

Influence of Teaching Strategies in Chemistry Practicals on Performance in Chemistry Subject

Corresponding Author: Ronoh Obadiah Cheruiyot

Abstract

Practical assist students gain understanding into scientific knowledge by acquiring a number of scientific skills, namely cognitive, manipulative and motivational required to enhance performance. This study was done to evaluate the influence of instructional strategies in chemistry practicals on performance in chemistry in secondary schools. The objective of the study was to evaluate the influence of teaching strategies in chemistry practicals on performance in chemistry subject. The study was carried out in Narok County of Kenya. The selection of the area of study was necessitated by its dismal performance in KCSE chemistry subject which also lacked internal consistency as from the year 2012 to 2017. Pragmatism research philosophy was used. A descriptive survey plan was utilized where a sample of three hundred and seventy-seven respondents were picked in a random manner from chemistry teachers and students of Form three class from one hundred and forty five public secondary schools. Data was gathered together using questionnaire, interview and observation schedule. Additional information was obtained from analytical study of documented work. Data was analyzed using statistical package for social science (SPSS) and Analysis of Variance (ANOVA) to test hypotheses. The findings of the study indicated that lecture, demonstration, practical with no supervision was utilized. Assessment of students as they perform practical was done occasionally. Discussion method was utilized to a small extent and questions were asked occasionally. Teaching methods used are not student motivating which translated to low performance in majority of the schools. The ANOVA results indicated that teaching methods are significant to performance in chemistry ($P < 0.05$). The study concluded that teaching method has significant influence on performance in chemistry. It recommended that there is need to adopt innovative instructional methods like computer based learning, simulation and guided inquiry laboratory to enhance content mastery of chemistry concepts for better performance. The results will be beneficial to the Ministry of Education Science and Technology, Donor community, teachers, students and researchers who will do more to realign measures for effective content delivery in Chemistry.

Key words: Teaching strategies, Performance, innovative instructional methods

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I. Introduction

Chemistry subject gives a stage for creating logical proficiency and for building fundamental logical information and aptitudes for deep rooted learning in science and innovation in arrange to meet the challenges postured by these advancements (CDC, 2007). The subject is hands-on or student-centered where students carry out investigations in a research facility using materials and device to solve examination problems (Achimugu, 2012). Agreeing with Odum, (2013), Chemistry practices are usually done in a research facility utilizing pieces of device and chemical reagents. Chemistry is basically a research facility action situated subject. No course in chemistry can be considered as total without students having to demonstrate their abilities. Research facility movement, here, is utilized to depict the viable exercises which students embrace utilizing chemicals and hardware in a chemistry research facility. The initial reasons for the advancement of research facility work in chemistry education lie within the need to create gifted professionals for industry and exceedingly competent specialists to inquire about research facilities (Belay, 2012).

The challenges in the education system today are the faulty methods e.g lecture, unsupervised discussion, assignments method among others used by teachers of science especially Chemistry in instructional presentations. They have concentrated on teacher-centered methods of teaching to accomplish their classroom activities. Therefore, there is need to assess the performance at every stage to ensure consistent acquisition of both skills and knowledge as teachers prepare the learners for a competitive world of science and technology (Majali, 2010).

When students are occasionally exposed to practical activities they perform poorly in summative evaluation (KNEC, 2009) Chemistry teaching should be approached by use of investigatory methods. Experiments ought to be performed and results be carefully analyzed to promote student understanding of

concepts (KNEC, 2007). Practical approach of instruction is a requirement for all teachers and therefore students should be permitted to experiment and develop imaginative thinking skills required in the education system

Alade and Ogbo (2014) explored the learning fashion inclinations utilized by students of chemistry in both government and private secondary schools in Lagos city, Nigeria. The result appeared that there was a noteworthy relationship between learning fashion inclinations of students and their execution within the chemistry accomplishment test in both schools. Visual learning fashion was the overwhelming inclination in both school sorts. It was suggested that chemistry instructors ought to utilize an assortment of educating styles to suit the different learning styles for content delivery. An arrangement between educating and learning styles would make strides the educating, learning and execution of students in Chemistry subjects.

Uzezi and Zainab (2017) did a study on effectiveness of Guided-Inquiry Laboratory Experiments on senior secondary schools' student academic achievement in volumetric analysis. The diligent destitute execution of students in practical tests in chemistry has been faulted on destitute choice of educating strategies and destitute understanding of fundamental concepts in subjective and quantitative examination. The reason behind the investigation was to examine the impacts of guided-inquiry research facility tests on Senior Secondary School students' scholastic accomplishment in Volumetric Investigation. The discoveries appeared that guided-inquiry research facility tests had critical impact on students' scholastic accomplishment in chemistry than the conventional instructing strategy since it propelled the students to better understand chemistry concepts which was reflected in their performance outcomes. The discoveries of this consider infer that guided-inquiry research facility tests had much more impact on students' scholarly accomplishment than the conventional educating strategy. Chemistry instructors ought to subsequently consolidate it into the teaching-learning handle since it created students logical and practical aptitude, develop student enthusiasm and cultivated the soul of competitiveness among them. On the other hand, traditional instructional methods affected students' achievements. This requires the use of innovative techniques like integrated computer technology to enhance students understanding and motivation.

Danili and Reid (2012) investigated on teaching styles to improve performance in Chemistry based on two cognitive factors. The study was centred on the challenges confronting the larger part of Greek pupils' in understanding chemistry concepts and, thus, performing well within the National Examinations. Modern educating materials were developed to play down any restrictions to learning caused by working memory space and issues related with being field subordinate. The use of the modern materials was compared to the typical educating handle working with 210 Greek students matured at 15 to 16. It was found that there was a significant difference in the average improvement of the experimental group and the control group, in favour of the experimental group. This result was independent of the effect of the teacher, and of the interaction of teaching method and the teacher. It is suggested that approaches to learning must take into account cognitive factors in the learners in the context of information processing understandings of learning. If this is done, learning is much more effective.

Aluko (2008) explored the relative viability of agreeable guidelines procedure on students' execution in secondary chemistry. The test gather (experimental group), which is cooperative instructional strategy gather and a Control bunch, were utilized. The results of the examination appeared that there was a critical distinction within the execution of chemistry students uncovered to cooperative instructional methodology and customary educating strategy. The cooperative technique was found to be more compelling in upgrading way better execution of the learners.

Ibrahim, Hamza, Bello and Adamu (2018) investigated effects of inquiry and lecture methods of teaching on students' academic achievement and retention ability among N.C.E 1 Chemistry students of Federal College of Education, Zaria. Investigation of information utilizing t-test insights appeared that the test gather which was instructed chemistry utilizing request educating strategies performed essentially superior than the control bunch which was instructed utilizing the conventional address strategy (lecture). Other discoveries of the investigation were that inquiry strategy of instruction was gender-sensitive which it improved maintenance. The study suggested, among others, that chemistry instructors ought to be energized to use inquiry strategy within the educating of chemistry.

Omwirhiren, (2015) sought to determine how academic achievement and retention in chemistry is enhanced using the two instructional methods among SSII students and ascertained the differential performance of male and female students in chemistry with a view of improving student performance in chemistry. There was critical distinction in students' execution when discussion and lecture techniques were utilized to instruct chemistry ($F_{cal} = 4.65 > F_{crit} = 3.85$ at $P < 0.05$). There was noteworthy distinction within the retention capacity of students instructed using discussion and lecture strategy ($r_{cal} = 0.9786 > 0.2353$ at $P < 0.05$). Male and female students instructed using the two method showed a significant difference in performance ($t_{cal} = 3.621 > t_{crit} = 2.000$ at $P < 0.05$). In conclusion, discussion instructional strategy improved performance in chemistry significantly better than lecture strategy. The study concluded that discussion improved superior

accomplishment and efficiency than the lecture strategy and therefore proposed to its utilization to educate natural chemistry in Nigerian Senior Secondary Schools.

KCSE performance in Chemistry in Narok County has been poor and lacked consistency over the years as shown below.

Table 1: Chemistry KCSE Mean grades

Year	2012	2013	2014	2015	2016	2017
Mean Grade	2.783	2.766	2.775	3.887	2.534	2.316

From the mean grades, it can be concluded that the performance in Chemistry in the County is poor and inconsistent. In this science subject practical paper determines candidates' mean grade to be awarded and therefore when practical paper is not performed well then the overall grade of the student drops. This study was conducted to evaluate the influence of teaching strategies in chemistry practicals on performance in chemistry in secondary schools.

II. Methodology

Pragmatism research philosophy was utilized where both quantitative and qualitative data were used to define relationships between the two variables Sauders, Lewis and Thornhill (2012).

A descriptive survey plan was utilized where a sample of three hundred and seventy- seven respondents were picked in a random manner from chemistry teachers and students of Form three class from one hundred and forty five public secondary schools. The results were then generalized to the larger population (Best and Khan 1993).

The study was carried out in Narok County of Kenya. The selection of the area of study was necessitated by its dismal performance in KCSE chemistry subject which also lacked internal consistency as from the year 2012 to 2017. The County long-delayed in the provision of excellent education to the learners which is attributed to infrastructure that is not fit for instruction NAYS, (2015)

There were 145 secondary schools in the County at the time research was being carried out. Population targeted consisted of 365 chemistry teachers and 6,314 students from Form three class which made a total of 6679 respondents. The class was chosen because in it many topics are practical centered. The population targeted was stratified as shown below

Table 2: Population Targeted

Respondents	Target population
Chemistry teachers	365
Students	6,314
Total Population	6679

Source: County Education Office, (2019)

The sample size was determined by using Yamane's Taro formula, $n = \frac{N}{1 + N(e)^2}$. Where n= Sample size, N=Population, e= acceptable sampling error of plus or minus 5% (0.05). Hence the results were given by;

$$n = \frac{N}{1 + N(e)^2}$$

Where;

n = the sample size, N = the population size, e= the acceptance sampling error

$$= \frac{6679}{1 + 6679(0.05)^2}$$

$$= \frac{6679}{1 + 16.6975}$$

$$= \frac{6679}{17.6975}$$

$$= 377 \text{ respondents}$$

Stratified sampling formula was used to calculate the proportion of respondents Neville & Sidney (2013)

where, (Sample size of the strata = size of entire sample / population size * layer size)

$$n_h = (N_h / N) * n$$

Where n_h is the sample size for stratum h, N_h is the population size for stratum h, N is total population size, and n is total sample size as given below (Table 3).

Table 3: Sample Frame

Respondents	Target population	Sample distribution
Chemistry Subject	365	21
Students	6,314	356
Total	6679	377

Different sampling techniques were used. Cluster sampling technique was used to divide the schools into sub Counties. The schools were selected for study using simple random sampling. Purposive sampling was used to select one chemistry teacher and proportion of Form three students. The sample was obtained through lottery.

Questionnaire, Interview and observation schedules were used as the main research tools in the study. Data were analyzed using SPSS and Analysis of variance (ANOVA). Data were then presented using tables.

Teaching Methods and Chemistry Performance

The results of teaching methods and Chemistry performance were obtained from questionnaire, interview and observation schedule. The results from the questionnaire were presented using frequencies, percentages and mean. The mean value was calculated from Likert scale using codes where 1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The results from the questionnaire were presented in Table 4.

Table 4: Teaching Methods and Chemistry Performance

Questions	5(SA)	4(A)	3(N)	2 (D)	1 (SD)	Mean
The teacher uses chemistry practical lessons to teach.	22(6.7%)	48(14.7%)	70(21.5%)	76(23.3%)	110(33.7%)	2.37
The teacher often conduct chemistry practical during practical lessons	27(8.3%)	83(25.5%)	95(29.1%)	81(24.8%)	40(12.3%)	2.93
Titration Demonstrated as learners observes	40(12.3%)	71(21.8%)	113(34.7%)	64(19.6%)	38(11.7%)	3.03
The students does practical without supervision of the teacher	36(11.0%)	88(27.0%)	113(34.7%)	71(21.8%)	18(5.5%)	3.16
Teachers assess learners in practical sessions	39(12.0%)	88(27.0%)	108(33.1%)	56(17.2%)	35(10.7%)	3.12
Students are motivated by the teaching method deployed during practicals	47(14.4%)	120(36.8%)	93(28.5%)	44(13.5%)	22(6.7%)	3.39

Source: Research Data (2019)

Table 4 investigated teaching methods on performance in chemistry practical. The results revealed that majority of teachers did not use chemistry practical lessons to teach chemistry where 22(6.7%) strongly agreed, 48(14.7%) agreed, 70(23.3%) neutral, 76(23.3%) disagreed and 110(33.7%) strongly disagreed. However, few teachers used chemistry practical lessons to teach chemistry theory (mean of 2.37) as compared to those who did not. This indicated that there are teachers who converted practical lessons to teach chemistry content.

The question on whether the teachers conducted chemistry practicals during practical lessons. The findings were 27(8.3%) strongly agreed, 83(25.5%) agreed, 95(29.1%) neutral, 81(24.8%) disagreed and 40(12.3%) strongly disagreed. This implied that teachers often conducted chemistry practical to a small extent during practical lessons (mean of 2.93). Therefore, some of the practical lessons were converted to teach chemistry content denying the students opportunity for practical exposure.

The findings revealed that 40(12.3%) strongly agreed, 71(21.8%) agreed, 113(34.7%) neutral, 64(19.6%) disagreed and 38(11.7%) strongly disagreed that teachers demonstrated titration experiments as the students observed a mean of 3.03. It implied that demonstration method was used to a small extent as indicated by the results.

The students did carry out practicals on their own without supervision of the teacher to some extent. This explained by 36(11.0%) strongly agreed, 88(27.0%) agreed, 113(34.7%) neutral, 71(21.8%) disagreed and 18(5.5%) strongly disagreed. The results indicated that to small extent students carried out practical lessons on their own without supervision of the teachers (mean of 3.16). This teaching method might result to low performance where there is no supervision of students during the actual practical activities.

According to the results on if teachers assessed the students as they proceed with practicals, 39(12.0%) strongly agreed, 88(27.0%) agreed, 108(33.1%) neutral, 56(17.2%) and 35(10.7%) disagreed. The teachers moderately assessed the students as they proceed with practicals (mean of 3.12). Low assessment as indicated by the results impacted negatively on chemistry practical performance and the entire subject.

It was also investigated if students were motivated by the teaching method deployed by the chemistry teachers during practical lessons. It was found that 47(14.4%) strongly agreed, 120(36.8%) agreed, 93(28.5%) neutral, 44(13.5%) disagreed and 22(6.7%) strongly disagreed. Hence, chemistry teachers deployed teaching methods that made the students to be motivated when handling practical to small extent (mean of 3.39). There is need to improve on the teaching methods utilized for better performance. Practical subject requires adaptation of innovative pedagogy for example use of integrated computer technology and simulations to enable the students internalize instructions and enhance motivation.

Interview Results

Interview results on the use of lecture methods in instruction of practical content showed that majority of the teachers' integrated lecture with experimental method in content delivery. Chemistry teacher 3 alluded that "I utilized lecture method when reviewing the lesson, introducing the topics and explaining concepts. I integrate the method with demonstration before the students handle actual experiments. This was possible because majority of practical lessons are double (80 minutes) which gives enough time for utilization of the methods."

In response on how often they carried out practical in chemistry, the entire respondents indicated that chemistry practical were done as timetabled while the single lessons were utilized for teaching chemistry theory. A few Chemistry teachers used extra time on Saturday to further their chemistry practicals. For instance, Chemistry teacher 3 commented that "yes, we often conduct practicals as per the timetable. But sometimes we utilize free time, morning or evening hours to give the students more practicals which have significantly improved the performance of chemistry as a subject in our school". Interview question that examined if the chemistry teachers demonstrated practical activities showed that majority utilized demonstration method before students conducted practicals on their own. Demonstration made the students understand the processes. This was explained by chemistry teacher 5, "teachers must demonstrate the practical since it enabled the students to understand how to manipulate the apparatus. The notion that chemistry practicals are hard could be demystified through demonstration enabling the students develop both knowledge and positive attitude towards the subject".

Finally, all teachers commented that chemistry practical was handled both individually or in groups based on availability of apparatus and reagents and the intensity of the practical. The response from chemistry teacher 10 alluded that "Both are significant and there are some practicals that needed individual students to conduct especially titration since the skills must be impacted to the individual. Some needed group based due to lack of sufficient apparatus and reagents or they needed general demonstration where the reagents reacted explosively like sodium and potassium based experiments". This showed conclusively that individual practical or group practical or demonstrations are applied at different levels to pass a specific skill based on resource availability. Despite the use of demonstration, practical or lecture method teachers interviewed did not point to the use of innovative methods which could have assisted in improving performance.

III. Observation Results

Observation schedule obtained data for teaching methods where mean and standard deviation were analyzed. The results were presented in Table 5

Table 5: Observation on Teaching Method

	N	Mean	Std. Deviation
Students are allowed to discuss and ask questions in the practical session	21	3.0476	.66904
Students have high practical skill	21	2.5714	.59761
Teachers assessed the practical done by the students	21	2.8095	.67964

Source: Research Data (2019)

Results from table 5 indicated that students were allowed to discuss and ask questions to low extent during the practical session (mean of 3.0476). Variation was low in students' discussion and question asking (standard deviation of .66904). Students had low practical skills (mean of 2.8095). Variation was low in practical skills (standard deviation of .59761). Teachers assessed the student's practicals to small extent (mean of 2.8095). Variation was low in practical assessment (standard deviation of .67964).

ANOVA results

The finding of teaching method and chemistry performance were further investigated using ANOVA analysis indicated below.

Table 6: ANOVA Teacher Method and Chemistry Performance

		Sum of Squares	df	Mean Square	F	Sig.
Performance in chemistry practical * Teacher contribution	Between Groups (Combined)	80.112	4	20.028	41.673	.000
	Within Groups	154.271	321	.481		
	Total	234.383	325			

Source: Research Data (2019)

In table 6 indicated that teaching methods used by the teacher had significant influence on performance in chemistry ($F_{(P=5\%, 4,321)}=41.673$, $P = 0.000 < 0.05$). F- ratio is 41.673 means there was greater dispersion. $P < 0.05\%$ value is less than 5% means that there is a significant relationship between variables. Null hypothesis is rejected and alternative hypothesis is accepted. The results revealed that teaching methods play a major role on performance in chemistry as a subject. Teaching methods used in practical had a significant effect in chemistry practical performance.

IV. Discussions

The results indicated that majority of teachers did not use chemistry practical lessons efficiently mean of 2.37. Few of the teachers were found using chemistry practical lessons for actual practical purposes while some used the lessons to teach chemistry content. Demonstration method, practical with no supervision were used mean (3.03 and 3.16). Teacher assessment was done occasionally mean 3.12. The current teaching methods used are not student motivating mean of 3.39. Majority of teachers integrated lecture with experimental method for content delivery. Demonstration method was utilized before the students could handle the experiments on their own. Laboratory activities were done individually or in groups depending on the nature of experiments and availability of apparatus although this was affected by lack of supervision and assessment which was done occasionally. This made the students perform below average in practical exams and the entire subject. There is need to adopt innovative instructional methods that would allow students develop required skills for examination and be motivated towards the subject. When student centered methods are used with proper supervision and assessment they improve on performance and on the contrary, where students are left to work on their own without supervision and assessment they will not perform well in practicals and in the final examination.

ANOVA results revealed that teaching methods are significant to performance in chemistry ($P < 0.05$). Demonstration and supervised practicals, assist in improving performance in chemistry practicals. But in the study practical supervision, assessment and question asking were low making students to develop science skills to a small extent. This affected practical outcomes and performance in the subject negatively. This concurred with observation results where students discussed and asked questions to a small extent and had low practical skills as well as their teachers did not often assess them in practicals. The results from Alade and Ogbo (2014) were associated with learning style which had positive significant effect on the performance in chemistry concurring with current research. They were associated with visual learning style which was highly utilized while the current research used lecture, demonstration and student practical that lacked supervision. This showed that there is need for a shift towards Integrated Computer Technology (ICT) to improve performance in chemistry and other science based subjects.

Okwiduba and Okigbo (2018) found significant effect of teaching methods on academic performance with respect to problem solving, student group learning and instructional material based learning as well as simulation which contributed positively on academic performance. The current study found that majority of schools still adopted traditional teaching methods that were teacher centered but students participated in practical activities with less supervision which reduced the effectiveness of the teaching method.

On the contrary Uzezi and Zainab (2017) investigation on Guided-Inquiry Laboratory Experiment showed that it had significant improvement effect as compared with traditional methods in volumetric analysis. The current research which is mainly traditional through demonstration can be improved to enable students gain problem solving experiences and other skills through Guided-Inquiry Laboratory Experiment. Similar results were also found by Ibrahim *et al*, (2018) where inquiry method had significant effect on academic performance than traditional methods. Their findings cut across all the subjects taught to students contrary to Uzezi and Zainab (2017) where it concentrated on Chemistry.

In a related research by Danili and Reid (2012) based on strategies to improve performance showed that teaching methods were highly dependent on laboratory materials and resources where experimental group performed better than controlled group (group instructed using traditional methods). It is important to improve in resource allocation. Similarly, cooperative instructional group was experimented where the results obtained showed that there was improvement than traditional methods. The current research finding indicated that majority utilized demonstration method hence there is need to improve on teaching methods in Kenyan secondary schools.

Discussion method was also found to be significant according to Omwirhiren (2015) which was contrary to the current research where demonstration and student based experiment with less supervision were studied. Discussion method used by the experimental group performed better in Chemistry than controlled group who used lecture method. Therefore, there is need to improve the instructional methods through adopting new methods like cooperative methods, computer based learning and guided inquiry laboratory methods in chemistry practicals as opposed to the traditional methods.

V. Conclusions

Teachers integrated lecture, demonstration and experimental methods for content delivery. Practicals were done as timetabled without teacher supervision and assessment was occasional. Instructional methods deployed were not motivating. Laboratory activities were done individually or in groups depending on the nature of experiments and availability of apparatus. Discussion method was utilized to a small extent and questions were asked occasionally. Teaching method has significant influence on performance in chemistry.

VI. Recommendations

- Teachers should utilize student centered participatory approaches more often like guided inquiry laboratory method, cooperative learning, computer assisted instruction than demonstration to master subject content.
- School principals should improve in teacher supervision especially during laboratory sessions and provide professional advice for proper selection of instructional strategies.

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