Volume XXI 2018
ISSUE no.2
MBNA Publishing House Constanta 2018

Scientific Bulletin of Naval Academy

SBNA PAPER • OPEN ACCESS

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To cite this article: F. Kara, Scientific Bulletin of Naval Academy, Vol. XXI 2018, pg. 213-220.

Available online at www.anmb.ro

ISSN: 2392-8956; ISSN-L: 1454-864X

doi: 10.21279/1454-864X-18-I2-027

Effect of drawing on science students' recognition of chemistry laboratory equipment and material

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Abstract: The purpose of this research is to examine the effect of drawing on recognition of chemistry laboratory equipment and material and uses of those. The research has been conducted with 80 students attending Science Teacher Department in their freshmen year at a university in Turkey. In this research was used quasi-experimental method with pretest-posttest control group. During the 10 weeks course of the research general chemistry laboratory classes were conducted with only the verification method with the control group whereas the experimental group used drawing alongside the verification method. The experimental group was asked for 10 weeks to draw the material they used in laboratory experiments and write down their uses. The research reached at the conclusion that the extra drawing method as applied to the experimental group is more effective in recognition of laboratory equipment and material frequently used in chemistry experiments in comparison to application of verification method alone as it was with the control group.

1. Introduction

Ever-changing science and technology of today force countries to continuous revision of their education programs (Kaptan & Kuşakçı, 2002). In order to remain relevant with those changes countries target to make their citizens scientifically literate by renewing their education programs. The field of chemistry has an important place in natural sciences in achieving the said goal. Since topics of chemistry are related to inner structure of matter they involve a lot of abstract notions. Hence chemistry is a course that is complex and hard to master (Nakhleh, 1992; Ayas & Demirbaş, 1997). Laboratory applications play an important role in students' understanding of those abstract concepts that are hard to grasp (Gallagher, 1987). Shulman & Tamir (1973) list the primary benefits of laboratory applications to education as follows:

1. Improvement of skills of research, inquiry, organization and interpretation,
2. Improvement of critical reasoning, problem solving, application, analysis and synthesis skills,
3. Helps understanding the nature of science by facilitating comprehension of how scientists work, scientific method and relation of science with other fields,
4. Expedition of conceptual understanding,
5. Facilitates interest, curiosity and positive attitude towards the class (Shulman & Tamir, 1973).

Lagowski (1989), states that laboratory application is very important in good chemistry education by mentioning that it is likely to increase students' work efficiency in laboratory work to provide information about laboratory in science classes and teachers have an important part to play in this. Hilosky et al, (1998) studied if laboratory assisted chemistry education in early years of higher education causes waste of time and effort, and concluded that best chemistry education is possible through laboratory work.

Despite laboratory application has such an importance in education and training processes and its advantages it is likely to cause hardships as well. Studies state that various factors are in place in inability to conduct laboratory applications in schools. Among those are students' concerns of preparation for university entrance exams, insufficient equipment and material in laboratories,

unsuitability of laboratories' physical conditions, over-load of curricula, over-crowded classes, absence of laboratory culture in students and teachers' lack of professional knowledge and skills in applications (Ayas et al, 1993; Çepni et al, 1994; Aydoğdu, 1999; Nakiboğlu & Sarıkaya, 1999; Korkmaz, 2000; Arslan, 2001; Çallıca et al, 2001; Güzel 2001; Şahin, 2001). Teachers faced with such problems tend to either make a limited number of presentations using simple demonstration experiments or abandon experiments all together (Ayas et al, 1993; Çepni et al, 1994; Aydoğdu, 1999; Nakiboğlu & Sarıkaya, 1999).

In order to make chemistry classes efficient teachers must be able to conduct experimental activities. Recognition of laboratory equipment and their uses are prerequisites for efficient conduct of experimental activities. Hence teachers need to have fundamental knowledge regarding laboratory equipment and their uses.

Teachers are supposed to have acquired knowledge and skills regarding laboratory equipment and material during their Professional training. However, certain findings suggest that prospective teachers are not able to get theoretical knowledge and practical skills regarding laboratory work they need during their training (Serin, 2001).

A research by Buluş-Kırıkkaya & Tanrıverdi (2009) inquiring whether teachers know laboratory equipment and material revealed that 61.8% stated that they know laboratory equipment and material while 35.1% said that they have partial knowledge and 3% answered no. Coştu et al, (2005) found that prospective teachers fail to use proper material for preparing solutions asked from them because they do not know uses of laboratory material. They also state that training of prospective teachers must emphasize proper use of laboratory equipment and material fort hey need to be able to use those properly for an efficient science education they are to provide in the future.

Drawing is utilized to reveal misconceptions and conceptual changes of students regarding a subject (White & Gunstone, 1992). Since it takes less time and includes more information compared to other revealing methods drawing is effective and efficient in terms of easy assimilation (Atasoy, 2004). Information can be taken from learners who do not like answering questions in an entertaining, easy and quick manner (Thomas & Silk, 1990).

Necessity of determining how well laboratory equipment and material and uses of those are known by prospective teachers is regarded as an important rationale in conducting this research. The goal of the research is to determine efficacy of drawing in prospective teachers' learning of laboratory equipment and material and uses of those.

2. Method

The research was conducted with 80 freshmen student in Science Teaching Department in Black Sea region of Turkey. The subjects were divided into experimental and control groups of 40. Composition of experimental and control groups was done randomly within a quasi-experimental approach. Quasi-experimental method is the method in which students are distributed into groups randomly (Sümbüloğlu, 1988; Çepni, 2007). Since distribution of students to classes had already been done by the school management in the beginning of the semester the already existing classes were divided into experimental and control groups in a quasi-experimental method.

Data Collection Tools

The research makes use of "the Test of Drawing Equipment and Material" which asks the participants to draw pictures of frequently used equipment and material in a chemistry laboratory. In addition, "the Test of Knowledge of Equipment's and Material's Use" which involves purposes of use of the said equipment and material.

Whether the former includes the proper elements as frequently used equipment and material is determined by an expert's opinion. The latter, which has been prepared by the author and which includes 43 items, was applied to 64 science students for item analysis. It has been emphasized that item difficulty must be around 0.50 and item discrimination must fit the below criteria in multiple

choice tests: if discrimination index is 0.40 or greater than the item is very good and does not require improvement; if it is in the interval 0.30 - 0.40 then it is good and does not require improvement; if it is between 0.20 and 0.30 then the item can be used without change when necessary or it can be changed; if it is below 0.20 the item must not be used or it must be improved (Crocker & Algina, 1986; Tekin, 1996; Büyüköztürk et al, 2008).

According to results of analysis the 5 items with discrimination indices lower than 0.20 among the 43 were discarded to make the test consist of 38 items. Kuder Richardson (KR 20) coefficient of reliability of the test was computed to be 0.704.

Application

The research was conducted for 10 weeks in a General Chemistry Course. The measurement tools were applied to the participants prior to the research as a pre-test and following the research as a post-test. Following the pre-test both groups were introduced the equipment and material and their use was described. Both groups were made do experiments involving the equipment and material in question for 10 weeks. The control group was asked to draw the equipment and material they used in each week and write down their use following the experiments. The control group was only made do experiments by verification method.

Data Analysis

After the application experimental and control groups' success levels in drawing the equipment and material and their knowledge of uses of those were compared in order to determine if the applied drawing method was effective.

Every correct answer in the test and every proper drawing (evaluated outside the test) by a participant was scored 1 point. Participants' pre-test and post-test scores were added and the total scores were analyzed using SPSS software package. Since data from drawings and test scores did not show normal distribution they were analyzed using a non-parametric test: Mann Whitney U test in order to determine if there is a significant difference between the groups. Significance level of p value was selected as 0.05 when interpreting the results.

3. Results

Descriptive statistics for the pre-test and post-tests of the tests used in the research are given in Table 1.

Tablo 1. Descriptive statistic values belonging to tests

	Groups	**Tests**	**N**	**Mean**	**Standard Deviation**
Drawing	*Experimental*	Pre-test	40	10.10	4.22
		Post-test	40	34.17	3.24
	Control	Pre-test	40	9.15	3.38
		Post-test	40	27.25	4.77
Knowledge	*Experimental*	Pre-test	40	16.78	3.25
		Post-test	40	31.55	3.94
	Control	Pre-test	40	16.15	4.89
		Post-test	40	27.75	4.23

N: Number of the students.

Whether there was a significant difference in experimental and control groups' level of skill in drawing the equipment and material and their knowledge as to use of those before the application was checked using Mann-Whitney U test and analysis results are given in Table 2.

Table 2. Mann-Whitney U test results regarding students' level of skill in drawing the equipment and material and their knowledge about use of those before the application.

Tests	Groups	N	Mean Rank	Sum of Ranks	U	p
Drawing	Experimental	40	44.58	1783.00	637.000	0.115
	Control	40	36.42	1457.00		
Knowledge	Experimental	40	41.74	1669.50	750.500	0.663
	Control	40	39.26	1570.50		

According to Table 2 there is not a significant difference in students' level of skill in drawing the equipment and material [U=637.000, p> 0.05] and their knowledge about use of those [U=750.500, p> 0.05] before the application. Hence, it can be said that it was appropriate to use those experimental and control groups, between which there was not a significant difference in terms of level of skill in drawing the equipment and material and the knowledge as to use of those in the pre-test.

Whether there was a significant difference in experimental and control groups' level of skill in drawing the equipment and material after the application was checked using Mann-Whitney U test and analysis results are given in Table 3.

Table 3. Mann-Whitney U test results regarding students' level of skill in drawing the equipment and material after the application.

Groups	N	Mean Rank	Sum of Ranks	U	p
Experimental	40	56.00	2240.00	180.000	0.000*
Control	40	25.00	1000.00		

**: p < 0.05*

According to Table 3 there is a significant difference [U=180.000, p< 0.05] in students' level of skill in drawing the equipment and material between the experimental and control groups as measured in the post-test. When mean ranks are taken into consideration it is seen that the average rank of the experimental group is higher than that in the control group. This result shows that the method applied to the experimental group is more effective than that applied to the control group in terms of skill in drawing the equipment and material.

Whether there was a significant difference in experimental and control groups' level of knowledge to use of the equipment and material after the application was checked using Mann-Whitney U test and analysis results are given in Table 4.

Table 4. Mann-Whitney U test results regarding students' level of knowledge to use of the equipment and material after the application.

Groups	N	Mean Rank	Sum of Ranks	U	p
Experimental	40	50.53	2021.00	399.00	0.000*
Control	40	30.48	1219.00		

**: p < 0.05*

According to Table 4 there is a significant difference [U=399.00, p< 0.05] in students' level of knowledge to use of the equipment and material between the experimental and control groups as measured in the post-test. When mean ranks are taken into consideration it is seen that the average rank of the experimental group is higher than that in the control group. This result shows that the method applied to the experimental group is more effective than that applied to the control group in terms of knowledge to use of the equipment and material.

Some drawings from the pre-test belong to one of the students from the experimental group are shown in Figure 1 and some from the post-test in Figure 2.

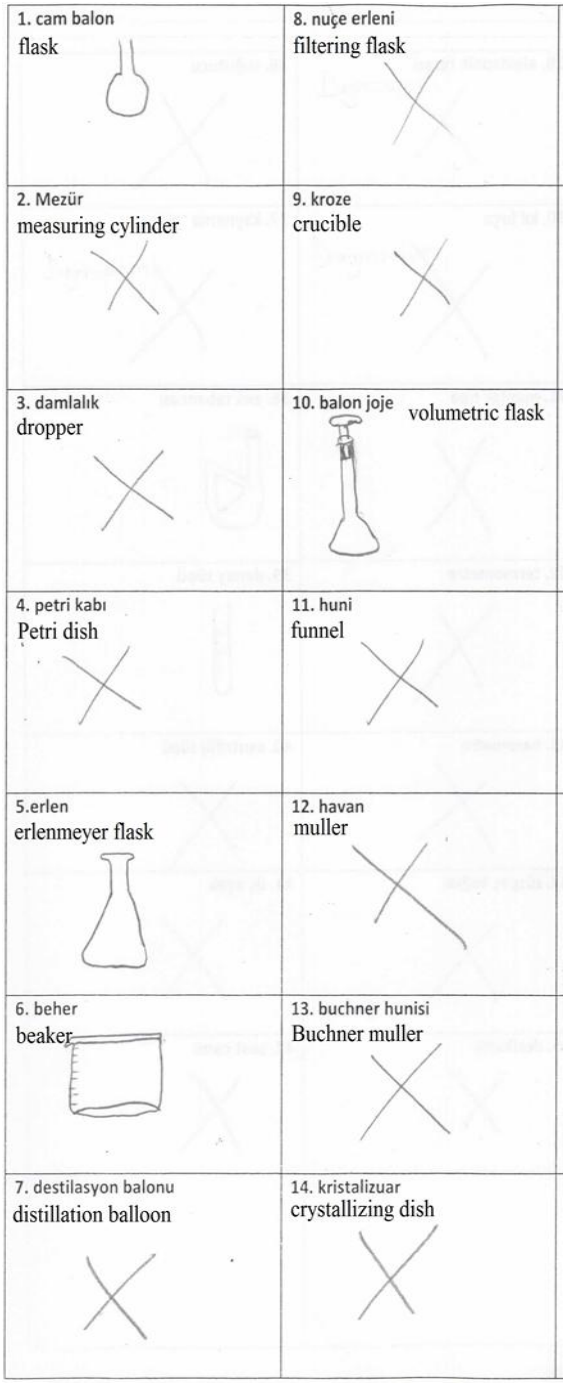

Figure 1. Some drawings from the pre-test belong to one of students in the experimental group

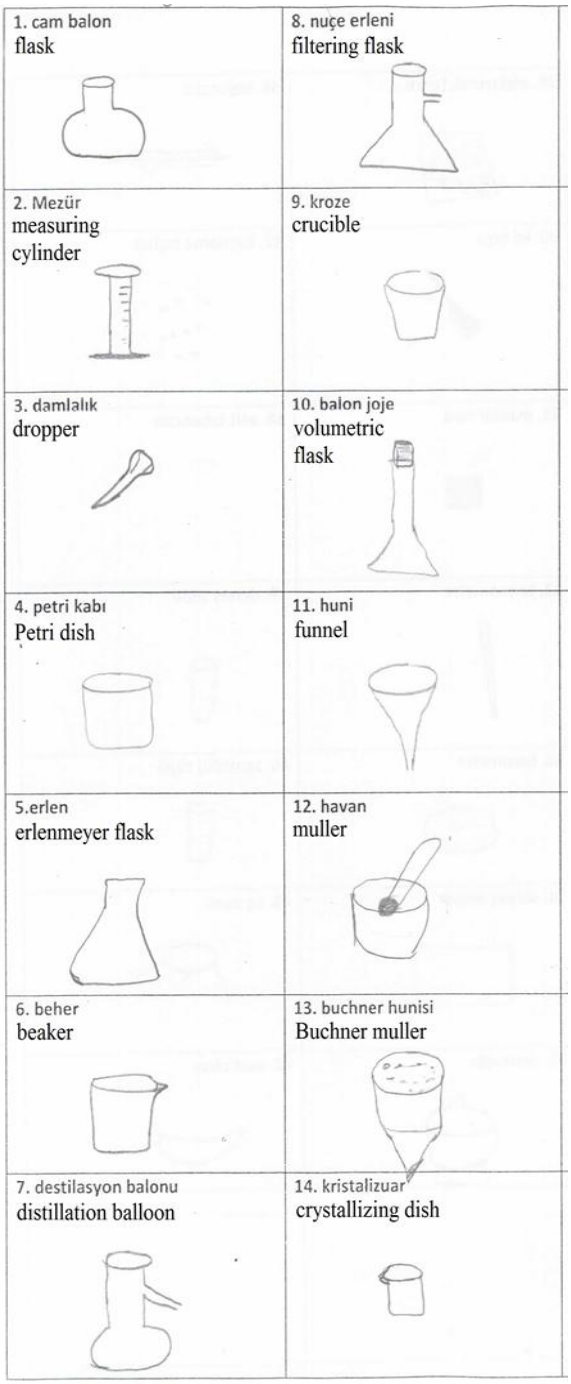

Figure 2. Some drawings from the post-test belong to one of students in the experimental group

Some drawings from the pre-test belong to one of the students from the control group are shown in Figure 3 and some from the post-test in Figure 4.

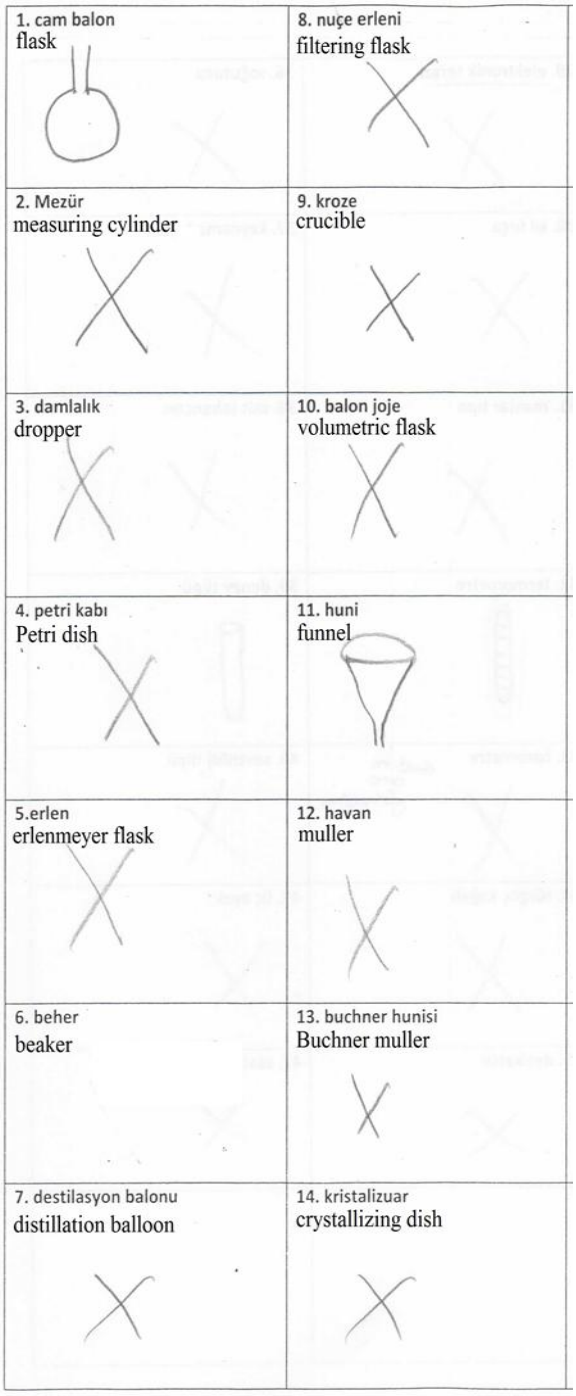

Figure 3. Some drawings from the pre-test belong to a teacher candidate in the control group

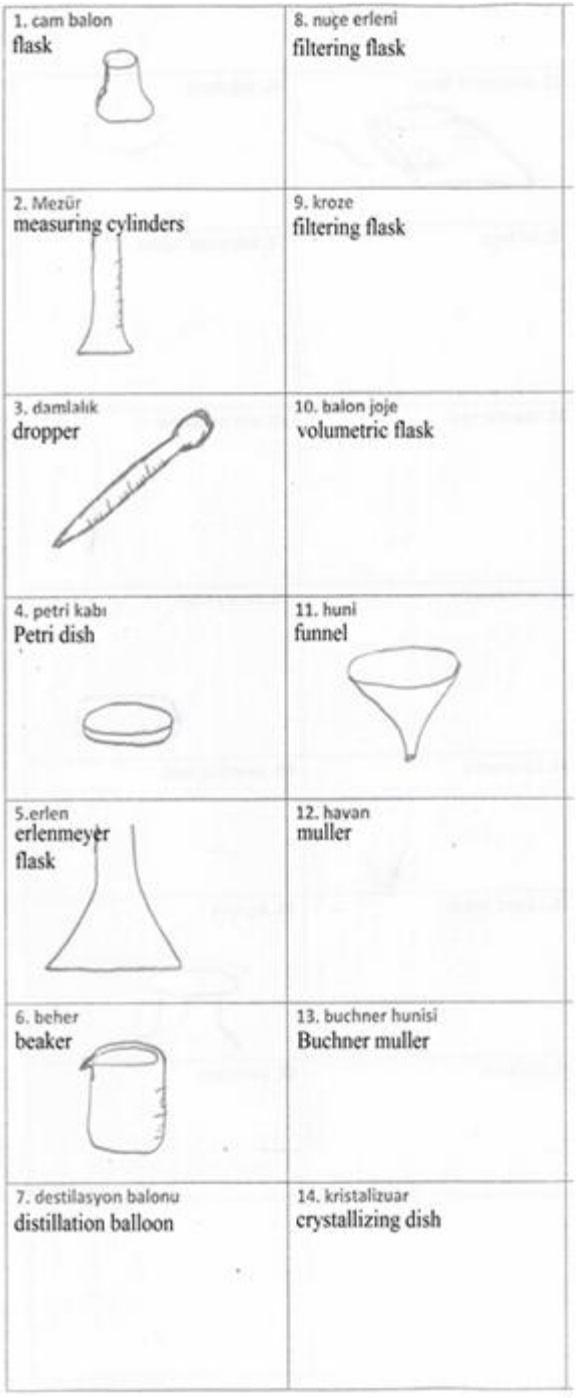

Figure 4. Some drawings from the post-test belong to a teacher candidate in the control group

According to result, it is seen that the student in the experimental group has 4 true drawings in 14 drawings during the pre-test and has 13 true drawings during the post-test whereas the student in the control group has 2 true drawings during the pre-test and 6 true drawings during the post-test. This

result shows that the drawing method applied to experimental group is more effective than control group on the level of drawing the equipment and materials.

4. Discussion and Conclusion

The research showed that there was not a significant difference between experimental and control group's drawing skills the equipment and material and their knowledge as to use of those in terms of pre-test scores. After the application a significant difference in drawing skill the equipment and material and their knowledge as to use of those as measured by post-test scores in favor of the experimental group was noted. Hence, it can be said that the method applied to the experimental group: verification method accompanied by drawing is more effective than that applied to the control group: mere verification method in terms of skill in drawing the equipment and material and their knowledge as to use of those.

It has been concluded that students in the experimental group benefited from drawing the equipment and material they used in the experiments for 10 weeks in terms of their skill in recognizing and drawing the equipment and material and their knowledge as to use of those.

When it is considered that whether the prospective science teachers who would serve as teachers of science, including chemistry, for future generations and who would supervise their prospective science teachers' laboratory work recognize equipment and material frequently used in a chemistry laboratory and know uses of those is very important it is sound to suggest using drawing more as an education tool in training of those prospective science teachers.

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