Enhanced Learners' Attitude towards Physics Practical's: The Micro Science Kits Experience in Kenya

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Abstract: **This study investigated the effect of integrated micro science kits on student's attitude towards physics practical work in form two students in Kakamega Central sub-county. The study adopted a quasi-experimental research design, randomized pretest – posttest experimental design. Two groups of the form two physics students from 16 secondary schools were assigned to experimental and control groups who participated in the study. The Students Attitudes Questionnaire (SAQ) was used to collect data for the study. Reliability was tested using Cronbach coefficient alpha to determine the internal consistency of the questionnaire items; A Cronbach's Coefficient Alpha of 0.814 was obtained. The collected data were processed and analyzed using descriptive and inferential statistics. The descriptive statistics included means and standard deviations. Inferential statistics used was a t-test and tested at $\propto = 0.05$ significance level. The data was analyzed using SPSS version 16. The findings indicated that students that used the Micro science kits performed better than those that used the conventional laboratory apparatus in physics practicals. The integration of practical work with the theory is deemed to have contributed to the positive response of attitude detected**

Key Terms: **Micro kit integration, conventional physics apparatus, Attitude towards physics,**

I. INTRODUCTION

The challenge in science education is creating a learning environment that helps students construct their knowledge, develop inquiry and psychomotor skills. Practical work has great potential of promoting positive attitudes and providing students with opportunities to develop science process skills ((Millar, 2004). The role of practical work is crucial to the learning and teaching of science (Woolnough and Allsop, 1985). The learning of science should involve seeing, handling and manipulating real objects and materials. Depending on the design of the activity it can become a powerful tool for making concrete a subject which is abstract and inherently difficult to understand.

Throughout the world, national education policies are geared towards creating generally scientific literate citizens. In Kenya, the National Education Policies clearly state aims and objectives that the learner would be given opportunity to acquire basic practical skills for self-reliance and employment. In realization of this laudable objective, the Kenyan government has taken a step of changing it's education system from 8-4-4 to Competency Based Curriculum (CBC) which is more practical oriented designed by the Kenya Institute of Curriculum Development (KICD). Practical activities should be an integral part of the teaching and learning of science in secondary schools because it offers first-hand knowledge of science concepts. One thing that is certain is that science educators agree about the values of practical activities in science teaching. Huxley in Buseri (1989) recognized the relevance of practical activities to the extent that he expressed that "if scientific training is to yield its most eminent results, then it must be made practical".

Physics is the science of experimental evidence, criticism, and rational discussion where knowledge and understanding of its concepts depends on the perception of the physical phenomena. According to Faour & Ayoubi (2018) meaningful learning, can be achieved when laboratory activities become an integral part of the science curriculum. Learning science has been restrained by the deficiency or inadequacy of laboratory equipment in schools (Onyesolu, 2009). As a result of this, Physics education has been perceived as an abstract and difficult subject. The current practice in developing countries (including Kenya), is to strive toward providing practical work experience for learners studying science. From this standpoint, there is need to explore new and unconventional alternative laboratory environment where students can conduct the different required experiments at any time and in safe conditions. One of the solutions that may help in overcoming these obstacles can be the use of micro science kits.

Research shows that a large number of students performance are affected by their attitude towards specific subjects, Education and academics generally. According to IRWANTO, Eli ROHAETI, and Anti Kolonial PRODJOSANTOSO(2018) Scientific attitudes refer to the phenomenon on how the students think, feel, and perform logical and systematical actions (Cavas, Ozdem, & Cavas, 2013; Kapici & Akçay, 2016; Montes, Ferreira, & Rodríguez, 2018; Schwarz, 2007). Several previous research indicate that scientific attitudes are extremely needed in learning. Scientific attitudes are one of the factors that motivate the students (Al-Rabadi, Al-Momani, & Al-Rabadi, 2013) and simultaneously determine their achievement in science learning (Ali, Iqbal, & Akhtar, 2015; Brown et al., 2015; Findings by Wasanga (2009) on the attitude between primary and secondary schools

in Kenya reveals that student have moderately positive attitude towards science. Factors identified to have influence on the perception of learners included: the opinion that science is difficult and abundance of poor teaching approaches where teachers did not explain well concepts to student. If students have a positive attitude towards the Physics practicals, they put in more effort to ensure they achieve higher scores. However if the attitude is negative the learners will not have interest in the subject and this could lead to poor performance in the subject.

Bennett, (2003) makes the distinction between attitude towards science and scientific attitudes. According to him, attitude towards science is linked with the views and images that the individual develops about science as a result of interaction with different situations. On the other hand the term scientific attitude is linked to the way of thinking or scientific method, which covers the skills and is related to the undertaking of practical work. Attitude towards science denotes interest or feeling towards studying science (Yara, 2009).

In Kenya, various initiatives have been put in place to address the aspects of poor performance in physics education. The Ministry of Education has initiated the Strengthening of Mathematics and Sciences in Secondary Education (SMASSE) project (SMASSE baseline report, 1998). For over twenty years, the programme has been involved in in-service capacity building of mathematics and science teachers. However, the Physics results show that the performance has not improved as expected. One wonders whether this persistent low result is due to students' attitude.

The micro science system uses small-scale equipment which is cost-effective, versatile, convenient and robust, and demands no special infrastructure. Thus microscale kits can be used as an excellent alternative to traditional equipment on the grounds of lower costs, greater safety, and lesser environmental impact. Micro scale experimentation strategy is an activity-based instructional approach. It was utilized in the national program for the science course for "educating scientifically literate individuals" (MEB, 2013 in Aktamis, Hidge&Ozden, 2016). In using micro scale experimentation strategy, students are actively engaged in scientific activities doing what Scientists do. Students observe and with evidence they provide explanations to scientific questions. Could the use of micro science kits influence the students attitude towards physics and hence improve performance?

Even though several African countries have embraced this new paradigm in teaching and learning of science, the use of micro science kits has not been employed in Kenyan secondary schools for science teaching. In light this, the study was carried out to determine students' attitude in practical physics by the use of micro science kits.

The Problem

The physics students' performance has continued to be the challenge of concern to education stakeholders in Kenya. The students' examination results and subject enrolment at Kenya certificate of secondary examination is very low compared to the other sciences. Could this be a problem of students' attitude? The way of conducting practical work was identified as one of the obstacle to improved performance in physics. This study considered the effect of using micro science kits on student's attitude change compared to the use of conventional practical equipment.

II. PURPOSE OF THE STUDY

The purpose of the study is to investigate the effect on attitude of students taught practical work using micro-kits compared to those taught using conventional apparatus.

The objectives of the study

The study was guided by two objectives

1. Compare the effect of teaching using micro science kits and conventional laboratory apparatus on students' attitude towards physics practical work.
2. Determine the effect of teaching using micro science kits and conventional laboratory apparatus on male and female students' attitude towards physics practical work.

Research Hypotheses

Ho1: There is no significant difference between the mean attitude score 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 attitude scores of male and female students in physics practicals when taught using micro science kits and conventional laboratory apparatus.

III. RESEARCH DESIGN

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

The Sample

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

Table 1: Gender wise distribution of the sample

Groups	Girls	Boys	Total
Experimental	157	162	319
Control	149	173	322
Total	306	335	641

There were 306 girls that took part in the study. Of these 157 and 149 respondents formed the experimental and control groups respectively. The boy respondents were 335. Of these, 319 and 322 formed the experimental and control groups respectively.

Research Instruments

The Students Attitudes Questionnaire (SAQ) was constructed by the researcher. The SAQ questionnaire comprised of seven items reflecting the subject's attitudes towards Physics practical work. Specifically the questionnaire was likert type with 5 scale rating as: 1 representing strongly disagree, 2 representing disagree, 3 representing undecided, 4 representing agree and 5 representing strongly agree. To score the scale, the response options were coded 1,2,3,4 or 5 according to the responses from strongly disagree to strongly agree. Reverse coding was used for negative items. Example of negative items included; Physics practical lessons taught using micro science kit were useless. The responses for every attitudinal attribute were expressed as percentage according to distribution frequency for each scale rating on the likert scale.

The attitude questionnaire (SAQ) was administered to 30 students selected from the two schools used for piloting in the same sub-county. Their responses were scored and treated using Pearson's product moment correlation (r) and a reliability of 0.75 was obtained using SPSS programme.

IV. DATA COLLECTION

To achieve the goal of this research, the sample was randomly assigned into two equal groups in 8 schools of each group. Group one was chosen to be the experimental group while Group two was chosen to be the control group making a total of 16 schools where the study was conducted.

The collection of data was organized in three different stages; Pre – treatment stage, Treatment stage and Post – treatment stage. In the pre– treatment stage, the researcher made a pre-visit to the schools to meet both the students and research assistants involved in the study. This was done to seek co-operation from the physic teachers (research assistants) and principals of schools. The micro science kits were distributed to the experimental group while the control group used the conventional laboratory apparatus. A pre-test was administered before treatment. The treatment stage involved the teaching session for both groups on physics practical work. This consisted of practical demonstrations using the micro science kits for the experimental group and the control group using the conventional laboratory apparatus. Four (4) periods per week of 40 minutes/per period for two (2) weeks was used for the treatment phase for the study. The topic of Cells and Simple Circuits was considered for the study. After the treatment, the students attitude questionnaire (SAQ) was be administered to the groups as post-test. The (SAQ) were administered by the research assistants. They were then collected and analyzed by the researcher.

V. RESULTS AND ANALYSIS

The results were analysed and presented by both descriptive and inferential statistics. Descriptive statistics employed were; means and standard deviations. An independent t-test and Ancova were used to test the significance of difference in student's attitude between groups at α=0.05 level of significance.

The findings of the study

This is provided under findings concerning students' attitude and gender effect on attitude towards physics practical work.

First Objective

The results under the first objective is presented as descriptive statistics then followed by test of hypothesis one. The first objective was to compare the effect of teaching using micro science kits and conventional laboratory apparatus on students' attitude towards physics practical work.

Descriptive Statistics

Table 1 below shows the overall students' pre-test and post-test mean attitude score results for the study in terms of experimental and control groups. Standard deviations for both groups are also provided.

Table 2: Comparison of the pre-test and post-test scores for groups

Group	N	Pre-test Mean	Pre-test Standard Deviation	Post-test Mean	Post-test standard deviation	Gain
Experimental	319	47.6	11.97	89.48	21.28	41.8
Control	322	49.2	12.11	61.09	14.53	11.8

The mean attitude post-test scores from (SAQ) indicates that there is a difference in attitude between the two groups (70.6 for the experimental group and 62.5 for the control group). The mean score of the experimental group (micro science kits) was significantly higher than that of the control group(Convention apparatus). The standard deviation of the experimental group was lower than that of the control group. To test the hypothesis, a t-test was performed for the post-test results on the attitude statements.

First Hypothesis

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

Table 3: Independent Samples t-test Results of the SAQ Scores

TEST	Experimental Group		Control Group		t-value	Critical value
	MEAN	S.D	MEAN	S.D	19.64	1.96
PPAT2	89.48	21.28	61.09	14.53		

To test the first hypothesis H01, a t-test was performed for the post-test results on the attitude statements. A t-test value of t=19.64 was obtained at α=0.05 and df=632. The t-test value was significant. It was more than the tabulated critical value of t =1.96.

These findings suggest that for the attitudinal attributes, the results were statistically significant. The experimental group had a positive attitude. This could be attributed to the use of micro science kits during class practical experiments. From this finding, the second hypothesis H01 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 male and female students' attitude towards physics practical work.

Table 4: Descriptive statistics

Dependent Variable: Post test attitudes scores				
Groups	Gender	Mean	Std. Deviation	N
Micro Science Kits	Male	72.2778	14.38573	162
	Female	66.6818	15.81857	157
Conventional Apparatus	Male	49.2333	15.48009	173
	Female	51.5000	14.11962	149
Total	Male	61.8030	18.76266	335
	Female	61.3235	16.73088	306
	Total	61.6400	18.01375	641

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 attitude						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	10653.084[a]	4	2663.271	11.783	.000	.332
Intercept	27163.996	1	27163.996	120.184	.000	.559
Pre-test on attitude	168.406	1	168.406	.745	.390	.008
Group	7617.518	1	7617.518	33.703	.000	.262
Gender	43.427	1	43.427	.192	.662	.002
Group * Gender	325.616	1	325.616	1.441	.233	.015
Error	21471.956	95	226.021			
Total	412074.000	100				
Corrected Total	32125.040	99				
a. R Squared = .332 (Adjusted R Squared = .303)						

From Table 5, it was shown that the interaction between gender and treatment was not significant since its calculated (F 1,95)= 1.441, at *P*=.23 . Since calculated *P*>0.05, the null hypothesis is upheld. This implies that there is no significant difference between the mean attitude change of male and female students in practical work based on micro science kits usage and conventional laboratory apparatus.

VI. DISCUSSION OF THE FINDINGS

The findings of this study concerning respondent's formed attitude about their interest in the practical lessons when learned using micro science kits(E) are in line with those of Madeir, (2005) who found that attitude of students from Mozambican junior secondary schools increased after using microchemistry kits compared to traditional apparatus. Towse, (1998) also reported that high school students had shown strong positive attitude towards microscale chemistry approach compared to use of conventional apparatus in South Africa.

The findings of this study concerning respondents formed attitudes about practical lessons being useless when taught using micro science kits (F) concur with the observations of Akoobai & Bradley, (2005) who found out that learners developed improved attitudes towards practical work as a

result of using micro science apparatus in chemistry compared to conventional apparatus. The findings of this study showed that the lessons were useful instead of being useless. Vermaak, (1997); & Kolobe, (1998) have reported that attitude of both teachers and students towards micro scale practical work were strongly positive after the experiments in South Africa.

The findings of this study concerning students formed attitude their happiness and excitement after learning practical work using micro kits (G) are also supported by the studies of Yoo, Hong & Yoon, (2006) who found differences in attitude among participants when micro chemistry experimentation was used individually in Korean high school students. They found that that the students who had used micro scale kits had decreased anxiety towards practicals. They were happy and excited with experimentation. Mafumiko, (2008) reported that integrating micro scale experiments into teaching chemistry helped to improve student's attitude towards chemistry in Tanzania as compared to the use of convention apparatus.

The study findings about attitude formed due to time spend on carrying out practical work when using different kinds of apparatus (H) concur with those of Bradley, 1999; Singh, Szafran & Pike, 1999; Vermaak & Bradley, 2003; Tallmadge, Homan, Ruth & Bilek, 2004, they found that conducting experiments with microscale techniques promoted saving time.

The findings of this study concerning students formed attitude the practical lessons being friendly to the environment when learned using micro scale apparatus (I) agree with those of Tallmadge, Homan, Ruth & Bilek, (2004). They observed that students who were trained using micro scale chemistry techniques changed their view on the environment since micro scale experiments are safer and more environmental friendly. They also stated that the application of micro scale chemistry experiments provides the opportunity to raise awareness of the values of environmental stewardship into pre- college students regardless of the field in which their interest lie.

VII. CONCLUSION

The use of micro science kits appears to improve the student's attitude in secondary school Physics practical work. This suggests that teachers of Physics have to recognize the potential of instruction in influencing student's attitude in practical work 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.

REFERENCES

[1] Abdullah M, Ismail Z and Mohamed N, (2005), Microscale experimentation in teaching Chemistry. In M. Ismail, S. Osman and H.Yunus (Eds), ***Proceeding for seminar Pendidikan JPPG 2005-Education for sustainable development***. Penang:Universiti Sains Malaysia. Pp29-57.

[2] Akoobhai B and Bradley JD, (2005), Providing practical experiences at home for students studying science at a distance. **Proceeding of ICDE World Conference on Open Learning and Distance Education**, November 2005, New Delhi

[3] Bradley JD, (2000), The micro-science project and its impact on pre-service teacher education, Washington, D. C.: ***The World Bank***. Pp 32-73.

[4] Faour, M.A. & Ayoubi, Z. (2018). The effect of using virtual laboratory on grade 10 students' conceptual understanding and their attitudes towards physics. Journal of Education in Science, Environment and Health (JESEH), 4(1), 54-68. DOI:10.21891/jeseh.387482

[5] Hanson R, Sakina A, (2014), Enhancing concept understanding through the use of micro chemistry equipment and collaborative activities. ***Journal of Education and Practice***; Vol 5 pp 120-130.

[6] Kenya National Examinations Council, (2010-2012). KCSE Examination Candidates Performance Reports. Nairobi-Kenya

[7] Kisaka L.G (2003). Teaching approaches and methods. A Paper presented during ***Cycle 1 of National SMASSE inset at Kenya Science Teachers College,*** August (2003) Nairobi Kenya, pp 3-12

[8] Kolb DA (1984), Experiential learning, Englewood cliffs, practice Hall, pg 256.

[9] Kolobe, L (1998), Introduction of RADMASTE Microchemistry kits in disadvantaged schools in Gauteng: a case study. MSc research report. University of the Witwatersrand, Faculty of Science, Johannesburg.pp 75-83

[10] Madeira, A.C.P., (2005). The influence of practical work on chemistry teaching and learning-an approach using microchemistry kits in Mozambican Junior Secondary Schools, Unpublished M.Sc. Thesis, University of the Witwatersrand, Johannesburg. Pp 62-69

[11] Mafumiko FMS, (2008).The potential of Micro-scale Chemistry Experimentation in enhancing teaching and learning of secondary chemistry: Experiences from Tanzanian Classrooms. ***NUE Journal of International Cooperation***, Vol 3, pp 63-79.

[12] Michieka R and Twoli N (2009), The effect of using micro-science kits in teaching primary school science in a developing country, Kenya. A paper presented at the ***International Conference in Education*** at Kenyatta University Nairobi, Kenya.

[13] Ministry of Education, Science and Technology – Kakamega Central sub-county KCSE Results analysis, (2012) unpublished.

[14] SMASSE Project (1998). Baseline studies document. An unpublished paper presented during National INSET at KSTC; Nairobi.

[15] Ssempala, F, 2005, Gender differences in performance of Chemistry practical skills among senior six students in Kampala District. PhD thesis. Boca Raton, Florida, USA, pp

[16] Somerset (1993). Putting experimentation back into science education. Vol.3. pp. 1-3