Micro Science Kits Intergration Approach: The Effect on Students' Acquisition of Process Skills in Kenyan High School Physics

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Abstract: **This study investigated the effect of integrated micro science kits on student's acquisition of practical skills in physics practical work in form two students in Kakamega Central sub-county. Two research objectives guided the study and two null hypotheses were postulated and tested at 0.05 level of significance. The study utilized quasi experimental design; specifically pre-test-post-test non-equivalent control group design. The sample consisted of six hundred and forty one (641) form two physics students. Two groups of the form two physics students from 16 secondary schools were a signed as experimental and control groups who participated in the study. The experimental group consisted of 319 students from 8 schools. They carried out experiments using micro science kits. The control group consisted of 321 students from the other 8 schools. The control group performed experiments using conventional apparatus. A Physics Process Skill Checklist (PPSC) was used for Data Collection. The instrument was validated by experts and the reliability co-efficient obtained was 0.84 using the test-retest method and followed by the Pearson Product Moment Correlation analysis. The data collected were analyzed using mean and standard deviation as descriptive statistics while t-test and analysis of covariance (ANCOVA) were the inferential statistics used to test the hypotheses test at 0.05 level of significance. The results revealed that students' use of micro science kits had a significant effect on science process skill acquisition in physics practical work. It also revealed that school type was a significant factor in students' science process skill acquisition in physics. Based on the findings of this study, it was recommended among others that teachers' should update their knowledge on the integration of micro science kits in teaching of practical work for enhancement of students' acquisition of science process skills in physics**

Key Terms: **Micro kit integration, Conventional physics apparatus, Acquisition of process skills in physics, School type.**

I. INTRODUCTION

Science education is a great enterprise upon which nations depend for development. It has the potential of developing citizens in an overall and integrated manner, such that they are scientifically and technologically literate and competent in scientific skills. Science education also leads to practice of good moral values, scientific and technological advances. It makes individuals to manage nature with wisdom and responsibility for the betterment of mankind (Kenya Institute of Curriculum Development, 2018). In Kenya, science is a core subject in the school curriculum for students from primary to secondary schools. The science curriculum comprises three core science subjects. The core science subjects(physics, chemistry and biology) at the secondary level is designed to produce students who are literate in science, innovative and able to apply scientific knowledge and process skills in decision making and problem solving in everyday life. The science subjects prepare students who are more scientifically inclined to pursue the study of science careers at the post-secondary level. Physics education is offered to students at the secondary level beginning in form one to form four. The subject is optional in the upper secondary school curriculum at form three and four.

Physics is one of the subjects in science education. It is an integral part of science that focuses on the study of matter, energy and their interactions (Chu & Lin, 2002). It plays a key role in the future progress of mankind. The interest and concerns of physics education form the basis of technology. Physics plays a major role in health education, economic development, energy and environment. The x-rays, radioisotope nuclear resource imaging, laser electron, microscope, synchrotron radiator among other advances in medicine depend on physics (Kola, 2013). The knowledge of electronics and quantum physics has enabled development of computers technology (Viladya, 2003). Our world is more connected through them and the conduction of business around the world is done almost effortlessly (Olufunke, 2012).

According to Abdullah , Ismail & Mohamed (2014), one of the unique features of effective science teaching is laboratory practical work. It is a unique learning environment that is effective in helping students construct their knowledge, develop logical and inquiry type skills and develop psychomotor skills. Practical work may be considered as engaging the learner in observing or manipulating real or virtual objects and materials (Millar, 2004). Appropriate practical work enhances learners experience, understanding, skills and enjoyment of science. Practical work enables the students to think and act in a scientific manner. The scientific method is thus emphasized. Practical work can induce scientific attitudes, improve conceptual understanding and enable learners develops science process skills.

Obialor 2017, reported that science process skills are the activities which scientists employ in carrying out scientific investigation in order to arrive at new knowledge. Science process skills can also be described as mental and physical abilities and competences which serve as tools needed for the effective study of science and technology as well as problem solving , individual and societal development (Nwosu and Okeke as cited in Akinyemi, 2010). Realizing the importance of science process skills as solution to scientific problem and national development, the Kenyan government put in place various initiatives concerning the teaching, learning and performance of sciences in general and physics in particular. The Ministry of Education has initiated the Strengthening of Mathematics and Sciences in Secondary Education (SMASSE) project to address this (SMASSE baseline report, 1998). For over twenty years, the programme has been involved in in-service capacity building of mathematics and science teachers. The thrust of SMASSE has been to improve on methodological intervention to make content delivery more meaningful for the learner (Amadalo & Wesonga, 2016)

Muchai & Twoli (2017) indicated that science process skills, necessary for the world of work are systematically developed. Twoli, 2006, asserts that through the practicals in Physics, the abstract ideas can be concretized and it also motivation and interest for learning Physics. Students tend to learn better in activity based courses where they can manipulate equipment and apparatus to gain insight in the content. According to Gladys (2013) the basic science process skills are useful in science and non-science situations while the integrated skills are the working behaviour of scientists and technologists. Thus, both basic and integrated science process skills are relevant and appropriate for all science subjects, at the senior secondary schools. Hence, there is need to find out the level of acquisition of the process skills, including the factors influencing their acquisition; and also to identify the science process skills inherent in the science practical examination in Nigeria. Process skills are very fundamental to science which allows students' to conduct investigations and reach conclusions; but there is still a serious educational gap in this area both in bringing these skills into the classroom and in the training of teachers to use them effectively.

Despite the various effort by government, various agencies, professional bodies to emphasis on students mastering of science process skills due to its central role in nations development and solution to scientific problem; there is still non acquisition of science process skill (Amadalo, Ocholla & Memba, 2012); and students may pass through their secondary school without acquiring enough scientific process such as observing, classifying , measuring, experimenting, manipulating, and hypothesizing (Obialor, 2016). Several factors have been identified as being responsible for this ugly and wholesome situation. One of the factors identified was teachers' instructional strategies (Nwagbo, 2001). Twoli (2006), asserted that most science teachers still prefer lecture method of teaching, that is, a teaching method in which the teacher presents a spoken discourse on a particular subjects and avoid the use of activity- oriented teaching method which are student- centered such as inquring method, discovering method, investigative laboratory approach. Obialor (2016), maintained that such teaching centre approach in which there is steady flow of information going from the teacher to students and students being passive listener do not enhance achievement or process skill acquisition needed for proper understanding of physical concepts.

One solution to overcome problems associated with physics practical work would be through the implementation of micro science kits. The use of micro science kits is a laboratory-based, environmentally safe, pollution-prevention approach which is accomplished by using miniature glassware and significantly reduced amounts of chemicals (Singh, Szafran & Pike, 1999). Micro scale physics involves techniques such as: improvisation of apparatus and equipments from locally available materials, use of economical laboratory apparatus that can be used even in absence of laboratory buildings. Such apparatus include micro science kits. It is an innovative method of teaching that promotes practical work through aesthetic micro-laboratories (Mohan, 2004). It also involves organizing for Science Fair Projects where students come up with research projects on areas that are of environmental concern and hence come up with the way forward.

The use of micro science kits in Kenya has not yet been empressed especially in Physics. However some efforts have been done to introduce use of micro kits in Chemistry in some schools (Wandiga, 2008, Michieka, 2009). There are some draw backs reported that include: lack of awareness and exposure, lack of policy supporting the implementation from stakeholders in the ministry of education and schools in the country and low accessibility to the micro kits. Besides these challenges, the advantages that come with micro science kits are enormous. These miniaturized equipment are worth being used in Physics practical work to improve the learner's achievement. Apart from teaching method/ strategy used by the teachers in teaching the students; school type may be implicated in students' acquisition of science process skills.

The Problem

The performance of students in secondary school Physics in Kenya has remained consistently poor. A survey of the performance of candidates in Physics in Kenya over the years reveals a worrying decline. The decline is noticed in spite of the various reforms and interventions from the ministry of education.

This situation remains a source of concern to educational experts and Science educators. It is possible that these various improved instructional materials and strategies have failed to improve the performance of candidates in physics because they could be expensive and therefore not usually implemented. It is also possible that even where these materials and methods are used, they still fail to produce results because students are not usually told before the lesson what they are expected to learn.

Thus, this study sought to determine the effects of integrating micro science kits on students' acquisition of science process skills in Physics practical work.

Purpose of the study

The purpose of the study is to investigate the effect of students' acquisition of science process skills when taught practical work using micro-kits compared to those taught using conventional apparatus.

The objectives of the study

a) To compare the overall practical skills acquisition of students taught practical work using micro science-kits with those taught using conventional laboratory apparatus
b) To determine whether there is a difference in the process skills acquisition in terms of school types by students taught practical work using micro science kits with those taught using conventional laboratory apparatus.

The Hypothesis of the Study

Ho1: There is no significant difference between the mean process skills acquisition scores of students taught using micro science kits and those taught using conventional laboratory apparatus physics practical work.

Ho2: There is no significant difference between the mean scores of process skills acquisition based on school type in physics practicals when taught using micro science kits and conventional laboratory apparatus.

II. RESEARCH DESIGN

The study utilized the two group pre-test, post-test quasi-experimental design. The subjects were selected according to streams at form two in each selected secondary school. Schools were chosen using random sampling. Each school produced one stream. Eight school formed experimental group which received the treatment i.e. use of micro science kits. The other eight schools were the control group which used conventional apparatus.

The Sample

The sample for the study from the 16 schools is shown in table 1 below.

Table 1: The overall sample for the study

Groups	Participants from County schools	Participants from Sub-County schools	Total
Experimental	80	239	319
Control	81	240	321
Total	161	479	640

There were 161 respondents from County schools. Of these, 80 formed the control group and 81 formed the control group. There were 479 respondents from Sub-County schools (also designated as District schools). Of these, 239 and 240 respondents formed the experimental and control groups respectively. In total the experimental group had 319 respondents while the control group had 321 respondent. The total respondents who took part in the study were 640

Research Instruments

The Physics Practical Skills Checklist (PPSC) was used to collect data on practical skills acquisition before and after post-test of achievement test (PPAT2). Data collection was done in term one. The duration between the pre-test and post-test was four weeks of continuous instruction to both experimental and control groups. Each week comprised of four (4) periods and each period was a forty minute(40) sessions. The treatment was conducted on the topic of Cells and Simple circuits. The Physics practical skills checklist (PPSC) consisted of 9 items. The items were classified according to types of practical skills. Thus the skills were categorized as: Experimental skills, Experience skills and Investigation skills. The checklist had scale rating of the level of how the respondent found the practical activities during the lessons for each skill as (E) Easily (NS) Not sure (D) Difficult. Frequency distributions were determined for each type of practical skill on (PPSC) for both Experimental and Control groups and skills acquisition mean scores determined. The mean scores were compared to determine the level of practical skills acquisition.

III. RESULTS AND ANALYSIS

The study utilized both descriptive and inferential statistics. The descriptive statistics used were; mean and standard deviation. An independent t-test and Analysis of covariance (Ancova) were used for significance of difference in physics practical skills acquisition between groups at $\alpha=0.05$ was considered significant.

The findings of the study

This is provided under findings concerning skills acquisition (experimental, experience and investigation skills) and process skills acquisition based on school type.

First Objective

Overall Practical Skills Acquisition after Instruction

Table 3 below shows the overall mean scores for pre-test and post-test results for the study in terms of experimental and control groups considering the process skills under(experimental, experience and investigation skills). Standard deviations for both groups are also provided.

Table 2: Descriptive of the pre-test and post test scores for experimental and control groups

Groups / Process Skills	N	Pre-test Mean	Pre-test Standard Deviation	Post-test Mean	Post-test standard deviation	Mean Gain
Experimental	319					
Experience Skills		51.48	12.66	86.44	20.56	
Experimental Skills		49.95	11.97	82.21	19.55	20.7
Investigation Skills		50.42	12.36	85.02	20.22	
Control	321					
Experience Skills		47.21	10.82	53.54	12.93	
Experimental Skills		50.11	12.11	62.5	15.34	11.3
Investigation Skills		48.60	11.26	55.39	13.17	

The mean post-test scores from (PPSC) indicates that there is a difference in performance between the two groups (70.6 for the experimental group and 62.5 for the control group). The mean score of the experimental group was significantly higher than that of the the control group. The standard deviation of the experimental group was lower than that of the control group. The independent samples t-test results yielded a value of 4.80 which was higher than the tables critical value of 1.93. This indicates that the post-test results were significantly different, attributable to the micro-kit intervention.

IV. HYPOTHESIS TESTING

First Hypothesis

Ho1: There is no significant difference between the mean skills score of students taught using micro science kits and those taught using conventional laboratory apparatus physics practical work.

Table 3: Independent Samples t-test of PPSC on Investigation

TEST INSTRUMENT / SKILLS	Experimental Group		Control Group		t-value	Significance value (p< .05)
PPSC	MEAN	S.D	MEAN	S.D	21.89	.000
Investigation Skills	85.02	20.22	55.39	13.17		
Experimental Skills	82.21	19.55	50.14	11.92	24.97	.001
Experience Skills	86.44	20.56	53.54	12.73	24.26	.000

To test the second hypothesis (H02), a t-test was performed for the investigation skills and a value of (t=21.89, p=.000) at α=.05 was obtained. For experimental skills, a t-test was performed and a value of (t=24.97, p=.001) at α=.05 was obtained and for experience skills, a t-test was performed and a value of (t= 24.26, p=.000) at α=.05 was obtained. From the initial indication, the second hypothesis (H02) which states that there is no difference in student's acquisition of Physics practical skills when taught using micro science apparatus compared to the use of traditional apparatus was rejected.

Second Objective

The results under the second objective is presented as descriptive statistics then followed by test of hypothesis one. The second objective was to determine the effect of teaching using micro science kits and conventional laboratory apparatus on students' acquisition of process skills in physics practical work based on school type.

Comparison of post-test scores for the schools categories was done. The categories were County and Sub-County (district) schools. There were 480 students from the Sub-County schools and 160 respondents from the county schools. Their results were as shown in table 3.3.

Table 4: Descriptive Statistics

Dependent Variable: post- test skills				
GROUPS	School type	Mean	Std. Deviation	N
Micro science Kits	County	67.8000	13.775	80
	Sub County	80.9545	11.239	239
Conventional Apparatus	County	57.0000	16.631	81
	Sub County	49.1250	20.267	240
Total	County	63.0968	15.900	161
	Sub County	67.5526	22.178	479
	Total	64.7900	18.556	640

The result shown in Table 4 above revealed that the post-test mean attitude scores in terms of gender and were exposed to micro science kits and conventional laboratory apparatus were higher than the pre-test mean scores. The attitude mean score of students that used micro science kits for male was 72.277 while that of female was 66.682. This indicates that male students that used micro science kits attained a better attitude change than their female counterpart. The results also showed the attitude scores of both male and female students that used conventional laboratory apparatus. The male students had a mean of 61.803, while the female students had a mean of 61,324 indicating that the male students had a slightly better attitude change than the female students.

Second Hypothesis

Ho2: There is no significant difference between the mean attitude scores of male and female students in physics practicals when taught using micro science kits and conventional laboratory apparatus. To test the hypothesis, an Ancova was performed to determine the interaction effect between gender and treatment. The results are shown in Table 5

Table 5: Tests of Between-Subjects Effects

Dependent Variable: post test skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11640.200[a]	4	2910.050	12.315	.000	.341
Intercept	25982.375	1	25982.375	109.956	.000	.536
Pretest skill	9.914	1	9.914	.042	.838	.000
Group	9842.631	1	9842.631	41.653	.000	.305
School type	156.079	1	156.079	.661	.418	.007
Group * School type	2537.132	1	2537.132	10.737	.001	.102
Error	22448.390	95	236.299			
Total	453863.000	100				
Corrected Total	34088.590	99				

a. R Squared = .341 (Adjusted R Squared = .314)

From Table 5, it was shown that the interaction between gender and treatment was not significant since its calculated (F 1,95)= 1.441, *P*=.23 at α=.05 . Since calculated *P*>.05, the null hypothesis is upheld. This implies that there is no significant difference between the mean process skills acquisition of male and female students in practical work based on micro science kits usage and conventional laboratory apparatus.

V. DISCUSSION OF THE FINDINGS

The study findings on experimental skills concur with those of Coil, Wenderoth, Cunningham & Dirks, (2010), in their study involving university and high school faculty they stressed the importance of practical experimental skills as the foundation of the scientific enterprise for learners. They indicated that the skills were gained principally through experimentation and practical work. Salim, Pute & Daud, (2011) have reported that important experimental skills are gained when students directly engage in laboratory experiment work in Jordan. Such skills include: circuit connection, reading instrument scales, recording the obtained readings and interpreting the findings. This research found out that these skills were gained more by the experimental group than the control group.

The findings on experience skills are in agreement with those of Haggeis, (1991) in his study, he reported that before learners can understand a thing, they need experience; seeing, toughing, hearing, tasting, smelling, choosing, arranging, putting things together and taking things apart.Hodson, (1994) says that the first step towards making sense of our world is familiarization with that world. Sense making is determined by our experiences, specifically experiences which are not merely events which happen, but events which connect with other experiences to make things meaningful. The current study findings also concur with those of Duckworth, (1992), he reported that practical work may provide students with experience which reinforce theoretical ideas they encounter and may help make sense of their world. Learning involves toying with ideas in an attempt to reduce complexities until simple and elegant generalizations emerge. It involves time to explore and become thoroughly familiar with objects and ideas.

Findings on investigation skills agree with those of Ssempala, (2005) who reported that practical work bequeathes on the learners the ability to manipulate equipment, make clear and detailed observations, report and record results accurately in Uganda. The findings also concur with those of Kandjeo-Marenga(2011) who found out that teacher demonstration led to little learner acquisition of pertinent science practical skills. Baser & Durmus, (2010) have shown that there is no difference in investigation skills attained through actual laboratory activities or through virtual learning environment in direct current electricity amongst pre-service elementary teachers.

VI. CONCLUSION

The use of micro science kits appears to improve the student's process skills in secondary school Physics practical work. This suggests that teachers of Physics have to recognize the potential of instruction in influencing student's acquisition of practical skills and general performance improvement in the subject. This shows that poor performance in examinations can be mitigated by careful selection of instructional intervention styles and materials.

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