were used. On the other hand, two-way-ANOVA was performed to investigate the effects of gender and university on participants' satisfaction with the laboratories and their facilities. Performing two-way-ANOVA enabled the researchers to determine the main effects of gender and university and the interaction effect of these two variables on satisfaction of the participants with the laboratories and their facilities.

FINDINGS

1. Findings on Prospective Biology Teachers

The highest score that the students can obtain from 14 items in the laboratory and its facilities sub-scale is 70 (indicating strongly satisfied), while the lowest score is 14 (indicating strongly dissatisfied). The overall mean score of the prospective biology teachers was 46.3 (M). The students seemed not to be highly satisfied with the laboratories and their facilities provided for them. However, they had tendency toward having satisfaction on this issue.

When considering each item in the sub-scale separately, the following table (table 2) can be produced. Students reported that they were satisfied with the number of the working staff in the lab ($M= 3.78$), provision of secure environment both for students and for academic staff in the lab ($M= 3.73$), identification of the steps of the experiments by the working staff ($M= 3.60$), identification of theories underlying the experiment ($M= 3.58$), capability of academic staff(s) on lab practices ($M= 3.57$), applicability of the experiment to the real life ($M= 3.55$), the application of theory into practice ($M= 3.53$), motivation and encouragement given by academic staff ($M= 3.47$). They were slightly satisfied with originality of the experiments ($M= 3.13$), use of instructional methods and techniques in the lab(s) during experiments ($M= 3.10$) and sufficiency of apparatus and chemical materials in the lab(s) for experiments ($M= 3.08$). However, the students showed

dissatisfactions with the use of technology in lab(s) ($M= 2.48$), working hours of lab(s) ($M= 2.82$) and diversity of materials in the lab(s) ($M= 2.88$).

Table 2. Mean and Standard Deviation of the Items in the Sub-scale

| Items | Prospective Biology Teachers | | Prospective Chemistry Teachers | |
|--|------------------------------------|-----------|--------------------------------------|-----------|
| | <i>M</i> | <i>SD</i> | <i>M</i> | <i>SD</i> |
| (1) The application of theory into practice in lab. | 3.53 | 1.04 | 3.28 | 1.14 |
| (2) Originality of the experiments carried out | 3.13 | 1.01 | 3.02 | 1.09 |
| (3) Applicability of the experiments to real life | 3.55 | 1.19 | 3.04 | .99 |
| (4) Capability of the academic staffs on experiments | 3.57 | 1.11 | 3.53 | .97 |
| (5) Encouragements of the academic staff to carry out experiments | 3.47 | 1.06 | 3.22 | 1.24 |
| (6) Identification of the theories underlying the experiments | 3.58 | .94 | 3.41 | 1.24 |
| (7) Identification of the steps of the experiments clearly | 3.60 | .86 | 3.29 | 1.22 |
| (8) Provision of security of both students and academic staff in lab | 3.73 | 1.14 | 3.45 | .98 |
| (9) Use of technology in the lab | 2.48 | 1.21 | 2.83 | 1.18 |
| (10) Use of instructional methods and techniques in the lab during experiments | 3.10 | 1.24 | 2.93 | 1.12 |
| (11) Sufficiency of apparatus and chemical materials in lab for experiments | 3.08 | 1.60 | 3.11 | 1.35 |
| (12) Diversity of materials used in the lab | 2.88 | 1.63 | 3.08 | 1.43 |
| (13) Adequacy of personals working in the lab | 3.78 | 1.31 | 3.59 | 1.02 |
| (14) Working hours of laboratories | 2.82 | 1.20 | 3.13 | 1.21 |

2 (gender) X 2 (university) ANOVA was performed to determine whether biology teaching students' satisfaction with laboratories and their facilities differed according to gender and university. The results for ANOVA conducted on the total sub-scale score indicated non-significant main effect for gender [$F(1, 56) = 2.98, p > .05$] and interaction effect of gender and university for total satisfaction level score [$F(1, 56) = 3.90, p > .05$], but a significant main effect for university [$F(1, 56) = 95.54, p < .05$, partial $\eta^2 = .63$]. Although gender did not contribute to the satisfaction of prospective teachers, the university variable predicted 63% of the variability of the satisfaction for prospective biology teachers with laboratories and their facilities. The students in the biology education program in Gazi University ($M = 56.39$) showed higher satisfaction than the students in Dokuz Eylül University ($M = 38.52$).

2. Findings on Prospective Chemistry Teachers

Similar procedures used for analyzing the data gathered from prospective biology teachers were followed for analyzing the data for prospective chemistry teachers. The overall mean score of the prospective chemistry teachers was 44.92 (M). Parallel to the findings with prospective biology teachers, prospective chemistry teachers also seemed not to be highly satisfied with the laboratories and their facilities.

Table 2 summarizes the satisfaction scores of prospective chemistry teachers for each item in the sub-scale. Students reported relatively higher satisfaction with the number of the working staff in the lab ($M = 3.59$), capability of the academic staffs on experiments ($M = 3.53$), provision of secure environment both for students and for academic staff in the lab ($M = 3.45$), identification of theories underlying the experiment ($M = 3.41$), identification of the steps of the experiments by the working staff ($M = 3.29$), the application of theory into practice ($M = 3.28$) and motivation and encouragement given by academic staff ($M = 3.22$) respectively. They were slightly satisfied with working hours of the lab(s) ($M = 3.13$), sufficiency of apparatus and chemical materials in lab for experiments ($M = 3.11$), diversity of the materials ($M = 3.08$), applicability of the

experiments to the real life ($M= 3.04$) and originality of the experiments ($M= 3.02$). But, students' satisfactions with the items of use of technology ($M= 2.83$), and use of instructional methods and techniques in the lab during the experiments ($M= 2.93$) were somewhat low and toward dissatisfaction.

2 (gender) X 4 (University) ANOVA was run so as to determine the effects of gender and university on prospective chemistry teachers' satisfaction with laboratories and their facilities. The results of ANOVA revealed no significant main effect for gender [$F(1, 93) = 0.06, p > .05$] and no significant interaction effect for gender and university [$F(3, 93) = 0.95, p > .05$], but significant main effect for university [$F(3, 93) = 35.54, p < .05$, partial $\eta^2 = .53$]. The main effect of university on satisfaction of last year prospective chemistry teachers with laboratories and their facilities was quite high. 53 percent variability on satisfaction with laboratories can be accounted for university enrolled. After finding significant main effect for university with four levels, follow up test (Post hoc) using Scheffe test was conducted to evaluate the pairwise differences among the universities. Table 3 illustrates the significant differences among the universities.

Table 3. Post hoc Results Conducted for Universities

| University | <i>M</i> | Sd | 1 | 2 | 3 |
|------------------------------------|----------|------|----|----|---|
| METU (1) | 57,13 | 2,34 | | | |
| Karadeniz Technical University (2) | 38,89 | 1,49 | * | | |
| Dokuz Eylül University (3) | 34,88 | 1,77 | * | NS | |
| Gazi University (4) | 53,45 | 1,53 | NS | * | * |

A significant level at .05 level

Asterisk (*) indicates significant difference between two university

NS indicates not significance

Given in Table 3, there were no significant mean differences between students in Dokuz Eylül University and Karadeniz Technical University, and students in the Middle East Technical University (METU) and Gazi University with regard to laboratory satisfaction. On the other hand, there were significant mean differences between students in Karadeniz Technical University and METU and Gazi University, and students in Dokuz Eylül University, and METU and Gazi University.

The last year prospective students in the department of chemistry teaching in Middle East Technical University showed highest degree of satisfaction with their laboratory facilities when compared to those in the other universities. However, the students in Dokuz Eylül University showed the greatest dissatisfaction with their laboratory facilities.

DISCUSSION and CONCLUSION

In this study, the satisfaction level of last year prospective biology ($n=60$) and chemistry ($n=102$) teachers' satisfaction with laboratories and their facilities were investigated. Furthermore, the effects of gender and university enrolled on students' satisfaction were also examined. The results indicated that students in both departments were not highly satisfied with their laboratories in which they carried out the experiments. However, the participants were dissatisfied with some items pertaining to the use of technology in lab, working hours of lab(s) and diversity of materials in the lab. They either satisfied or slightly satisfied with the other items. Similar findings were observed in another study conducted with 288 Turkish prospective classroom teachers (Ceylan & Demirkaya, 2006).

Looking at the effects of gender and university on satisfaction of students with laboratory, it can be concluded that gender did not contribute to the satisfaction of students in both departments. The further comparison considering overall mean score of both groups refers no significant mean difference between male and female students with regard to laboratory satisfaction. This may perhaps be because in the university, only students with a greater interest in science study that subject unlike in elementary or high school. So, the sub-sample of more interested males and females is not expected to show significant differences.

The main effect of university on students' laboratory satisfaction was significant for both departments. For prospective biology teachers, the university contributed 63 percent of the variances in the laboratory satisfaction. Similarly, for prospective chemistry teachers, the university contributed 53 percent of the variances. These findings show that university enrolled has a rather great impact on students' satisfaction and predicts most of the variances of the students' satisfaction with laboratories and their facilities. The final year students in department of biology teaching in Gazi University were more satisfied than the students in the same department in Dokuz Eylül University. As clearly understood from the follow-up test, the students in METU and Gazi University were satisfied while those in Dokuz Eylül University and Karadeniz Technical University were dissatisfied with laboratories and their facilities provided by their faculties and departments. This might be due to different lab facilities and opportunities (e.g. number of the staff, design of the lab, and quality of the academic staff, sufficiency of tools and equipments, and so on) provided by different universities. The curriculum pertaining to the lab instruction in all faculties of education can be supposed to be same or similar. For that reason, the significant contribution and impact of university enrolled might not be due to curriculum. It seems to be due to infrastructure, quality and the number of the academic staff worked in/for the lab(s), and quality and number of the tools and equipments in the lab(s). Further, overall satisfaction of students with campus environment and academic department might also influence these students' laboratory satisfaction. The parallel findings were also found in previous studies aiming to explore the effects of university on students satisfaction with academic department (Erdogan & Usak, 2007), with curriculum/program (Erdogan & Usak, 2006), with social facilities (Erdoğan, Usak & Aydin, 2008). For all of these studies, university factor explained more than 50 % of total variances of students' satisfaction.

Laboratories in science education (especially chemistry, biology and physics education) have important places where the students have chances to implement theoretical knowledge into practice. At the same time, students find chances to improve their creativity and thinking skills as well as hands-on skills in laboratories. In this regard, providing laboratory facilities of the desired level and meeting prospective teachers' needs and expectations would directly influence their satisfaction. Elliott and Shin (2002) indicate that satisfaction has directly impact on motivation. Motivation is also directed with students' performance and achievement. In this regard, it can be concluded that satisfaction might have an impact on students' motivation and thus success. The findings of the study by Centra and Rock (1983; as cited in Umbac & Porter, 2002) supported this claim and revealed that students' achievement is significantly related to satisfaction. Thus, it is apparent that increasing students' satisfaction with overall laboratory will enhance their motivation to work in lab and result in more success in lab instruction and thus science.

SUGGESTIONS

This study does not address to “why” question and does not investigate the reason(s) behind students’ dissatisfaction. It is suggested to other researchers that further qualitative research seeking in-depth information be performed to explore the reasons, and get students’ perspectives and recommendations. It is known that the laboratories enable the students to make connection between theory and practice. One of the areas contributing to students’ science achievement might be considered as students’ success in the lab. In order to enhance students’ motivation, satisfaction and thus success, the laboratory environment should be designed in line with needs and expectations of the students. When considering the least satisfied areas from the present study, the following issues should be considered; (1) Laboratory facilities provided should be enhanced, (2) Laboratory working hours should be reorganized, (3) The use of technology in laboratories should be encouraged and the technological devices should be provided for students during conducting experiments, (4) The number of the equipments, materials and apparatus used in the lab should be increased so as to give chance to all students to conduct experiments, and (5) Different instructional methods and techniques should be implemented during experiments, (6) Financial support should also be provided for the universities to improve the quality and quantity of the laboratories and their equipments.

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