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Effect of Nature 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 study investigated the effect of nature of chemistry practicals on students' performance in chemistry in public secondary schools of Machakos and Nairobi counties in Kenya. The study examines and describes the effect of the nature of practicals used in teaching and learning of secondary school chemistry. 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 class experiment and teacher demonstration lessons in 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 students taught chemistry using class experiments lessons performed better than those taught using teacher demonstration comprising the whole class or large groups. Results from the study showed that the use of class experiments lessons when teaching secondary school chemistry had a positive effect on students' performance in chemistry. This implies that the nature of chemistry practicals used in the instruction of chemistry has an effect on the performance of students in the subject. The results of the study also indicate that the students had comparable performance in chemistry before treatment and that there was a significant difference in performance in the post test between the experimental and control groups. The study recommends that the nature of chemistry practicals be taken into consideration when planning and teaching secondary school chemistry so as to improve performance in the subject.***

Keywords: Chemistry practicals, Nature of Practicals, Students' Performance, Class Experiments, Demonstration experiments

1. Introduction

Instruction in secondary school chemistry is done through practicals and theory work. The term chemistry practical means experiences in school chemistry lessons where students interact with materials to observe and understand the natural world. Chemistry practicals are chemistry lessons where experiments are either carried out by the learners themselves or with the help of the teacher during the learning of chemistry. Practicals are an essential feature of secondary science education (Abrahams & Millar, 2008), hence high proportion of chemistry lesson time in secondary schools is given to practicals work with assumption that they lead to distinctive attainments in students.

Chemistry practical classes (experiments) are believed to help students in understanding theories and chemical principles which are difficult or abstract (Lagowski, 2002). Practicals offer several opportunities to students such as: handling of chemicals safely and with confidence, acquiring hands-on experience in using instruments and apparatus, developing scientific thinking and enthusiasm to chemistry, developing basic manipulative and problem solving skills, developing investigative skills, identifying chemical hazards and learning to assess and control risks associated with chemicals (Lagowski, 2002; Pickering, 1987; Carnduff and Reid, 2003; Ravishankar and Ladage, 2009). Although chemistry teaching and learning essentially involves practical work and has a long tradition of student experimental work in schools, questions have been raised about the appropriate role and the reality of what is actually achieved by the practical work especially with continued decline in performance in the subject.

Although chemistry courses at all levels include practicals where students follow procedures directing them to mix chemicals, make measurements, analyze data, and draw conclusions, Shakhashiri (2009) argues that the practicals often consists of what is generally described as "cook-book" exercises and is often dull and routine, rather than engaging or inspiring. Hence, even with the widespread use of practical work 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 its effectiveness (Abrahams & Millar, 2008). For example, Hodson (2001) wrote "despite its often massive share of curriculum time, laboratory work often provides little of real educational value" as students continue to perform poorly in the subject.

2. The Nature of Chemistry Practicals

There are two main ways of performing chemistry practicals. These are: demonstration experiments and class experiments lessons. Demonstration experiments are those lessons where the teacher performs the experiments as students observe. The demonstration can be performed in the laboratory, classroom or outside the classroom. The teacher performs a demonstration using bought or improvised apparatus. The demonstrations can be performed with or without learner participation and 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.

Class experiments are those lessons where the students perform the practical activities, make and record the observations themselves. 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 such 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. Learners can write a scientific report in which they can justify their conclusions based on the data collected. Also, in class experiments, learners can design and do their own 'open-ended' investigations. Learners reflect on the quality of the design and data collected and make improvements when and where necessary. Through discussions with the teacher, learners can interpret data in support of competing theories or explanations.

Practicals are an essential feature of secondary science education (Abrahams & Millar, 2008), hence high proportion of chemistry lesson time in secondary schools is given to practicals work with assumption that they lead to distinctive attainments in students. 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. Since the importance of practical work in school science is widely accepted, it is also important that the nature of the practicals be supportive to learning (Dillon, 2008). For many students, what goes on in the laboratory in form of practical work is said to contribute little to their learning of chemistry or to their learning about chemistry and its methods (Millar, 2009). Hence, Abrahams & Millar (2008) report that questions have been raised by some science educators about the effectiveness of practicals as a teaching and learning strategy.

3. Objectives of the Study

The study sought to achieve the following objectives:

1) To establish students' performance in chemistry in the pre-test.
2) To examine the effect of the nature of chemistry practicals on students' performance in secondary school chemistry.
3) To find out if there was a significant difference between the experimental and control groups in the performance of the post test.

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 students taught using class experiments lessons (experimental group) was compared to the performance in chemistry of the students taught using teacher demonstration lessons involving the whole class as a group (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 of either class experiment or teacher demonstration methods in teaching of the chemistry topic 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 438 Form Two students from 16 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	254	13.47	5.37
	Control	184	13.40	5.36

Table 1shows that in the pre-test, the groups' mean score were almost equal (a difference of 0.07) 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 below, shows 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	0.07

The information in Table 2 shows a t value of 4.02; $p > 0.05$, implying that the observed sdifference in pre-test mean scores of 13.47 and 13.40 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 examine the effect of the nature of chemistry practicals on students' performance in secondary school chemistry. 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	254	15.41	4.28
	Control	184	14.20	4.57

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 1.21, implying that the use of class experiments lessons when teaching secondary school chemistry 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 using teacher demonstration for the whole class. 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 in performance of the chemistry post-test between the experimental and control groups. The results are presented in Table 4.

Table 4: 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 4 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 in the experimental group and those in the control group. This indicates that students taught using the class experiment method performed better than those taught using the teacher demonstration method. This implies that performance in secondary school chemistry improves when the class experiment method is used in teaching the subject. This is in agreement with Twoli (2006) who reports that successful learning of chemistry depends on correct use of a teaching method whose activities target most learning senses.

6. Conclusions and Recommendations

6.1 Conclusion

The study found that students taught chemistry using class experiments lessons performed better than those taught using teacher demonstration lessons comprising the whole class or large groups. This implies that the nature of chemistry practicals used in the instruction of chemistry has an effect on the performance of students in the subject. Results from the study showed that the use of class experiments lessons when teaching secondary school chemistry had a positive effect on students' performance in chemistry. That is, consistent planning and use of the class experiment lessons as the teaching and learning method will lead to improvement of students' performance in chemistry. The findings confirm that the use of right nature of practicals is an effective way of improving learners' performance in secondary school chemistry.

6.2 Recommendation

Since chemistry is a subject that encourages 'hands on' experiences, then, the more practical oriented modes of instruction should be selected. Therefore, the study recommends that the nature of chemistry practicals be taken into consideration when planning and teaching secondary school chemistry in Kenyan public secondary schools.

References

[1] Abrahams, I. & Millar, R. *(2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science*. International Journal of Science Education. *30.14:* 1945-1969.
[2] Carnduff, J. & Reid, N. (2003). *Enhancing undergraduate chemistry laboratories: Pre- laboratory and post-laboratory exercises*. London: Royal Society of Chemistry.
[3] Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research (2nd ed.).* Columbus, OH: Pearson – Merrill Prentice Hall.
[4] Dillon, J. (2008). *A review of the research on practical in school science*. London: Kings College.
[5] Hodson, D. (2001). *Chemistry practicals in science: Time for a reappraisal.* Studies in Science Education, 19, 175-184.
[6] Lagowski, J. J. (2002). *The role of the laboratory in chemical education*. Retrieved from http://www.utexas.edu/research/chemed/lagowski/jjl_beijing_02.pdf (Accessed on 15th Aug, 2015).
[7] Millar, R. (2009*). Analysing practical activities to assess and improve effectiveness: The Practical Activity Analysis Inventory (PAAI).* York: Centre for Innovation and Research in Science Education. University of York.

Available from http://www.york.ac.uk/depts/educ/research/ResearchPaperSeries/index.htm

[8] Ormrod, J. E. (2003). *Educational psychology. Developing learners (4th ed.).* Columbus, OH: Merrill Prentice Hall.

[9] Reid, N. & Shah, I. (2007). *The role of laboratory work in university chemistry*. Chemistry Education Research and Practice*;* 8 (2), 172-185.

[10] Sharpe, R. M. (2012). *Secondary school students' attitudes to chemistry practicals in school Science.* Unpublished PhD thesis. University of York.

[11] Twoli, N.W. (2006). *Teaching secondary school chemistry*. Nairobi, Kenya: Nehema Publishers.