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Recognition of the tools used in general chemistry laboratory of science teacher candidates and determination of their levels of knowledge

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Abstract

Informal and formal observations have made over many years on General Chemistry Laboratories and it has been determined that the students in the laboratories are in an attitude in which they act like as if they have never seen or used the laboratory equipments before. We believe that our observations should be investigated scientifically based on the evidence. The purpose of this study is to evaluate the science teacher candidates' knowledge and understanding of the chemistry laboratory equipments. 55 teacher candidates who started their first semester in 2016-2017 academic years in Uludag University studying science participated in this study. Teacher candidates were given an open-ended test, in which the names of the laboratory instruments mentioned in the experiments in high school freshman, sophomore and junior year textbooks and were asked whether they know the shape of the instrument, what it is used for, if they have seen it before, and learning of which concept it contributes to. According to the findings, a large majority of prospective teachers graduated without using or seeing these laboratory tools. The obtained data will be explained in this study with the help of the rubric

Keywords: Chemistry laboratory tools; chemistry teaching; laboratory experiments.

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1. Introduction

Due to their contribution to technological developments and information age, the importance of physical sciences is increasing day by day. The laboratory method accepted as one of the key elements of science education influences discernment, critical thinking and understanding of science and makes students acquire the skills of learning the ways of generating information (Wheatley, 1975; Cepni, Akdeniz & Ayas, 1995).

The practicability of the study methods, principles and inventions of chemistry, one of the branches of physical sciences, in every area of daily life makes up its applied general quality (Ayas et al., 2002). Since laboratory provides students with experience at first hand by doing observations and experiments in chemistry education, it has started to be regarded as an important factor in learning (Yilmaz, Uludag & Morgil, 2001). Since laboratory works have a great importance in having students acquire the objectives targeted in chemistry education, the desired success level can be reached through attaching more importance to laboratory works in the teaching of chemistry lessons. Various studies were made on the contribution of the use of laboratory in chemistry education to teaching (Hofstein & Lunetta, 1982). In order for works performed in chemistry laboratories to achieve their goals, many tools should be used in addition to the selection of laboratory method. One of the most important points to consider is that people who are to do experiment should have sufficient knowledge of these tools and equipment. As a result of previous studies made on laboratory practice, it appeared that teachers did not have sufficient knowledge and skills about this matter; they did not know laboratory tools and equipment well and they did not have any idea why and how to use them (Ayas, Akdeniz & Cepni, 1994; Akdeniz, Cepni & Azar, 1998). This incapability in our teachers might result in our high school students' being unable to know the laboratory tools and equipment sufficiently in such subjects as chemistry, physics and biology including laboratory practice and learn their functions. In this respect, in the preservice teacher training process of education faculties, it is considered that studies aiming to determine problems related to the use of laboratory tools and equipment and eliminate insufficiencies will make important contributions.

In a study made on the subject of laboratory tools and equipment and the preservice classroom teachers' knowledge levels related to the tools and equipment used in science and technology course were examined, it was observed that although the preservice teachers knew the names of many tools and equipment used in primary education experiments, they had insufficient or incorrect knowledge about the use of some tools and equipment (Harman, 2012). In another study through which the university first year students' levels of knowledge of basic physics laboratory tools and equipment were determined, it was found that they had insufficient foreknowledge and experience about the laboratory tools and equipment mentioned in the experimental activities included in the high school physics coursebooks le (Temiz & Kanli, 2005).

The present study aims to determine the science education first year students' levels of recognition of the tools and equipment used in general chemistry laboratory and knowledge of their functions.

2. Purpose

The purpose of this study is to evaluate the science teacher candidates' knowledge and understanding of the chemistry laboratory equipments using scientific data. In this study, the answers for the questions below were seeked for those who are in their first year of education in university to become teacher candidates.

1. Given the names, draw what the laboratory equipments look like.
2. Have you ever seen those laboratory equipments in high school? If yes, indicate the ones you have seen.
3. Have you ever used any of the laboratory equipments? If yes, indicate the ones you have used.
4. What are these laboratory equipments used for?

5. Which concepts do these equipments help one to understand better.

3. Method

3.1. Research Model

In this research, to seek answers to the research questions, opened ended questions were used and the answers were evaluated by the use of content analysis and holistic rubric. The names of 15 laboratory instruments mentioned in the experiments in high school freshman, sophomore and junior year textbooks and were asked whether they know the shape of the instrument, what it is used for, if they have seen it before, and understanding of which concept it contributes to.

3.2. Research Sample

In this research, in the selection of the participants was used the purposeful sampling, which gives researchers the opportunity to choose people thanks to whom they can find answers to their research questions (Cohen, Manion & Morrison, 2007). Participants of the study were identified with purposeful sampling that allows the researcher to choose the people she believes will be responsive to research problems. 55 teacher candidates who started their first semester in 2016-2017 academic years in Uludag University studying science participated in this study.

3.3. Data Collection Resources

The data of the study was collected via 7 basic open-ended questions being administered to the students. For the 55 participants in the survey, the questions asked during the first week of the university school year are related to the most commonly mentioned 15 laboratory equipment's in the experiments in grade 9, 10 and 11 textbooks. These equipment's are beaker, erlenmeyer, measuring cylinder, pipette, burette, flask, volumetric flask, separatory funnel, funnel, spatula, suction bulb, glass rod, trivet, amianth wire, test tube.

In order to determine whether teacher candidates recognize the laboratory instruments, they were asked to draw the shapes of the instruments given in the first question. In the second and third questions, they were asked to give information about whether they had seen these tools before and whether they had used them. Students' answers to these questions are examined; frequency and percentages of the answers are calculated by content analysis. In the fourth and fifth questions, it was asked for what purpose the given tools are used for and which concepts they contribute to understand. The obtained data were evaluated using holistic rubric.

4. Findings and Discussion

The findings of the research are presented in the following tables: Firstly, the frequencies and percentages of the correct answers given by the teacher candidates for the question "Draw the shape of the laboratory instruments given their names" are presented in Table 1. When Table 1 is examined, it is seen that most of the teacher candidates can not draw the laboratory instrument apart from the beak, experiment tube and funnel.

Table 1. Percentage-frequency plot for drawing laboratory tools

Tools	f	%	Tools	f	%
Beaker	35	64	Funnel	25	45
Erlenmeyer	17	31	Spatula	12	22
Measuring cylinder	11	20	Suction bulb	-	-
Pipette	15	27	Glass rod	1	2
Burette	2	4	Trivet	5	9
Flask	9	16	Test tube	37	67
Volumetric flask	1	2	Amianth wire	11	20
Seperatory funnel	5	9			

Secondly, the responses for the question "Have you seen these lab tools before in the laboratory and have you used them before? "are shown in Table 2. When we look at Table 2, we see that a great majority of teacher candidates have not seen laboratory instruments in high school years before and almost all candidates have not used these tools except a few equipments.

Table 2. Percentage-frequency table for teacher candidates who previously saw and used laboratory equipments

Tools	Seen		Used		Tools	Seen		Used	
	f	% f	%		f	% f	%		
Beaker	8	15	3	5	Funnel	6	11	2	4
Erlenmeyer	5	9	1	2	Spatula	2	4	1	2
Measuring cylinder	3	5	1	2	Suction bulb	-	-	-	-
Pipette	3	5	-	-	Glass rod	-	-	-	-
Burette	-	-	-	-	Trivet	-	-	-	-
Flask	1	2	-	-	Test tube	10	18	5	9
Volumetric flask	-	-	-	-	Amianth wire	1	2	1	2
Seperatory funnel	3	5	-	-					

Finally, questions "What are the purpose of laboratory tools (what are they used for) and understanding of which concepts do these equipments contribute to?" were directed to prospective teachers. Candidates' answers to these questions were evaluated using holistic rubric. In the grading criteria, the codes "1" for teacher candidates who don't know what the laboratory equipments are used for at all or have a faulty knowledge of it, "2" for the teacher candidates who know the task of the laboratory tools partially, "3" for teacher candidates who know what the laboratory equipments are used for; however, have insufficient explanation for understanding of which concepts these laboratory equipments contribute to or explaining a wrong concept, "4" for teacher candidates who correctly indicated the concept that is being understood better with the use of the laboratory tools and who knows what the equipments are used for at the same time have been used.

Table 3. Evaluation of data related to the purpose of use of laboratory equipments, linking them with the appropriate concepts and evaluating the data by holistic rubric

Tools	1	2	3	4
Beaker	10	20	15	10
Erlenmeyer	20	18	10	7
Measuring cylinder	25	19	6	10
Pipette	17	18	10	10
Burette	38	13	2	2
Flask	15	23	9	8
Volumetric flask	40	12	1	2
Seperatory funnel	26	10	5	4
Funnel	15	17	15	8
Spatula	15	10	25	5
Suction bulb	55	-	-	-
Glass rod	45	3	6	1
Trivet	45	5	5	-
Amianth wire	30	5	20	-
Test tube	5	13	35	2

5. Conclusion and Suggestions

In the present study aiming to determine the science education preservice teachers' recognition of the tools and equipment used in general chemistry laboratory and knowledge of their functions, the preservice teachers were addressed five open-ended questions. Firstly, the preservice teachers were

given the names of 15 laboratory tools and asked to draw the pictures of these tools. It was observed that an important part of the preservice teachers could not draw the pictures of all the given laboratory tools except for those of test tube, beaker, erlenmeyer, funnel, measuring cylinder, pipette and spatula or the number of those who could draw was very low. It is considered that it this might have resulted from the fact that since the students had not worked with these tools in the laboratory environment very much before, they may not have put them in their visual memory. In a study carried out by Temiz and Kanli (2005), it was found that high school students graduated from high school without doing sufficient number of experiments and getting to know the experimental tools and equipment.

The second question was addressed to the preservice teachers with the aim of learning if they had seen the laboratory tools and equipment, whose names were given, before. A great majority of the preservice teachers stated that they had not seen many of the laboratory tools and equipment in high school years; it was also determined that there were even not any preservice teachers having seen some laboratory tools such as buret, volumetric flask, suction bulb, glass rod and trivet. The number of the preservice teachers having seen such tools and equipment as glass flask, separating funnel, spatula, amianth wire, measuring cylinder and pipette was very low. Later, the question “Have you used these laboratory tools before? If your answer is 'Yes', please specify which of them you have used before.’’ was addressed to the preservice teachers. Of the preservice teachers, only 5 preservice teachers stated having used the test tube; but, almost all of the preservice teachers, except for 1 or 2, stated having never used the other tools in the classroom before. These results can be considered to be arising from the university examination system in our country. Students and teachers are not inclined toward meeting the requirements of contemporary science education, but instead, they are inclined toward meeting the requirements of the examination system. Moreover, when the literature is examined, it is observed that there are studies revealing that teachers' lack of knowledge and skills plays a role in not performing laboratory works at schools sufficiently (Ayas, Akdeniz & Cepni, 1994; Akdeniz, Cepni & Azar, 1998; Aydogdu, 1999; Nakiboglu & Sarikaya, 1999). However, it was concluded from the study that preservice teachers should personally perform the experiments which they are supposed to do when they are teachers and be sufficiently knowledgeable of the difficulties which they are likely to encounter when doing experiments as teachers and the methods of using the apparatus to be used before they graduate from their institutions (MEB, 1995).

In many other studies, it was reported that teachers did not use the laboratory very actively in their lessons. Insufficient physical conditions (Nakiboglu & Sarikaya, 1999) not having been trained according to the applied science education in their undergraduate education years, not having received education on how they will apply the experiments and achieve laboratory management (Nakiboglu & Sarikaya, 2000; MNE Branch Office for Measurement and Evaluation, 1995), insufficient in-service training courses (Nakiboglu & Sarikaya, 1999) are listed as the main reasons preventing teachers from using the laboratory. Moreover, Ekici et al. (2002) revealed that although there were laboratories fulfilling the necessary conditions at schools, teachers did not use these environments and regarded laboratory as a burden since they lacked necessary knowledge of the tools.

As the fourth question, the question “Please specify the functions of these tools (for what purposes they are used).” was addressed to the preservice teachers. According to the result of the evaluation made via using the holistic rubric, it was determined that the laboratory tools, whose functions in the laboratory were known by the preservice teachers better than the others, were the test tube, beaker, erlenmeyer flask, pipette, funnel, spatula and amianth wire. A great majority of the participant preservice teachers did not know the functions of buret, volumetric flask, separating funnel, measuring cylinder, glass rod and trivet completely. Finally, when the answers given to the question 'Learning of which concepts does the use of laboratory tools and equipment contribute to?' are evaluated, it was observed that approximately 18% of the preservice teachers stated that such tools as beaker, erlenmeyer flask, measuring cylinder, pipette and glass flask could be used in liquid measurement procedures and associated these tools with the concept of volume. On the other hand, the rate of the preservice teachers associating the buret used in titration works and the volumetric flask used in preparing solutions with the concept of volume was only 4%. While the rate of the preservice teachers

associating the separating funnel separating liquids from each other by benefiting from the density difference between them was 7%, the rate of the preservice teachers associating the funnel with such definitions as decomposition and separating substances was 13%. Moreover, many other laboratory tools and equipment either could not be associated with any concepts or the rate of the preservice teachers being able to make the association was very low.

The results of the study indicated that a great majority of high school students graduate without doing the experiments included in the high school chemistry coursebooks, seeing and using the laboratory tools and equipment and learning about their functions. For this reason, in general chemistry laboratory lessons given at education faculties, students should primarily be introduced the laboratory tools and equipment and they should also be taught their using techniques.

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