Pre-service Teachers' Opinions and Visual Images About Science Laboratory[1]

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Abstract
The study aims to examine the opinions of pre-service classroom teachers about science laboratories. The research was conducted with 66 third-year students (50 female, 16 male) studying in the classroom teaching undergraduate program of a university in the fall semester of the 2019-2020 academic year. In selecting the participants, taking the "Science Laboratory Applications" course before their volunteerism was taken as a basis. The Drawing-writing technique was used as a data collection tool, and the data were analyzed by content analysis. According to the findings obtained, it was seen that the pre-service teachers mostly used laboratory tables and volumetric flasks in their laboratory drawings. Participants stated that there are mostly chemicals, microscopes and test tubes in the laboratory environment. Almost all pre-service classroom teachers thought that the greatest advantage of using laboratories in science is to embody scientific phenomena. In addition, some pre-service teachers thought that there is no disadvantage in using the laboratory, while some thought that there might be various accidents. According to the findings, it was concluded that the pre-service classroom teachers had a general knowledge of science laboratories and thought that using laboratories in science education would provide an advantage rather than a disadvantage.
Keywords: Laboratory, Science, Teacher training, Pre-service classroom teachers, Science laboratory, Visual images.

Introduction

Laboratories are defined as workplaces where a subject or a concept is presented to students individually or as a group and where teaching is done in different ways by using various materials and equipment (Bozkurt, 2018). This place can be a specific room in the school, or sometimes a museum, park, nature center, or even a school garden (McComas, 2014). There are many types of equipment, materials and tools in science laboratories established in certain places in the schools. Materials required in the laboratory can be classified as laboratory equipment, lab labware, mechanical materials, glassware, optical equipment, chemicals and paper materials (Şimşek, 2017). Science laboratories have many tools such as a pipette, burette, thermometer, test tube, beaker, volumetric flask, mortar, lab tripod, dynamometer, lenses, compass and microscope (Bozkurt, 2018). Equipment, tools and materials to be used in the laboratory should be cheap, instructive, multi-purpose, not easily perishable and suitable for learning objectives (Şimşek, 2017).

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Laboratories provide students with the opportunity to interact with the world directly using tools, data collection techniques and models (National Research Council [NRC], 2006). Laboratories are important in learning science subjects meaningfully and effectively and in permanent learning. Science laboratories enable students to embody abstract concepts. Science laboratories contribute students to work collaboratively, to develop problem-solving skills, psycho-motor skills, scientific process skills and positive attitude towards science, and to learn scientific methods (Arslan et al., 2011; Bozkurt, 2018; Şimşek, 2017).

Teachers have an important role in leading students' laboratory experience to support their learning (NRC, 2006). For the use of laboratories to be efficient and beneficial in science education, teachers should have a good command of the laboratory environment and the tools and equipment used. In this framework, pre-service classroom and science teachers, who will conduct primary and middle school science courses in the future, take various courses related to science laboratories. When the undergraduate program of classroom teaching is examined, it is seen that the "Science Laboratory Applications" course is included. Through this course, pre-service teachers will be able to specialize in the subjects such as the purpose and importance of the laboratory, safety in the laboratory, and conducting laboratory experiments (Council of Higher Education, 2018).

There are studies in the literature that examine perceptions, attitudes, self-efficacy and awareness of pre-service teachers about science laboratories. In studies examining the perceptions of pre-service classroom teachers regarding the science laboratory concept, it was stated that pre-service teachers generally described laboratories as an exploration environment (Gökbulak, Uzun, & Şenler, 2020; Ural & Başaran Uğur, 2018). In a study conducted with pre-service science teachers, it was determined that pre-service teachers referred to the science laboratory as a place to explore and produce new products (Arık & Benli Özdemir, 2016). In the studies investigating the knowledge of the pre-service classroom teachers about the tools and equipment used in the laboratory, it was found that they were knowledgeable about the frequently used equipment and microscopes. However, it was revealed that they had incomplete or incorrect information about some equipment (Harman, 2012). In another study conducted in earlier years, it was found that most of the pre-service classroom teachers could not know the laboratory materials sufficiently (Kurt & Birinci Konur, 2011). In a study conducted with pre-service biology teachers, it was determined that the pre-service teachers, who were asked to draw the reminders of the laboratory concept, mostly drew the tools used in the laboratory (microscope, beaker, test tubes, volumetric flask, Erlenmeyer flask, lab coat, pipette, laboratory oven, etc.) (Yücel Cengiz & Ekici, 2016).

According to the accessible literature, there is a clear lack of literature about pre-service classroom teachers' visual images and opinions about science laboratories. In this framework, it is thought that the research carried out will contribute to the literature. The aim of the study was determined as examining the visual images and opinions of pre-service classroom teachers about the science laboratory.

Method

Research Design

A case study as a qualitative research design was used in the research. In the case study, the current situation(s) is examined and defined in depth through observations, interviews, documents and reports carried out in a certain period (Creswell, 2013; Merriam & Tisdell, 2015). In this context, pre-service teachers' opinions about science laboratories are examined and defined in the present study.

Participants

Criterion-based (purposive) sampling was used to determine the participants (Creswell, 2013). The research was conducted with 66 third-year students (50 female, 16 male) studying in the classroom teaching undergraduate program of a university in the fall semester of the 2019-2020 academic year. In selecting the participants, taking the "Science Laboratory Applications" course before their volunteerism was taken as a basis.

Data Collection Tool

The main techniques to elicit students' ideas and thoughts include drawing, writing, concept mapping, individual or group discussions and concept cartoons

(Pope, 2019). The Drawing-writing technique was used as a data collection tool in the research. The following questions were asked to the pre-service teachers:

1. Please draw a science laboratory environment.
2. What are the things found in a science laboratory?
3. What are the advantages and disadvantages of using laboratories in science?

Data Analysis

The data were analyzed by content analysis, which is used to formulate codes, themes and categories to organize and make sense of large amounts of descriptive information (Fraenkel et al., 2012).

In the study, the researchers coded and categorized the data separately. The percentage of consensus among researchers was 82% for the writing technique and 92% for the drawing technique (Miles & Huberman, 1994). This rate indicates high reliability.

Results

Results Regarding the Drawings

According to the findings, 37 codes were generated. It was observed that almost half of the pre-service classroom teachers included laboratory tables and volumetric flasks in their drawings (Table 1).

Table 1: Findings Regarding the Drawings of the Pre-service Teachers

Codes	N	%	Codes	N	%	Codes	N	%
laboratory bench/ table	29	44	Bunsen burner	8	12	lancet	2	3
volumetric flask	29	44	chemicals	8	12	human model	2	3
teacher's table	17	26	skeleton model	7	11	electroscope	2	3
laboratory locker	17	26	gloves	5	8	smart board	2	3
students	16	24	Erlenmeyer flask	5	8	slide projector	1	2
lab stools	15	23	earth model	5	8	spring	1	2
instructor	14	21	safety goggles	5	8	inclined plane	1	2
microscope	13	20	equal arm scale	5	8	litmus paper	1	2
beaker	12	18	no drawing	5	8	power supply	1	2
graduated cylinder	12	18	hot plate	4	6	amperemeter	1	2
lab sink	12	18	magnifying glass/ lens	3	5	cover glasses and coverslips	1	2
test tube	10	15	paper-and-pencil	3	5			
magnet	9	14	molecular model	2	3			

The drawing examples of two pre-service classroom teachers are given in Figures 1 and 2.

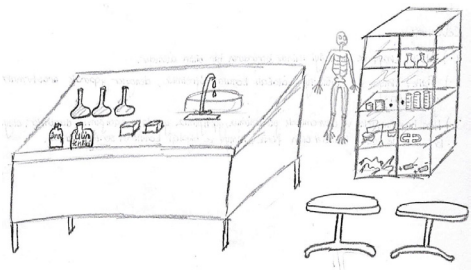

Figure 1: Drawing of P21

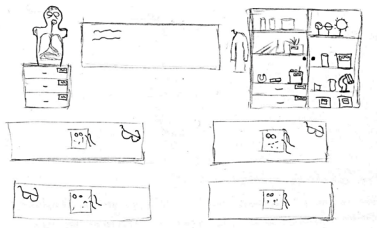

Figure 2: Drawing of P41

Results Regarding the Things Found in a Science Laboratory

According to the findings, 39 codes were generated. The pre-service classroom teachers think there are mostly chemicals, microscopes and test tubes in the laboratory environment, respectively (Table 2).

Table 2: Findings Regarding the things Found in a Science Laboratory

Codes	N	%	Codes	N	%	Codes	N	%
chemicals	33	50	lab sink	8	12	plant/ animal	3	5
microscope	31	47	litmus paper	7	11	paper-and-pencil	3	5
test tube	26	40	hot plate	7	11	lancet	2	3
laboratory bench/ table	19	29	magnifying glass	6	9	scissors	2	3
beaker	18	27	Lens	6	9	dynamometer	2	3
magnet	18	27	Bunsen burner	5	8	amperemeter	2	3
gloves	14	21	electrical circuit	5	8	thermometer	2	3
skeleton model	14	21	cover glasses and coverslips	4	6	telescope	2	3
lab stools	10	15	computer	4	6	earth model	2	3
lab coat	10	15	flashlight	4	6	atom model	2	3
safety goggles	10	15	equal arm scale	4	6	mirror	2	3
lab equipment storage cabinet	9	14	graduated cylinder	4	6	mask	2	3
human model	8	12	planet model	3	5	voltmeter	1	2

According to Table 2, half of the participants answered "chemicals" to the second question in the form. Regarding this question, P3 stated that "There are many things such as tables and chairs, chemicals, beakers, cover glasses and coverslips, and microscope in a science laboratory."

Results Regarding the Advantages and Disadvantages of Using Laboratories in Science

According to the findings, 15 codes for advantages and 14 codes for disadvantages were generated. Almost all participants thought the greatest advantage of using laboratories in science is that learning becomes permanent (Table 3). Moreover, some pre-service teachers thought there was no disadvantage of using laboratories, while others thought that various accidents might occur.

Table 3: Findings Regarding the Advantages and Disadvantages of using Laboratories in Science

Advantages	N	%	Disadvantages	N	%
Permanent learning takes place.	28	42	None	14	21
Learning becomes easier.	18	27	There may be accidents.	13	20
Theoretical knowledge is put into practice.	16	24	Contacting with chemicals	7	11
Abstract concepts become concrete.	10	15	There may be injuries.	7	11
It appeals to the eyes.	9	14	There may be an explosion.	6	9
It is fun.	7	11	There may be a fire.	5	8
It improves hand skills.	4	6	It is time consuming.	5	8
It increases interest in the lesson.	3	5	It can cause health problems.	5	8
It makes students active.	3	5	It can be difficult to deal with students individually in crowded classrooms.	3	5
It provides to recognize laboratory equipment.	2	3	It may harm the environment.	2	3
It improves science process skills.	2	3	Classroom management can be a problem.	2	3
It enables students to socialize with each other.	1	2	It can be costly.	2	3
It improves visual memory.	1	2	There may be an electric shock.	2	3
More information is learned in a short time.	1	2	Students may be bored.	1	2

It was concluded that participants thought that using laboratories in science education would provide an advantage rather than a disadvantage. For instance, P24 answered this question as follows: "Thanks to the laboratory, the student understands and concretizes the information s/he learned better. In addition, the student's interest in the lesson increases. Moreover, the student recognizes the laboratory equipment."

Conclusion and Discussion

In the study, it was observed that almost half of the pre-service classroom teachers associated the laboratory environment with laboratory tables and volumetric flasks looking at their laboratory drawings. Similarly, in a study carried out with pre-service biology teachers, it was determined that pre-service teachers drew mostly laboratory tools (microscope, beaker, test tubes, volumetric flask, Erlenmeyer, lab coat, pipette, oven, etc.) (Yücel Cengiz & Ekici, 2016).

Half of the pre-service teachers answered, "What are the things found in a science laboratory?" as "chemicals." 47% of the participants answered this question as "microscope," while 40% answered as "test-tube." As an interesting finding in this question, which was prepared parallel with the first (drawing) question, 29% of the pre-service teachers answered "laboratory tables." In contrast, none of the pre-service teachers used the expression "volumetric flask." Accordingly, it can be inferred that the pre-service teachers understood some laboratory materials visually. Still, they had less information about the names of the materials. In the study conducted by Harman (2012), pre-service classroom teachers were given pictures of some of the tools and equipment used in the laboratory and asked to write their names. In this study, similar to the present study, it was determined that some pre-service teachers could not write the name of the volumetric flask correctly. In yet another study, it was determined that most of the pre-service classroom teachers did not know the laboratory materials sufficiently (Kurt & Birinci Konur, 2011).

Pre-service teachers thought that the biggest advantage of using laboratories in science is that the learning becomes permanent. In addition, the participants stated that the laboratory facilitated learning and was effective in turning theoretical knowledge into practice. In parallel with these findings, in the study of Uluçınar, Cansaran and Karaca (2004), most science teachers stated that paper-based studies were easy but not instructive enough; and they emphasized that students were more eager to learn in the laboratory and gained permanent knowledge. There are many studies that show that permanent learning can only be achieved by participating in the learning activity personally (Aksoy & Doymuş, 2011).

According to the findings, approximately one-third of the pre-service teachers thought that using laboratories in science does not have any disadvantages. At the same time, the same percentage of them stated that various accidents could occur in the laboratory. In the study of Uluçınar et al. (2004), only 7% of science teachers stated that working in the laboratory could be dangerous. Based on this, it is thought that the fact that the pre-service classroom teachers are less intertwined with the laboratory compared to the science teachers has caused this result.

Recommendations

In future studies, pre-service classroom teachers' knowledge, awareness and attitude about science laboratories can be investigated. In this way, their status regarding science laboratories can be evaluated in more detail.

The research was conducted with 66 pre-service classroom teachers. Studies conducted with larger samples would increase the generalizability. A qualitative data collection tool was used in the study. Research findings can become more meaningful by supporting qualitative data with quantitative data collection tools.

According to the findings obtained in the study, it was found that although pre-service teachers had a visual understanding of some laboratory materials, they had less information about the names of these materials. Based on this finding, it was understood that pre-service classroom teachers should be informed in more detail about the names and use of the materials in science laboratory lessons.

Another finding obtained in the study is that

pre-service teachers mentioned the advantages of laboratory use, whereas they stated laboratory accidents among the disadvantages. It is important for the pre-service teachers to have information about laboratory accidents and precautions that can be taken. Therefore, laboratory accidents and precautions that can be taken should be included in the course contents for pre-service teachers to have information about these issues during the undergraduate education.

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