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Effect of Chemistry Practicals on Students' Performance in Chemistry in Public Secondary Schools of Machakos and Nairobi Counties in Kenya

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Abstract: ***The purpose of the study was to investigate the effect of chemistry practicals on students' performance in chemistry in public secondary schools of Machakos and Nairobi counties in Kenya. The students' performance in chemistry was determined from scores obtained by students in Students Achievement Tests (SATs) done just before and immediately after exposure to the topic under investigation. Descriptive and inferential statistics such as the mean and independent t-test were used to discuss the research findings. The study found that there is a positive relationship between the use of chemistry practicals and learners' performance in chemistry. The results of the study indicate that the students had comparable performance in chemistry before treatment; that the performance of the students taught using chemistry practicals improved after the treatment; and that there was a significant difference in performance in the post test between the experimental and control groups. The study recommends that students should be taught using practicals so as to improve in performance in chemistry.***

Keywords: Chemistry, Practicals, Students and Performance.

1. Introduction

Chemistry is the branch of science that deals with the study of the composition and properties of matter, changes in matter, the laws and the principles that govern these changes (Ebbing, 1996). Instruction in chemistry is done through practicals and theory work. A chemistry practical refers to the experiences in a school chemistry lesson where students interact with materials (matter) to observe and understand the natural world. Hence, chemistry practicals are the experiments carried out by the learners themselves or with the help of the teacher during the learning of chemistry. Chemistry practicals are mainly done as student experiments (also known as class experiments) in the laboratory and as teacher demonstrations either in laboratories or in the classroom, while the theory is often done in the classroom (Twoli, 2006). Wellington (1998), describes chemistry practicals as teacher demonstrations or as class experiments. In secondary schools, practicals are designed and conducted to engage students individually, or in small groups (student experiments) and in large-group demonstration settings (teacher demonstrations) (Hofstein and Mamlok-Naaman, 2007). Successful learning of chemistry depends on the nature of the practical, that is, on correct use of a teaching method whose activities target most learning senses.

Demonstration experiments are those types of practicals that are performed by the teacher as students observe. The demonstration can be performed in the laboratory, classroom or outside the classroom and are performed with or without learner participation. They are used to illustrate concepts and to promote inquiry (Sharpe, 2012). A teacher uses classroom demonstrations to help develop concepts, to illustrate lessons or to promote some form of learner inquiry. This is performed using bought or improvised apparatus. Class experiments are those types of practicals where the students perform the practical activities, make and record the observations themselves. The learners are working as individuals or in small groups of learners engaged in similar or different tasks. In this type, learners perform chemistry practicals either as individuals or in groups using the provided apparatus and are told what to do, either by the teacher or a worksheet. In students' experiments, commonly known as class experiments, the teacher designs practical work in such a way as to encourage learner discovery of information. Learners perform guided discovery type practical work in small groups engaging in hands-on activities. Also, in class experiments, learners can design and do their own 'open-ended' investigations. Through discussions with the teacher, learners can interpret data in support of competing theories or explanations and write a scientific report in which they can justify their conclusions based on the data collected.

2. Importance of Practicals in Chemistry

Practical work is an essential feature of secondary science education (Abrahams & Millar, 2008), hence a high proportion of chemistry lesson time in secondary schools is given to practicals with assumption that they lead to distinctive achievement in the subject by the students. Like other sciences, chemistry teaching and learning is supported by laboratory practicals (Reid & Shah, 2007). Chemistry practical classes (experiments) are believed to help students in understanding theories and chemical principles which are difficult or abstract (Lagowski, 2002). Students have a lot to benefit from chemistry practicals which may include increasing students' interest and abilities in the subject as well as their achievement in chemistry (Pavesic, 2008). Although chemistry courses at all levels include practicals where students follow procedures directing them to mix chemicals, make measurements, analyze data, and draw

conclusions, (Abrahams, 2009) argues that chemistry practicals often consists of what is generally described as "cook-book" exercises and are often dull and routine, rather than engaging or inspiring. Despite the widespread use of practicals as a teaching and learning strategy in school chemistry, and the view that increasing its amount would improve chemistry learning, some science educators have raised questions about their effectiveness (Abrahams, 2009).

According to Millar (2009), many science teachers believe that practicals lead to better learning and indeed better performance – because we all understand and remember things better if we have done them ourselves, however, many educators have expressed concern they are not effective in promoting learning. These concerns have led to calls for more 'authentic' practical experiences, or to re-think, re-evaluate, and perhaps reduce, the number of practicals, to leave more room for other learning activities. Abrahams and Millar (2008) maintain that it is time for an appraisal of the nature and role of practicals in the teaching and learning of chemistry. Therefore, this study sought to find out the effect of chemistry practicals on students' performance in chemistry in Kenyan secondary schools in a bid to improve the academic achievement in the subject.

3. Objectives Of The Study

The study sought to achieve the following objectives:
(i) To establish students' performance in chemistry in the pre-test.
(ii) To determine whether performance in chemistry of those students taught using practicals improved after treatment.
(iii) To find out if there was a significant difference in performance of the chemistry post test between the experimental and control groups.

4. Research Methodology

The research was conducted using quasi experimental of the pre- test – post test design. The quasi-experimental approach of the pre-test – post test design was suitable for this study because the performance in chemistry of the group of students taught with methods integrating chemistry practicals (experimental group) was compared to the performance in chemistry of the group taught without chemistry practicals (control group). Student Achievement Tests (SATs) were used to test learners' performance in chemistry. In both groups a pre-test and a post- test was used to determine the performance of the groups before and after treatment. The use or non use of chemistry practicals in teaching was done without affecting the classroom set up so that the learners were not aware of their involvement in the study. Multi-stage cluster sampling and purposive sampling were used to obtain a sample of 735 Form Two students from 24 public secondary schools in Machakos and Nairobi counties for this study. The data for this study were collected using student achievement tests (SAT) – that is, the Pre-test and the Post test.

Student academic achievement in both the experimental and control groups used in the study was evaluated using the researcher created chemistry student achievement tests (SAT). Two student achievement tests: a pre-test and a post-test, were constructed and used by the researcher. Pre-tests are administered as formative evaluations to assess student pre-treatment chemistry academic abilities (Creswell, 2005). A post test is administered as summative assessment after every treatment period to measure student academic gain in chemistry (Ormrod, 2003). The topic was conveniently chosen because it is normally taught to form two classes at that time of the school calendar and which was also the chosen time of the study. This did not inconvenience teachers during their planning process and also the learners were not aware of their involvement in the study. The tests consisted of questions that were of knowledge, comprehension and application levels while a few were of the analysis level in Blooms taxonomy of objectives. Performance of the students was based on the scores attained after marking the achievement tests. The data obtained was analysed and reported using descriptive and inferential statistics.

5. Findings and Discussion

The findings of the study were discussed as per each objective.

Research Objective 1
Objective one sought to establish students' performance of the experimental and control groups before treatment. The findings are presented in Tables 1 and 2.

Table 1: Pre-Test Scores of the Experimental and Control Groups

Test type	Student Group	N	Mean	Std. Deviation
Pre Test	Experimental	443	13.99	5.96
	Control	292	14.08	5.05

Table 1shows that in the pre-test, the groups' mean score were almost equal (a difference of 0.09) implying that the two groups of students were at the same level of performance in chemistry before the treatment was done. The results in Table 2 show the findings of the t-test analysis of the pre-test scores of the experimental and control groups.

Table 2: t-Test Results on Pre–Test Scores between Experimental and Control Groups

Independent T test		t	DF	Sig. (2-tailed)	Mean Difference
Pre-Test	Equal variances not assumed	4.02	688.73	.17	0.14

The information in Table 2 shows a t value of 4.02; $p > 0.05$, implying that the observed difference in pre-test mean scores of 13.99 and 14.08 between the experimental and control groups respectively before treatment was not significant. This indicates that the two groups of students were similar in chemistry achievement before the treatment was done.

Research Objective 2
Objective two sought to determine students' performance in chemistry after treatment. The information is presented in Table 3.

Table 3: Post-test Performance of Learners in Experimental and Control Groups

	Test type	N	Mean	Std. Deviation
Post Test	Experimental	443	15.73	4.32
	Control	292	14.18	4.79

The findings presented in Table 3 shows that the experimental group's mean score is higher than the control group's mean score by a value of 1.55, implying that the treatment, that is, the use of practicals had a positive effect on students' performance in chemistry. The higher mean observed in experimental groups compared to that of the control groups suggests that students in the former understood the chemistry concepts and performed better than those taught without the practicals. The results corroborate the studies done by Abrahams & Millar (2008), and observations made by (Lagowski, 2002) and (Reid & Shah, 2007).

Research Objective 3

Objective three sought to find out if there was a significant difference between the post-test mean scores in chemistry of students exposed to practicals and those not so exposed.

The results are presented in Table 3.

Table 3: t-Test on Post-Test between Experimental and Control groups

Independent t- test		t	DF	Sig. (2-tailed)	Mean Difference
Post-Test	Equal variances not assumed	4.47	577.34	.00	1.55

The data in Table 3 shows that the t value of the post test is 4.47; $p < 0.05$, indicating that there was a significant difference between the post-test mean score in chemistry of students exposed to practicals and those not so exposed. This indicates that students exposed to practicals performed better than those taught without the practicals. This implies that performance in secondary school chemistry improves when different types of practicals are used. This is in agreement with Pavesic (2008), who reports that students have a lot to benefit from chemistry practicals which may include increasing students' interest and abilities in the subject as well as their achievement in chemistry.

6. Conclusions and Recommendations

Conclusion

The study found that students exposed to practicals performed better than those taught without the practicals. Results showed that chemistry practicals have a significant positive effect on learners' performance in secondary school chemistry. This implies that there is a positive linear relationship between practicals and learners' performance in secondary school chemistry. Therefore, the use of practicals should be considered when teaching and learning chemistry. That is, consistent planning and use of practicals by teachers should take place if the students' performance in chemistry is to improve. The planning and use of various types of practicals by teachers involves selection. The selection of the types of practicals to be used requires that teachers know which practical applies to what concept. The selection requires that teachers know what practicals to do first and which ones to follow. This implies that teachers should have a good knowledge of how to plan and perform practicals. That is, teachers should have a tacit knowledge of how to do practical work themselves. The findings confirm that the use of practicals is an effective way of improving learners' performance in secondary school chemistry. The study recommends that chemistry practicals be considered when planning and teaching secondary school chemistry in Kenyan public secondary schools.

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