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Chemistry Laboratory Experiences of Prospective Biology Teachers: A Case Study

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Abstract –This study aims to evaluate the experiences of prospective biology teachers in the chemistry laboratory. Prospective biology teachers' experiences, including their preparation for laboratory work, the duration of laboratory work, experiences following laboratory work and benefits derived from the work were investigated and methods of optimizing laboratory conditions were identified by observing current situations. Participants comprised prospective biology teachers studying at Hacettepe University in the Department of Biology Education and registered in the General Chemistry Laboratory II course. The case study research design—a qualitative research method was utilized. The data for the research were collected through interview, observation and document analysis. The results obtained were evaluated by applying content analysis to assess data. Prospective biology teachers were found to have several different types of needs with respect to chemistry laboratory experiences.

Key words: chemistry laboratory, prospective teachers, qualitative case study, observation, interview, document analysis

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Introduction

The most distinctive feature of the natural sciences in comparison to other fields is that it enables experimental research, observation and inquiry and thus improves students' abilities to pose questions, develop research strategies, establish hypotheses regarding any subject and evaluate results (Odubunmi & Balogun, 1991). Science education has a significant function in educating individuals, who develop scientific attitudes through investigating, discussing,

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experimenting and constantly increasing their own knowledge about nature (Çilenti, 1985). Laboratory activities are of great importance and also an advantage in scientific fields (Azizoğlu & Uzuntiryaki, 2006; Beach & Stone, 1988; Hofstein & Lunetta, 2004; Lagowski, 1989; Lawson, 1995; Odubunmi & Balogun, 1991; Tanish, 1984; Tezcan & Günay, 2003; Tobin, 1990). Hofstein and Lunetta (2004) stated that laboratory work is the basis for the science education curriculum. In addition, they stated that it is useful for students to participate in learning events comprising laboratory activities. Tobin (1990) engaged in research on the effectiveness of learning and teaching in the science laboratory and noted that meaningful learning is possible only if students have opportunities to use appropriate equipment and materials to acquaint themselves with information regarding scientific events and concepts related with these events.

Laboratory practices are highly significant in the field of chemistry. Lagowski (1989) noted the importance of laboratory practice as the best way of teaching chemistry and indicated that providing information required for laboratory work improves learners' efficiency in experimentation. It is not possible to learn chemistry concepts, many of which are abstract, without laboratory experimentation; therefore, individuals can acquire the requisite skills only through education involving laboratory experimentation (Ayas, Karamustafaoğlu, Sevim, & Karamustafaoğlu, 2002). Further, laboratory work provides sensory, participatory experiences for students in chemistry courses. Students gain more pleasure by actively engaging in courses through experimenting, experiencing and observing, and the lessons they learn in this manner have a permanent impact (Akdeniz, Çepni, & Azar, 1998; Temel, Oral, & Avanoğlu, 2000). Laboratories are very important in terms of making abstract theoretical concepts concrete and understandable (Demirtaş, 2006). Therefore, laboratory experimentation is the focus of and complementary to science education, especially in chemistry. Thus, the importance of effective utilization of chemistry laboratories and laboratory courses for chemistry education is quite clear. In addition to providing scientific knowledge, laboratory courses also benefit students by facilitating scientific thinking and cultivating attention, positive attitude, satisfaction and a curiosity about science. They help students become more open minded and provide skills related to observation, creative thinking, interpretation, data collection and analysis, critical thinking, problem solving and decision making as well as psychomotor skills (Ausubel, 1968; Ayas, Akdeniz, & Çepni, 1994; Kaptan, 1998; Shulman & Tamir, 1973; Sweeney & Paradis, 2004). Thus, students' intellectual and practical skills arguably develop as a result of laboratory courses as does their skill in performing scientific processes.

Freedman (1997) observed that many factors affect the degree of students' success in laboratory work, such as the students' attitudes towards the laboratory, the number of students, teacher–student interaction, lab books, laboratory conditions and the teaching methods employed in laboratory education. Therefore, understanding how students perceive laboratory practices and laboratory courses as well as their thoughts regarding laboratory activities and the learning process are significant criteria for improving and revising laboratory activities. Demirci (1993) argued that success in science education can be achieved through an experimental method-based learning conducted by well-trained prospective teachers. As the laboratory experiences of prospective teachers will be crucial in their academic lives as well as for laboratory teaching in their professional lives, it is important to assess any anxiety and fear they might have towards the chemistry laboratory and eliminate any existing fallacies as well as correct any incomplete or incorrect techniques. According to the literature examined with regards to laboratory use, many studies have been conducted on the measurement of laboratory success, the implementation of various methods and techniques for laboratory practices and the attitudes towards laboratory experimentation (Adami, 2006; Aydoğdu, 2003; Choi, Hand, & Greenbowe, 2013; Cronholm, Höög, & Martenson, 2000; Giddings, Hofstein, & Lunetta, 1991; Hofstein & Lunetta, 1982, 2003; Karatay, Doğan, & Şahin, 2014; Kaya, 2008; Köseoğlu, Budak, & Kavak, 2000; Köseoğlu & Bayır, 2012; Reyes, España, & Belecina, 2014; Rollnick, Lubben, Lotz, & Dlamini, 2002).

In Turkey, prospective teachers studying in departments other than the chemistry education program in faculties of education, such as science, biology and physics, must opt for the chemistry laboratory course during their undergraduate study. Chemistry laboratory experiences are essential for providing prospective biology teachers with practical and psychomotor skills, such as knowledge about chemicals, preparation of solutions and working with labware, as well as personal and academic skills, such as scientific thinking, attention, creative thinking and problem solving. In addition, the laboratory experiences of prospective teachers will affect their laboratory use in their professional lives. Therefore, through examination of the chemistry laboratory experiences of current prospective biology teachers, it is important to reconsider the existing laboratory process and recommend new policies where necessary to improve the conditions for future prospective teachers. Few studies have evaluated the implementation and working conditions in chemistry labs for prospective chemistry and science teachers and students (Ayas et al., 2002; Borrmann, 2008; Karamustafaoğlu, 2000; Polles, 2006; Rigano & Ritchie, 1994; Yılmaz, Uludağ, & Morgil, 2001). However, no study has yet evaluated the chemistry laboratory experiences of prospective biology teachers. Thus, this study aims to fill this gap by examining the experiences of prospective biology teachers who opt for the general chemistry laboratory course during the two academic semesters in their first year at university. Further, it utilises this data to determine their needs related to chemistry laboratory experiences. In the scope of this study, the following problems are addressed:

1) What are the current experiences in the chemistry laboratory among prospective biology teachers? How do prospective biology teachers

A) prepare for chemistry laboratory activities?

B) conduct their experiments?

C) prepare reports after laboratory activities?

2) What are the challenges faced by prospective biology teachers in the laboratory?

3) What are their opinions about their chemistry laboratory experiences?

4) What are their opinions regarding an ideal chemistry laboratory?

5) What are the needs for chemistry laboratory experiences of prospective biology teachers?

Method

Research Model

In this study, ‘case study’ one of the qualitative research design was used for the investigation of chemistry laboratory experiences of prospective biology teachers, the components of their laboratory experiences and the meaning ascribed to their laboratory experiences. Case studies are a qualitative strategy in which the researcher conducts an in-depth exploration of a program, an event, an activity, a process or one or more individuals (Creswell, 2007). In education, case study research is conducted to identify and explain specific issues and problems regarding practice. Qualitative case studies in the field of education can be further defined by arranging them into categories or types based on disciplinary orientation, that is, whether the overall intent is to describe, interpret, or evaluate some phenomenon (Merriam, 1998). Because of its nature, the case study used this study is descriptive in nature and disciplinary oriented.

Study Group

The participants in this study comprised 14 prospective teachers studying at the Department of Biology Education, Hacettepe University, enrolled in the course 'General Chemistry Laboratory II'. An easily accessible case sampling method of purposeful sampling was used. One of the researchers was assigned as a chemistry laboratory assistant. Purposeful sampling allows for the detailed investigation of cases considered to be rich in information (Patton, 2002).

Observations were limited to 14 students performing experiments in the chemistry laboratory in which the researcher assisted. The number of participants is relatively as small for case studies as in many qualitative research methods. This condition is the result of being detailed and in-depth research method feature of case study (Yıldırım & Şimşek, 2011). Though a small number of people participated in this study, the data obtained were greater in amount and detail. Qualitative research does not aim to generalize but rather to investigate particular content in depth and in detail (Bogdan & Biklen, 1982). Documents written by five prospective teachers were examined in the document analysis. Interviews were conducted with four individuals; two female and two male were chosen from the individuals observed. Participation was voluntary. The demographic characteristics of four prospective teachers are given in Table 1.

Table 1 Demographic Characteristics of Interviewees

	Type of school graduated	Field of study	Post-graduation preference for the career choice of teaching	Feelings expressed regarding chemistry laboratory course
Prospective teacher 1	Anatolian high school	Biology and genetics	No	Enjoyable course, entertaining
Prospective teacher 2	Regular high school	Biology	No (academic work preferred)	Entertaining
Prospective teacher 3	Anatolian high school	Chemistry and biology	Yes	Neither 'like' nor 'dislike' (neutral): 'like' due to the familiarity with chemistry and 'dislike' due to the fear of failure
Prospective teacher 4	Regular high school	Biology	Yes	'Like' except for quizzes; 'like' dealing with materials

Procedures of the Chemistry Laboratory Course

Prospective biology teachers take General Chemistry I–II and General Chemistry Laboratory I–II as their classes of university in the first two academic semesters. They opt for Chemistry Laboratory I in the fall semester and Chemistry Laboratory II in the spring semester. This research was conducted during the Chemistry Laboratory II course. These laboratories are traditional and are held for two hours per week, during which students perform expository experimentation. Prospective teachers taking these courses performed the following experiments: the effect of temperature on reaction rates, chemical equilibrium, pH and pOH, acid–base titrations, the determination of iron (II) by redox titration, copper plating by electrolysis and preparation of soap.

The prospective teachers familiarized themselves with the experiment before conducting it during laboratory hours. They were required to prepare for the experiment; the lecturer assigned quizzes to determine their pre-laboratory readiness levels. If their scores were acceptable, they were allowed to perform the experiment. The quizzes addressed theoretical knowledge and knowledge about the experiment, materials and definitions. Those who failed had to conduct the experiment during another week of the course (generally during the last week of the semester). Laboratory classes observed the following procedures: prepare for the experiment, perform the experiment and perform activities after the experiment. After laboratory activities, students compiled laboratory reports, which detailed the name and objective of the experiment, materials, procedure of the experiment, theoretical knowledge, data, results and answers to questions from the lab instruction sheet. The research problems in this study were framed by considering all dimensions of laboratory activities.

Data Collection

Observation, interview and document analysis were used as the methods of data collection. An observation form was prepared by the researchers before the investigation, and the final version of the form was designed after obtaining experts' opinions and finalized with input from experts. Unstructured field research was one of the observation techniques used in this study. This study was performed in a natural environment using the participant observation method, in which the researcher participated in the social situation under observation (Fraenkel & Wallen, 2006). In this study, participant observation was conducted by the researcher working as the laboratory assistant. Two experiments (four hours) were observed during the two laboratory courses. Besides taking notes, the investigation period was recorded using a video camera during a laboratory period with the permission of the prospective teachers to ensure that the data obtained through observation was more detailed, to facilitate an in-depth examination of the event observed and to avoid overlooking issues that require careful consideration.

Interviews were conducted with the aim of obtaining depth and different perspectives in the data obtained and acquiring varied, new information. Before conducting interviews, an interview form was prepared to obtain the prospective teachers' opinions. It comprised 29 questions, including alternative questions and probes for five sub-problems. In addition, pilot tests were conducted during the preparation of the interview form; a high priority was given to the questions' comprehensibility and alternatives to necessary questions. Probes for almost every question were written, and additions and corrections were made; the final version of the form was confirmed after consultation with an expert. Using the final form, interviews were conducted with the four prospective teachers. Each interview was recorded with a voice recorder with permission of the participants. All records were then decoded by the researcher using a computer, and records relating to each participant were converted into document form and aligned according to content analysis.

The document analysis method was used to determine the differences in opinions expressed by prospective teachers in the written document. Related, similar expressions were collected using a different data collection tool as were the opinions of prospective teachers not participating in interviews in written form. Therefore, utilization of different data collection methods also served to triangulate the data in terms of data collection and analysis. For document analysis, prospective teachers were requested to maintain a diary regarding their laboratory experiences. In the instructions related to the diary, prospective teachers were asked to write about their chemistry laboratory experiences and consider the stages of preparation for laboratory, process of conducting the experiment, security measures taken, difficulties encountered and experiences after the experiments. They were also asked to describe the importance of the chemistry laboratory and their ideas regarding an ideal chemistry laboratory.

Data Analysis

Data collected by the researchers via observation, interviews and document analysis were subjected to content analysis. Content analysis is a systematic technique and an analysis of the contents of a communication (Fraenkel & Wallen, 2006). It refers to any qualitative data reduction and sense-making effort that considers a volume of qualitative material and attempts to identify core consistencies and meanings (Patton, 2002).

First, the recorded one-on-one interviews were completely transcribed and analyzed with respect to code, categories and themes based on the sub-problems clarified in the interview form and interview questions. The data were then tabulated. The information noted on the observation forms and the data recorded by camera were analyzed according to the codes specified on the observation form. Further, the compliance of results of the analysis was obtained, and the findings were supported with related results. The diaries (documents) maintained by the prospective teachers were also subjected to content analysis and coded. Specified codes were combined, under which themes and identified sub-themes were determined through content analysis of the interviews. The themes and codes identified via interview were compared with those identified as a result of document and observation analysis; this comparison revealed consistency in the results. When the research problems, interview forms, observation forms and contents of the daily diaries were examined, the findings obtained from the form for specified research problems corresponded with each other. This outcome is important for ensuring data triangulation for research analysis, employing varied data collection tools in order to address all related sub-problems and strengthening the validity of the study.

Results

This section presents the findings obtained from the content analysis of the interviews, observation and documents in the context of the research problems of this study.

Answers to all problems were obtained via interviews. Answers for sub-problems 1B and 2 were obtained via observation, and answers to sub-problems 1A, 1B, 2, 3 and 4 were obtained through document review. The sub-problems under problem 5 were answered based on the findings of the case study. The results were described in the interview analysis results by including the results of related observations and document analysis.

Themes associated with the analysis of data, categories and codes are detailed in Tables 2, 3, 4, 5, 6, 7, 8 and 9. Codes that are mentioned only once are not assigned a number in the tables. Findings are presented according to themes identified as a result of the data analysis.

With regard to *the first research problem of the study, the current condition for chemistry laboratory experiences of prospective biology teachers for chemistry laboratory experiences* were under three themes (1A, 1B and 1C) examined.

1A) Prospective Biology Teachers' Preparations for Chemistry Laboratory

After transcription and content analysis of related interview questions and document analysis of data for the first sub-problem, results for *prospective biology teachers' preparations for chemistry laboratory* were grouped into four categories. In Table 2, for *sections studied in preparation for laboratory course,* it was observed that 50% of the prospective biology teachers studied the sections on the materials and experimental procedures, the name of the experiment as well as its aim, definitions, theoretical knowledge, the types of chemicals used, related quizzes and the safety precautions to be taken during the experiment. Document analysis clearly supported the interview data findings stating that the prospective teachers had studied the experiment's procedure and its aims.

Table 2 Theme: Prospective Biology Teachers' Preparations for Chemistry Laboratory

Sections studied in preparation for laboratory course		Sources used for laboratory preparation/studying		Reasons for not learning/missing subjects during preparation		Learning/studying methods for laboratory preparation	
Word–word groups (codes)							
	f		f		f		f
•Materials	2	•Course book	3	•Unfamiliar with related subjects/unable to correlate	2	•Learning via sequential thinking	2
•Check over chemicals		•Laboratory instruction sheet	3	•Skipping related parts		•Learning via understanding	
•Precautions to be taken		•Internet	2	•Not studying		•Indicating the things stuck in his/her mind	
•Related to theoretical knowledge				•Not interpreting		•Searching	
•Experiment	2			•Not rationalizing		•Summarizing/writing	
• Quiz				•Not searching		•Equating to cooking	
•Name of experiment				•Waiting for the teacher		•Highlighting the important parts	
•Aim of experiment				•Not understanding the experiment		•Imagining how it will happen/visualisation	3
•Definitions				•Not paying attention		•Trying to understand the experiment	
						•Reading the lab instruction sheet	4
						•Reading the experiment text	
						•Memorising	
						•Reading regarding how to experiment	
						•Not memorising	2
						•Plotting (drawing)	

It was determined that for *sources used for laboratory preparation/studying*, 75% of the prospective teachers utilised the course book, 75% of them utilised the laboratory instruction sheet and 50% of them used the internet.

For *reasons for not learning/missing subjects during preparation*, 50% of the prospective teachers did not know the subject or understand the relationship between terms. Further, they stated that the reasons for not studying included that they did not understand the experiment procedure, were waiting for a demonstration of the experiment from the teacher, had not researched and were unable to draw correlations.

Although *learning/studying methods for laboratory preparation* is not under the scope of the sub-problems of this research, it was included as a category because of the orientation of answers given by prospective teachers during research period. Answers indicated that 100% of the prospective biology teachers prepared by reading the laboratory instruction sheet, 75% by visualisation and 50% by sequential thinking without memorisation. In addition, they studied by highlighting the main points, plotting (drawing) and memorising. These findings corroborate the results obtained through document analysis. Twenty percent of those maintaining the diary studied by memorisation as well as imagination/visualisation as stated in their interviews. They also utilised the note-taking and reading methods.

1B) Prospective Biology Teachers' Experiences in the Chemistry Laboratory

Results obtained via observation and document analysis data for the second sub-problem, *prospective biology teachers' experiences in the chemistry laboratory* were classified into five categories. In Table 3, for *preparation before the experiment*, 100% of the prospective teachers wore lab coats and gloves, 50% tied back their hair and 50% located the right materials for the experiment. In addition to the preparatory process, they reported that they enquired regarding the chemicals to be used, prepared a notebook and pen and cleaned the laboratory materials to be used in the experiment. With regards to document analysis, 60% of the prospective teachers wore lab coats and gloves before the experiments. It was observed that prospective teachers wore lab coats and gloves but did not tie their hair.

In the category of *preferences/opinions regarding working with friends or individually*, all prospective teachers dwelled on the advantages and disadvantages of working in the laboratory in groups or alone; however, they had no definite preferences.

For *activities performed after the experiment*, 100% of the prospective teachers cleaned the materials used, 75% cleaned the work area, 50% bottled the waste chemicals and cleared the materials used and 25% prepared the data obtained in the lab. Document analysis showed that 40% of the prospective teachers delivered the data. Observations made after the completion of the experiment revealed that all prospective teachers cleaned the work area and cleared away used materials.

For *prospective teachers' opinions regarding laboratory assistants*, participants compared assistants to teachers, commanding officers, assistants or siblings and described them as instructive, helpful, aiding preparation, leading, providing tips and friendly. Document analysis showed that research assistants were role models for prospective teachers.

Table 3 Theme: Prospective Biology Teachers' Experiences in the Chemistry Laboratory

<table>
<tr><th colspan="2">Preparation before the experiment</th><th colspan="4">Preferences/opinions regarding individual experiments</th><th colspan="4">Preferences /opinions regarding working with a friend or group</th><th colspan="2">Activities performed after the experiment</th><th colspan="2">Opinions regarding laboratory assistants</th></tr>
<tr><td colspan="14">Word-word groups (codes)</td></tr>
<tr><td></td><td>f</td><td colspan="3"></td><td>f</td><td colspan="3"></td><td>f</td><td></td><td>f</td><td></td><td>f</td></tr>
<tr><td rowspan="5">•Wearing a lab coat
•Locating the right materials
•Wearing gloves
•Tying hair
•Wearing reading glasses
•Placing materials
•Getting a notebook and pencil
•Setting up the experiment
•Cleaning the materials to be used
•Acquiring the needed chemicals
•Enquiring whether anything is missing</td><td rowspan="5">4
2

4
2</td><td colspan="4">•Group friends are selfish
•Dominant personality
•Leadership qualities
•Inability related to group work
•Sufficient information available</td><td colspan="4">•Group friends are insightful
•Insufficient information available
•Help needed
•Experiment lengthy in duration</td><td rowspan="5">•Preparation of data
•Cleaning of materials
•Replacing materials after use
•Cleaning the places which were worked in
•Bottling waste chemicals</td><td rowspan="5">

4

2

3

2</td><td rowspan="5">•Teacher/educator
•Instructor
•Helpful person
•The person who prepares
•The person who teaches
•Commander
•Leader
•The person who acts close/intimate
•Helpers
•The person who gives tips
•The person who completing lacks
•Closer than teachers
•Brother/sister
•Sensible
•The person who does not hold off</td><td rowspan="5">
2
3

2

2</td></tr>
<tr><td colspan="2">Advantages</td><td colspan="2">Disadvantages</td><td colspan="2">Advantages</td><td colspan="2">Disadvantages</td></tr>
<tr><td colspan="8">Word-word groups (codes)</td></tr>
<tr><td></td><td>f</td><td></td><td>f</td><td></td><td>f</td><td></td><td>f</td></tr>
<tr><td>•Take responsibility
•Retain control
•Obligation to know subject
•Less confidence among friends
•Learning
•Manipulative skills</td><td></td><td>•Having difficulty when in need of help</td><td></td><td>•Getting help for difficult experiments
•Socialisation
•Group work
•Enjoyable
•Learning by observation</td><td></td><td>•Problems with friends
•Somebody to do that
•Lack of sharing/decentralisation
•Thoughts of not learning
• Distracting conversations</td><td>
2

2</td></tr>
</table>

1C) Prospective Biology Teachers' Report Preparation Processes

Replies obtained for *prospective biology teachers' report preparation processes* belonged to seven categories. In Table 4, for *opinions on the necessity of preparing a report*, 50% of the prospective teachers considered it absolutely necessary, 25% of them considered it necessary and the other 25% considered it least necessary. Fifty percent of the prospective teachers indicated that report preparation was necessary so that the instructor could know what students were doing in their experiments and in the laboratory course; they also considered it necessary to enable them to internalise the subject matter of the experiment.

For *report preparation methods*, they stated that they prepared their reports by writing the name of the experiment (50%), the aim of the experiment (50%), materials used (50%), the procedure (50%), theoretical knowledge (75%) and comments (75%).

For *difficulties encountered in preparing the report*, 100% of the prospective teachers reported having difficulties regarding the calculations for the experiment. Other difficulties were with regards to understanding the theoretical background of the experiment performed, answering the related questions and finding the right information about the experiment.

Each prospective teacher explained the *reasons for difficulties in preparing the report* in a different way. Responses included not listening to the tips given to them, not interpreting ideas from the explanations, not researching, lack of resources, not having information about the subject and not understanding the subject. For the *sources or people who helped in report preparation*, 75% of the respondents listed friends, 50% listed teachers and 25% listed the internet or nobody.

In relation to *sources used in report preparation*, 100% of the prospective teachers reported using the internet, 50% used the textbook, 75% used the lab instruction sheet and 25% utilised books from the library and consulted with friends studying in the chemistry department. In relation to *with whom the report was prepared and why*, 100% of the prospective teachers stated that they prepared their reports individually as this allowed for a more comfortable learning environment and that they preferred not relying on someone else's knowledge. They also indicated a preference for being individually responsible for reporting, a dislike of group work and a preference for preparation outside of school and for individual learning.

Table 4 Theme: Prospective Biology Teachers' Report Preparation Processes

Opinions on the necessity of preparing a report	f	Report preparation methods	f	Difficulties encountered in preparing the report	f	Reasons for difficulties in preparing the report	f	Sources or people who helped in report preparation	f	Sources used in report preparation	f	With whom the report was prepared and why	f
Word-word groups (codes)													
•Absolutely necessary	2	•Name of the experiment	2	•Sourcing theoretical knowledge		•Not listening to tips given		•Friend	3	•Laboratory instruction sheet	3	•Individually	4
•To indicate what the student is doing	2	•Aim of the experiment	2	•Calculations	4	•Inability to make inferences from descriptions		•Teacher (instructor)	2	•Textbook	2	•To learn	
•To remember the subject		•Materials used	2	•Answering questions		•Not studying		•Internet		•Internet	4	•Comfortable working	
•To internalize the subject	2	•Procedure	2	•Finding the right information		•Lack of resources		•Nobody		•Books in the library		•Not relying on someone else's knowledge	
•To provide visual evidence		•Theoretical knowledge	3			•Not possessing information about the subject				•Consulting with friends in the chemistry department		•Different preparation style	
•To encourage persistence		•Comments	3			•Not understanding the subject						•Prepared with attention	
•Least necessary		•Seeking answers to the questions										•Dislike of group work	
•Theoretical knowledge gaps hinder report		•Recording the experiment										•No communication with friends in the group	
•To answer the questions		•Reading the laboratory manual										•Easier	
•Necessary		•Solving questions										•Preparation out of school	
•To correct mistakes												•Not to be confused	
•To prepare for exams													

In relation to the second research problem, *difficulties encountered in the laboratory environment* were grouped into four categories (Table 5) after transcription and content analysis of the related questions from the interview, observations and document analysis data.

Table 5 Theme: Difficulties Encountered in the Laboratory Environment

Difficulties encountered during the experiment		Fear/anxiety factors in the laboratory		Difficulties experienced in using materials		Potential dangers in the laboratory	
Word–word groups (codes)							
	f		f		f		f
•Excitability		•Destroying equipment		•Unaware of the purpose of use		•Explosion	
•Idea of inability to conduct experiment		•Breaking equipment		•Unaware of alternative materials		•Disruption of the skin	2
•Uncoordinated movement of hands/arms	2	•Burning		•Regarding transfer of chemicals		•Splashing of dangerous chemicals	
•Not understanding		•Falling				•Injury	
•Lack of concentration		•Being involved in accidents				•Burns	2
•Confusion related to materials		•Failing the course				•Falling	
•Not knowing the amount of materials to be utilised		•Incorrect experimentation				•Being hurt by broken glass	
		•Being unsuccessful in achieving result				•Breaking of glass	
		•Being hurt by glass				•Boiling flush/splash	
		•Contact with hazardous chemicals					
		•Splashing of chemicals					
		•Dropping materials to the floor					

Regarding *difficulties encountered during the experiment*, 50% of the prospective teachers reported coordination problems with their hands/arms as well as problems related to understanding, confusion regarding the materials to be used and difficulties in determining the amount of material to be used. Document analysis showed results similar to those of interviews. Prospective teachers indicated that they experienced difficulties such as nervousness and lack of manual coordination in the laboratory. Observation showed that the prospective teachers experienced difficulties in setting up their experiments.

Regarding *fear/anxiety factors in the laboratory*, prospective teachers cited anxiety and fear of breaking laboratory equipment, being burned, falling, experiencing accidents, failing, making mistakes during the experiment and failing to obtain results, being injured by glass, contact with hazardous chemicals, chemical splashes and dropping the materials. Document analysis showed that they feared failing quizzes, being unable to achieve results, breaking materials and having accidents. Further, observation showed that they feared being burned, being unable to get results and being unaware of what to do in the case of failure.

For *difficulties experienced in using materials*, prospective teachers experienced difficulties such as being unaware of the purpose for which the materials were used, being unaware of alternative materials that could be used and transferring chemicals. Document analysis showed that they had difficulties in knowing how to use the material and deciding which material was to be used. Observation showed that prospective teachers had difficulty recognising and locating materials.

For *potential dangers in the laboratory*, 50% of the prospective teachers feared skin irritation and burns from chemicals. Others feared blasts, injuries, falls, being cut by glass, being splashed by boiling liquids and hazardous chemicals. Document analysis indicated concern about the risk of chemical splashes during boiling or mixing, whereas observation revealed a risk of burning. For example, during the soap preparation experiment, the liquid phase mixture splashed while being poured. Interviews and documents describing the incident indicated that the prospective teachers panicked, were unaware of the steps to be taken and immediately informed the laboratory assistant on duty. The laboratory assistant moved the prospective teachers away from the heater, turned it off and put the beaker holding the fluid on an asbestos wire rack to cool.

For the third research problem, after transcription and content analysis of related interview questions from the interview and document analysis, *prospective biology teachers' opinions about their chemistry laboratory experiences* were classified under two themes (3A and 3B): *relationship between the chemistry laboratory and classroom courses* (3A) and *benefits of chemistry laboratory activities for prospective biology teachers* (3B).

The relationship between the chemistry laboratory and classroom courses (for prospective biology teachers) could be divided into four categories (Table 6). Table 6 shows that with regards to *the integration of classroom and laboratory chemistry courses*, 50% of the prospective teachers felt that the courses were integrated and progressed in parallel. In addition, they felt that the integration of the chemistry laboratory and classroom courses was helpful, interactive and logical. They also felt that subject matter should be discussed before relevant experiments, and thus, theoretical information about the related subject should be presented before performing experiments.

For *contribution of chemistry laboratory experiences to chemistry courses*, 75% of the prospective teachers characterised the chemistry laboratory as effective in helping them learn the subject matter. They specifically stated that performing calculations (50%), understanding the subject (75%), practising (50%) and making the subject matter concrete (50%) helped them learn chemistry laboratory subjects. In addition, they noted that laboratory experiences provided permanent learning and the opportunity to practice and gain problem-solving and comment-making skills.

Table 6 Theme: Relationship Between Chemistry Laboratory and Classroom Courses

Opinions regarding the integration of chemistry and chemical laboratory courses		Contribution of chemistry laboratory experiences to chemistry courses		Actions to be taken to develop an effective chemistry laboratory for chemistry learning		Methods used to understand chemistry subjects outside the chemistry laboratory	
Word–word groups (codes)							
	f		f		f		f
•Having integrity	2	•Effective	3	•Increase the class hours of chemistry courses		•Study from books	2
•Chemistry course must be conducted before the experiment chemistry		•Calculations	2	•The experiment–subject parallelization		•Problem solving	
•Subjects handled before laboratory	2	•Understanding the subject	3	•Larger laboratory		•Memorisation	
•Logical		•Permanent learning		•Improvement of physical conditions		•Studying for the exam	
•Similar to jigsaw pieces	2	•Providing visuals		•Laboratory sensation		•Studying from notebook	
•Parallel continuity		•Integration		•Increase the number of sections		•Studying the laboratory instruction sheet	
•Helpful		•Reinforcement		•Comfortable working environment		•Study of data	
•Interactive		•Practicing	2	•Reduction in crowd		•Study of calculations	
•Ease of experimentation		•Not only theoretical				•Internet research	
•Convenience in understanding the subject		•Embody	2				
		•Observation					
		•Understanding the cause					
		•Comment					
		•Transfer of information					
		•Problem solving					
		•Learning through practice					

For *actions to be taken to develop an effective chemistry laboratory for chemistry learning*, prospective teachers cited a need for increased chemistry course hours, coordination between experiments and the course subject matter, a bigger laboratory, an increased number of sections and smaller class sizes. Document analysis confirmed the necessity of an effective laboratory environment for effective learning.

For *methods used to understand chemistry subjects outside the chemistry laboratory*, 50% of the prospective teachers reported studying from books and solving problems individually, memorisation, studying for exams using the course notebook, using the laboratory instruction sheet, data and calculations and internet research.

Benefits of chemistry laboratory activities for prospective biology teachers fell into two categories (Table 7).

Table 7 Theme: Benefits of Chemistry Laboratory Activities for Prospective Biology Teachers

Opinions regarding benefits of the laboratory for prospective teachers' knowledge and skills		Opinions regarding benefits of the laboratory for prospective teachers' professional life	
Word–word groups (codes)			
	f		f
•To gain manipulative skills •Permanent learning •To gain experience/ability to experiment •To gain an idea about the laboratory •Recognition of the materials •Learning security measures •Analytical thinking •To gain planning/Programming skills •To gain scientific process skills •To provide the reinforcement of subject •Contribution to wish of academic/scientific study •General culture	3 2 2	•No contribution to biology education •Important contribution to studies other than biology •Not to be sure •Not to perform about deficiencies observed •For conducting experiments (only in the position of a science teacher) •Only if they acquire the position of a chemistry teacher in the place assigned •Due to the proximity of biology and chemistry	

For *the benefits of the laboratory for prospective teachers' knowledge and skills*, 75% of the prospective teachers reported that laboratory work provided permanent learning, 50% stated that it provided the ability to experiment and gain experience and 50% stated that it contributed to the general culture. In addition, they reported that it provided individual familiarity with the materials and aided acquisition of skills related to analytical thinking, planning and programming, scientific processing as well as psychomotor skills and subject matter reinforcement.

Regarding the analysis of opinions on *the benefits of the laboratory for their professional lives*, the prospective teachers cited the contribution of laboratory work as not doing deficiencies in the laboratory generally and that it may have benefits beyond the scope of biology education. Document analysis results, the idea, which was not included within the opinions of prospective teacher, showed that laboratory experiences encourage students to study scientific research, to protect their school laboratories and to develop the laboratories to enable better contribution to teachers' professional lives.

Regarding the fourth research problem, *the prospective biology teachers' ideal laboratory environment* fell into five categories (Table 8).

For *prospective teachers' opinions regarding the chemistry laboratory environment*, 100% of the prospective teachers perceived the chemistry laboratory environment as enjoyable. In addition, 50% described the atmosphere as good. The laboratory environment was also described as challenging, active and crowded. Document analysis indicated that participants described the environment as enjoyable as well as boring.

Table 8 Theme: Prospective Teachers' Ideal Laboratory Environment

Opinions regarding chemistry laboratory environment	f	Opinions regarding the ideal chemistry laboratory environment	f	Issues to be added/addressed for laboratory activities.	f	Assessment of all aspects of chemistry laboratory experiences	f	Opinions regarding the functioning of an ideal chemistry laboratory	f
Word–word groups (codes)									
•Good	2	•Larger facilities	3	•Information about chemicals		•Without chaos		•Should include individual follow up during experimentation	
•Plenty of material		•With personnel areas/divisional		•Correlating chemical with daily life		•Informative		•Should rely on student/student truth	
•Enjoyable	4	•Individual working fields		•Information about materials		•Necessary	2	•Trust for student	
•'Like' the course		•More secure		•Not memorization		•Should be learned		•Bring into student truth	
•Negative in terms of class mates		•Science building		•Demonstration experiment		•Learned at the end		•Explanation	
•Challenging		•Laboratories in a single building	2	•Create interest		•Problem on daily life correlation		•Material information	
•Effective in training of scientists		•More opportunities		•Crowded		•Organizing		•No quizzes	
•Effective learning		•Security-related equipment				•Providing discipline		•Chemicals information	
•Feeling as if not in a laboratory		•Better physical conditions				•Providing to be planned and programmed		•Correlation of chemicals–daily life	
•Crowded		•Not crowded				•Application		•Security measures with chemical information	
•Active						•Observation		•Effective individuality	2
						•Widen scientific perspective		•Considering individual characteristic/preferences	2
						•Experienced		•Demonstration experiment	2
						•Experience transferred to real life			
						•Enjoyable			
						•Fond memories			
						•Good			
						•Specific acquisitions			
						•Good operation			
						•Clean			
						•Enough material			
						•Active role			
						•Delightful			

Regarding *the ideal chemistry laboratory environment*, 75% of the prospective teachers said that laboratory facilities should be larger, and 50% stated that the laboratories should be in a single building. They also asserted that the ideal laboratory environment should be more secure, should be better equipped in terms of security and have individual study areas. Moreover, it should not be crowded. Document analysis indicated that all the prospective teachers opined that the ideal laboratory environment should be more spacious and allow longer working times for the purpose of studying.

Each prospective teacher expressed different ideas regarding *the issues to be added/addressed for laboratory activities*. They suggested sharing of information about the materials and chemicals used, correlating chemicals to everyday life and demonstrating experiments and laboratory work with fewer people in a less crowded environment. Consistent with the interview data, document analysis showed that prospective teachers would prefer to perform laboratory experiments with fewer people around and to understand the correlation between the experiment's subject matter and daily life.

For *assessment of all aspects of chemistry laboratory experiences*, 50% of the prospective teachers asserted the necessity of laboratory practice. They also described the laboratory experiences as organised, informative, an opportunity to observe and practice, a chance for playing an active role and an environment for making certain gains in knowledge.

Regarding *the functioning of an ideal chemistry laboratory*, 50% of the prospective teachers stated that laboratory activities should consider individual differences and that demonstration of the experiments should be provided during the laboratory course. They characterised the ideal laboratory environment as one excluding quizzes, providing detailed information regarding the uses and manner of use of chemicals and accommodative of individual preferences and safety. In contrast to interviews, document analysis presented suggestions for laboratory teaching styles to be developed and presentations to aid in understanding the logic of the laboratory activities.

Table 9 shows the results of assessment and examination for the fifth research problem, *prospective biology teachers' needs for chemistry laboratory experiences*, which was divided into two categories: *needs related to the physical conditions of the chemistry laboratory* and *content and organisational needs related to the chemistry laboratory*.

Table 9 Prospective Biology Teachers' Needs for Chemistry Laboratory Experiences

Needs related to the physical conditions of the chemistry laboratory	Content and organisational needs related to the chemistry laboratory
•More spacious laboratory environment •Individually comfortable working environment •Personnel area to work comfortably •Security-related equipment •All laboratories in a single building •Sense of belonging	•Co-ordination between chemistry course and experiment subject •Theoretical base before experiment •Increasing the number chemistry course class hours •Increasing the number of sections of the classroom •Less crowded sections of the classroom •Solution for lack of source during report preparation •Keeping informed regarding chemicals and materials used •Explaining the correlation of chemicals used with daily life •Alternative teaching methods requiring no memorisation •Demonstration experiments •Individual follow-up during experimenting •No quizzes: rely on student/student truth •Explanation of security measures before using chemicals •Regarding personal preferences •Development of learning styles for laboratory applications •Providing comprehension of the logic behind the experiment (application) •Increasing the number of laboratory class hours

For *needs related to the physical conditions of the chemistry laboratory*, prospective biology teachers indicated a need for a more spacious laboratory environment, an individually comfortable working environment. For *content and organizational needs related to the chemistry laboratory,* prospective teachers expressed a need for coordination of classroom courses and experimental subject matter, explanations of how chemicals are used in daily life and an increased number of laboratory class hours. They also indicated a need for alternative teaching methods which do not require memorization.

Reliability and Validity of the Study

In order to ensure the validity and reliability of the study, diversification and interpretation of the analyses were ensured through both triangulation of data collection instruments (observations, interviews and documents) and analysis of the data in these three dimensions (observation, interviews and document analysis). With respect to the reliability of the study, as the researcher was also an observer, all processes in the laboratory were recorded with a camera and audio recording tool during the interviews to ensure accurate and complete observation. In addition, to increase internal validity, some methods and forms were designed with input from expert consultants, and expert reviews were engaged for data analysis of the interviews. The similarities and differences in the coding conducted by two coders were compared and inter-rater reliability was calculated at 96%. The formula suggested by Miles and Huberman (1994) was applied to measure inter-rater reliability (r = [number of agreements / total number of agreements + disagreements] × 100). Qualitative research should reach a confidence level of at least 70% or 80% (Fraenkel & Wallen, 2006; Lombard, Snyder-Duch, & Bracken, 2002; Miles & Huberman, 1994; Yıldırım & Şimşek, 2011). This process also increases the reliability of the results. The results were shown to agree with the data analysis. Therefore, the internal reliability (consistency) of the study also increased. To increase the external reliability of the study, the entire process (research model, study group, demographic characteristics of interviewee, data collection tools and data analyzed) were explained in detail. With regards to internal validity, the results were found to be consistent and significant in themselves. In addition, they were found to be sufficient for ensuring the external validity of the study, the characteristics of the sample, environment and process were explained and described in detail.

Discussion and Conclusion

The objective of this study was to investigate the chemistry laboratory experiences of prospective biology teacher opting for a chemistry laboratory course during the first two academic semesters of their university studies. Results were obtained by the analysis of data collected via interviews, observation and related documents.

Sub-problem 1A examined prospective teachers' experiences before laboratory work. Because of pre-laboratory quizzes, prospective teachers studied the related subject matter and the experiments' objectives, procedures, chemicals and theoretical background before attending the laboratory class every week. Though the prospective teachers responded negatively to the pre-laboratory quizzes, these quizzes positively affected their performance. Many studies have shown that pre-laboratory exercises and quizzes increase understanding and positively impact students' performance (Deacon & Hajek, 2011; Johnstone, Watt, & Zaman, 1998; Reid & Shah, 2007). Prospective biology teachers developed their own study methods for laboratory work preparation; these methods included memorising, step-wise study without memorisation, plotting (drawing) and visualisation. They reported primarily using the lab instruction sheet, course book and internet for preparation. Sources used other than the internet were limited to those recommended by the course instructor. Ayas et al. (2002) reported that 69% of prospective science teachers utilised the lab instruction sheet, and

9% of them utilised other chemistry source books to prepare for chemistry laboratory practice. When they could not relate the theoretical concepts to the experiment to be performed and lacked any background on the subject matter, they were unable to relate the experiment to the area of chemistry being studied. According to several authors, during students' preparation for laboratory work, inconsistencies between the course and laboratory topics affected their performance in the laboratory (Deacon & Hajek, 2011; Hanif, Sneddon, Al-Ahmadi, & Reid, 2009). For sub-problem 1B, prospective teachers were found to have learned safety precautions at the beginning of the laboratory period, and before starting the experiment, they exhibited behaviours such as wearing lab coats and gloves, cleaning the materials to be used, arranging the chemicals, bottling waste chemicals after the experiment, washing the materials after use and storing them, cleaning their workplaces and delivering the data obtained. Results obtained were consistent with both the prospective teachers' own statements (interview data) and the results of document analysis and observation. These findings also indicated that the prospective teachers performed as per the instructions received at the beginning of the class. For sub-problem 1C, the prospective teachers reported that it was important to teach students how to report an experiment (i.e. writing an experiment report) for monitoring students, soliciting feedback to determine if the correct information was conveyed and providing writing opportunities to help students internalise new knowledge. Sources used for preparation were generally lab instruction sheets, textbooks and the internet. Ayas et al. (2002) reported that 53% of the prospective science teachers stated that compiling a report after performing the experiment effectively aided the comprehension of the experiments, which is consistent with the data obtained.

For the second problem, the prospective teachers indicated difficulties in recognising and locating the materials to be used in the laboratory, fears about possible dangers such as burns, explosions and disruptions and worries about failure during the experiment. Ayas et al. (2002) reported that 48% of the prospective science teachers had difficulties in setting up experiments and understanding the working principles of some of the tools and equipment used in experiment. The third problem aimed to identify prospective biology teachers' opinions about their chemistry laboratory experiences. Examination of these opinions fell into two sub-themes: the importance of the chemistry laboratory for prospective biology teachers and prospective teachers' opinions about the personal benefits of laboratory work. Regarding the importance of the chemistry laboratory for prospective biology teachers, the prospective teachers reported ease in understanding when the classroom chemistry course and laboratory course ran parallel. They also reported that such coordination between classroom and laboratory material resulted in permanent learning by making the classroom material concrete. However, they reported difficulty in understanding the material and conducting experiments when there was no coordination between the course and the laboratory material. Thus, they considered it necessary to learn the relevant subject matter before the experiment. Feyzioğlu et al. (2011) reported that it is unthinkable to separate laboratory work from background courses, and indeed, if necessary, specific courses should be coordinated with laboratory activities. When evaluating and identifying the personal benefits of laboratory work, prospective teachers cited permanent learning, practice, experience, observation, learning to be organised, learning to plan and analytical thinking skills. They expressed few opinions regarding the benefits of the chemical laboratory for their future professional lives. They believed it could be useful if they obtained employment in areas other than biology. Document analysis revealed that one of the prospective teachers stated that she would protect the school laboratory to which she was assigned. She further stated that she would consider the laboratory important and make an effort to develop it. Previous research indicated that teachers who did not garner regular laboratory experience during their university studies were uninterested in laboratory activities (Değirmençay, 2000; Üstüner, Ersoy, & Sancar, 2000). Thus, it is significantly clear that prospective teachers should possess knowledge and experiences in laboratory work regardless of their chosen field. For the fourth problem, prospective teachers expressed their opinions regarding an ideal chemistry laboratory. First, they emphasized that a small and crowded laboratory environment was undesirable. Cheung (2007) stated that a crowded space affects laboratory work. Further, prospective teachers stated that there should be a separate building for laboratories and that all scientific research should be carried out in these laboratories. They also expressed a dislike for quizzes and proposed demonstration of experiments to engage their interest. Other features proposed were a teaching style to enable learning without memorization and teaching centred on understanding the logic of the lesson. Hofstein and Lunetta (2004) reported that instructional strategies and sources should be developed and evaluated to increase the effectiveness of science education, and these strategies and sources should accommodate students' differing abilities, learning styles, motivations and cultural structures.

In light of these findings, prospective biology teachers were satisfied with the overall laboratory process, appeared to find the course enjoyable and learned what they were taught. No difference based on demographic characteristics was found in the prospective teachers' opinions about chemistry laboratory. However, the findings for the last (fifth) problem regarding the laboratory experiences of prospective biology teachers indicated several needs related to the chemistry laboratory experience, the physical conditions of laboratory and content and applications of the chemistry laboratory. Regarding the physical conditions of the chemistry laboratory, prospective teachers expressed a need for a more spacious laboratory environment, an individually comfortable working environment and an environment equipped to provide security. For the content and conduct of the chemistry laboratory, they expressed a need for chemistry courses coordinated with the experiments, increased hours for chemistry courses and laboratory work, more information about materials and chemicals used and the correlation of the chemicals used and daily life, accommodation of individual preferences and teaching methods emphasizing individuality. Newman (1982) argued that if laboratory courses are conducted in an enjoyable manner according to students' needs, students will inevitably succeed. Because prospective teachers' laboratory experiences will affect their laboratory use in their future professional lives, their learning experiences—even if unrelated to their chosen field—are important as is reconsideration of the existing laboratory process and new policies as required in order to ensure improved laboratory experiences and better laboratory conditions in the future for prospective teachers. Kavcar (2002) argued for qualified teaching in training faculties for teachers and noted the importance of training courses for professional experience. No detailed studies consistent with this study exist in the literature on the chemistry laboratory experiences of prospective biology teachers. Deacon and Hajek (2011) examined students' perceptions of the value of physics laboratories in terms of benefits, interest or enjoyment, relevance, difficulty and the friendliness of assistants, preparation titles their results were coherent with our results. Using the results obtained in this study, future studies that reconsider issues requiring reform and improvement in learning conditions will be conducted to ensure better training for prospective teachers. Such studies will consider reviews, criticism, opinions and comments obtained from prospective teachers. A quantitative dimension could be employed in future studies by developing a questionnaire using the findings of this research.

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Biyoloji Öğretmen Adaylarının Kimya Laboratuvar Yaşantıları: Bir Durum Çalışması

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Özet – Bu çalışmada biyoloji öğretmen adaylarının kimya laboratuvarı yaşantılarının değerlendirilmesi amaçlanmıştır. Bu bağlamda kimya laboratuvarına hazırlık, laboratuvarda geçirilen süreçler, yaşanan zorluklar, laboratuvar sonrası yaşantılarına ve laboratuvarın onlara katkılarına ilişkin sorulara yanıtlar aranmış ve laboratuvar koşullarının daha iyi duruma getirilmesi adına onlar tarafından değiştirilmesi istenen konularda bilgi alınmıştır. Çalışmaya Hacettepe Üniversitesi Biyoloji Eğitimi Anabilim Dalında okuyan ve Temel Kimya Laboratuvarı II dersine kayıtlı olan öğretmen adayları katılmıştır. Çalışmada nitel araştırma desenlerinden; durum çalışması araştırma deseni kullanılmıştır. Araştırmada veriler; görüşme, gözlem ve doküman inceleme yollarıyla toplanmıştır. Verilerin analizi için içerik analizi yapılarak, sonuçlar değerlendirilmiştir. Ayrıca biyoloji öğretmen adaylarının kimya laboratuvar yaşantılarına ilişkin ihtiyaçları da belirlenmiştir.

Anahtar kelimeler: kimya laboratuvarı, biyoloji öğretmen adayları, nitel durum çalışması, gözlem, görüşme, doküman inceleme

Geniş Özet

Giriş

Laboratuvar uygulamalarının hedefine ulaşmasında, öğrencilerin laboratuvara karşı tutumları, öğrenci sayısı, öğretmen-öğrenci etkileşimi, laboratuvar kitapları, laboratuvar şartları ve laboratuvar öğretiminde kullanılan yaklaşımlar gibi pek çok unsur etkili olmaktadır (Freedman,1997). Öğrencilerin laboratuvar uygulamalarını ve laboratuvar dersini nasıl algıladıklarının; yapılan etkinlikler ve süreç konusunda düşüncelerinin öğrenilmesi, laboratuvar uygulamalarının elde edilen veriler ışığında iyileştirilmesi ve yeniden düzenlenmesi açısından önem taşımaktadır. Demirci (1993), fen bilimleri eğitiminde başarının deneysel yönteme dayalı öğrenme ile sağlanabileceğini, ancak bunun alanlarında iyi yetişmiş öğretmenlerle gerçekleştirilebileceğini belirtmiştir. Bu nedenle öğretmen adaylarının geçirdikleri laboratuvar yaşantıları hem akademik yaşantılarında hem de özellikle meslek

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yaşantılarında laboratuvar kullanma süreçlerinde de etkili olacağından, öğretmen adaylarının kimya laboratuvarına yönelik düşünce, endişe ve korkularının belirlenip, var olan yanlış düşüncelerin ve yapılan eksik veya yanlış uygulamaların giderilebilmesi önemlidir. Bu bağlamda, çalışmada biyoloji öğretmen adaylarının geçirdikleri kimya laboratuvar yaşantılarını değerlendirmek ve elde edilen sonuçlar ışığında kimya laboratuvar yaşantılarına ilişkin ihtiyaçlarını belirlemek amaçlanmıştır.

Yöntem

Araştırma Modeli

Çalışmada biyoloji öğretmen adaylarının kimya laboratuvar yaşantılarını incelemek adına nitel araştırma desenlerinden 'durum çalışması' kullanılmıştır.

Çalışma Grubu

Çalışmaya Hacettepe Üniversitesi Biyoloji Eğitimi Anabilim Dalı'nda okuyan ve "Temel Kimya Laboratuvarı II" dersine kayıtlı olan 14 öğretmen adayı katılmıştır.

Verilerin Toplanması ve Analizi

Araştırmada veri toplama aracı olarak gözlem, görüşme ve doküman inceleme kullanılmıştır. Gözlem, görüşme ve doküman inceleme sonucunda toplanan veriler araştırmacılar tarafından içerik analizine tabi tutulmuştur. Verilerin içerik analizi sonucunda temalar, kategoriler ve kodlar belirlenmiştir.

Bulgular

Veriler; "kimya laboratuvarına hazırlık", "kimya laboratuvar deneyimleri","kimya laboratuvarı ve kimya dersi ilişkisi", "kimya laboratuvar aktivitelerinin biyoloji öğretmen adaylarına yararları", "biyoloji öğretmen adaylarının ideal bir kimya laboratuvarına ilişkin görüşleri" ve "biyoloji öğretmen adaylarının kimya laboratuvar yaşantılarına ilişkin ihtiyaçları" temaları altında incelenmiştir.

Sonuç ve Tartışma

Araştırma sonucunda biyoloji öğretmen adaylarının genel olarak laboratuvar sürecinden memnun oldukları, dersi eğlenceli buldukları ve konuları öğrendiklerini ifade ettikleri belirlenmiştir. Ayrıca öğretmen adaylarının kimya laboratuvar yaşantılarında, kimya laboratuvarı fiziksel şartlarına ve kimya laboratuvarı içerik ve uygulamalarına ilişkin ihtiyaçları olduğu belirlenmiştir. Bu çalışmadan elde edilen sonuçlar, öğrenme koşullarının iyileştirilmesi ve öğretmen adaylarına verilecek eğitimlerin düzenlenmesinde yol gösterici olacaktır.