

Effective Practical Work on Physics Students' Performance in National Examination at Selected Schools in Sirisia Division, Bungoma West Sub-County, Kenya

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Abstract

Practical skills and ability development in the learners are very essential in the teaching/learning of Physics and other related science subjects. This is because they help learners to relate theory to reality, thus, making it easy for them to understand difficult and abstract concepts. Pursuing Physics at high school enables the students to participate in technology related studies in tertiary and higher institutions. The national enrolment at form three show that Physics is the least studied subject at this level. In addition, performance in the subject at the end of secondary school is dismal. Most students lack motivation to engage in activities related to Physics such as process skills. It is in this respect therefore, that this study investigates the factors that affect learners' practical abilities in Physics during classroom interaction and its impact on performance in Physics' National Examination. Relevant literature review concerning the study was done under specific headings in chapter two. Eight teachers of Physics and one hundred forty Form three students were observed during Physics lessons. Data was collected using questionnaires and observation schedules. The Lickert scale was used to measure the attitude of students towards Physics practical. Six schools and their respective teachers and students, were randomly selected from fourteen schools within Sirisia Division Bungoma County. Data collected was qualitatively and quantitatively analysed using basic statistics like percentages and frequency counts, to provide information that helped answer questions raised by the researcher. The findings of the study revealed that class demonstrations and experiments, as well as project learning enhance learners' ability to develop practical Physics skills. The study found that teachers play a major role in nurturing students' capabilities in developing positive skills towards Physics and assist learners' to develop manipulative as well as recording skills in practical Physics lessons. The findings showed that available Physics teaching resources influenced learners' development of practical Physics skills and lastly the study also found out that learners' attitude towards Physics influences their performance in Physics. The study recommends that secondary schools be provided with standard laboratory (especially the state-owned public schools) in which improvised and other concrete materials such as models and specimens could be stored for the purpose of Physics teaching through demonstrations, class experiments and project learning. Teachers should be taught on how to improvise on certain laboratory materials as well as help the students to discover ways of improvising the laboratory equipment from locally and available materials to enhance the teaching of practical Physics lesson and make it possible for better KCSE results.

Keywords: Practical work, performance in physics, attitude change, Science process skills acquisition, Physics Achievement-National Examination.

INTRODUCTION

All technology is beholden to Physics due to its emphasis on addressing phenomena involving the interaction of matter and energy. This interaction is necessary for the technological needs of a changing society (Judeviciene & Karenauskaite, 2004; and Zhaoyao, 2002). Physics continues to influence applications in medicine (X-rays, CT-scanning, Ultra-sound echo techniques, MRI techniques). Diagnostic patient screening techniques (Freeman, 2012) are based on principles of physics. Currently, a wide variety of treatment techniques are made possible by the discovery of radioactivity and other high frequency radiations. The unravelling of the DNA structure and the subsequent genome project required a significant input from Physics techniques (Stanley, 2000). Continuing research into challenges posed by diseases such as Cancer, Ebola, and HIV/AIDS, will require Physics principles. The current fixation with Information, Communication Technologies (ICTs) could not have occurred without the primal Physics discovery of the semiconductor diode and transistor that led to integrated circuits. Computers, mobile phones and their attendant spin-off technologies show the indispensability of Physics. Photonics and other quantum nanostructures show promise in terms of optical fibre based communication systems (Sharma *et al.*, 2010). Laser applications are used in commerce and industry. Electromagnetism is vital in the generation of electricity, mobile phone communication, optical and satellite communication, portable electronics, radio and radar communication, and X-ray crystallography (Campbell, 2006).

However, Physics education is in crisis. Enrolment in Physics courses at all levels across African countries is low. Reasons for this range from inadequate learner preparation, weak mathematics background, inadequate teacher qualifications as well as possession of below standard pedagogical and content knowledge on the part of the teacher (Semela, 2010). Many students regard Physics as difficult, abstract and theoretical, and they therefore find the subject boring and non-enjoyable (Hirschfeld, 2012). Enrolment in Kenyan high school Physics is decreasing, learning motivation is declining, and the examination results are getting worse (Garwin *et al.*, 2003). In many school settings, little time is allocated to the discipline as compared to the time allocated to the languages and mathematics, which are the other important and core subjects. Worse still, this subject is made an elective at Form Three level which makes its attractiveness less to the learners many of whom opt out as early as at Form Two level.

Teaching is geared around memorization of basic concepts and their reproduction in examinations (Sadiq, 2003). The students who enrol for the subject resort to cramming definitions and formulae. Consequently, it is difficult for even the high achievers to apply what they have learnt in novel situations.

Training in conducting school type science experiments to a large extent is completely ignored in many university teacher-training curricula. Many, if not all, Kenyan university-trained Bachelor of Education (Science) graduates lack the skills of handling high school type practical work. There are no school-type laboratories

set aside for this exercise in the various universities that train teachers (Masingila & Gathumbi, 2012). Being a science subject, effectiveness of teaching Physics should be judged by the kind of practical activities that teachers and students engage in (Oyoo, 2004). The consequence is that Physics teachers lack the skills for effectively guiding learners in conducting laboratory work; and therefore the attendant advantages of performing practical work are lost on the learners.

Practical work is considered as: engaging the learner in observing or manipulating real or virtual objects or materials (Millar, 2004). Appropriate practical work enhances pupils' motivation, understanding, process skills, and improves enjoyment of science. Practical work enables the students to think and act in a scientific manner. Practical work in Physics develops familiarity with apparatus, instruments and equipment thus helping the learner develop manipulative skills and therefore concretising abstract ideas and concepts. Students tend to learn better in activity based courses where they can manipulate equipment and apparatus to gain insight in the content. Doing practical work from the early part of secondary school period aids critical thinking skills and puts the student at the centre of learning, whereby they can participate in, rather than, be told about Physics; thus the desire and eagerness to know more about the subject is developed.

This research addresses the great role that well planned and delivered practical work in Physics can play in influencing students learning Physics in Kenyan secondary schools. For this to happen, practical work has to form a central part of classroom learning of Physics. Deliberate efforts have to be made to attract and retain the students into the Physics class by appealing to the curiosity-raising element and discovery component of practical work in the subject. The theoretical subject content and pedagogical content knowledge of the teacher, the ways in which the teacher delivers instruction, and the teachers attitudes towards science have been shown to have an impact on student learning and achievement (Ware, 1992). This is especially so in the laboratory where the essence of practical instruction is not immediately clear to the learners. Learners can benefit from an inspirational and knowledgeable teacher. All of these factors are related to the teacher's own education, both as a teacher and as a former school pupil. Practical work in secondary school Physics takes the form of class experiments, class demonstrations, project work, fieldwork and excursions. Teacher innovativeness and creativity could also introduce novel modes of practical investigations. In Kenya, these innovations include: Physics micro-kits, specifically prepared Science Equipment Production Unit (SEPU) kits, and preparing science and mathematics teachers by capacity building, through Strengthening of Mathematics and Science Education (SMASE, 2007) programme, at the Centre for Mathematics and Science Teacher Education in Africa (CEMASTE) at Karen, Nairobi. Of late, efforts are being made to utilize virtual laboratory that rely on the interplay between the computer and the internet (Scheckler, 2003). Clearly every effort is being made to create an interest in the students to study Physics. Whereas the above efforts could be lauded, this study concentrated on exploring the role traditional laboratory experiments play in developing interest in learning Physics. The research investigated how such an interest may be ignited in average performing secondary schools in the western part of Kenya.

Statement of the Problem

In the Kenyan system of education, students may choose to pursue Physics in their last two years of secondary education or opt out of it (Wambugu & Changeywo, 2008). In Sirisia Division, however, very few students study Physics in Form Three as compared to those choosing to study either Chemistry or Biology, although these too, are optional science subjects. In addition to the low enrolment, the performance of those students who do Physics is found to be poor at the National Examination level; very few quality grades are recorded. Thus, the results of Physics in the Division are usually skewed positively from the normal.

Examination results analysis (Kenya National Examination Council 2013, 2014) of 2012, 2013 and 2014 for Sirisia Division reveal that the best student in Physics scored a mean grade of B+. According to the Physics grading system, a candidate cannot raise a mean grade of B- unless he/she scores at least a grade of D+ in Physics practical paper. This, however, indicates that majority of students in the said Division could be performing dismally in the practical paper; an issue that must be addressed to possibly improve performance and enhance enrolment in the subject. It was in this respect that the researcher wished to find out whether effective practical approach of teaching, as opposed to the theoretical approach commonly used could affect performance in National Examination and improve student enrolment in Physics in Sirisia Division.

Objectives of the Study

The objectives of this study were to:

1. Determine whether demonstrations, class experiments and project teaching methods employed by teachers help develop learners' practical skills during classroom interaction.
2. Find out whether the role of the Physics teachers in the Physics practical lessons affects the learners' practical skills development.
3. Determine whether the availability of equipment, learning aids and facilities affect the practical skills abilities of the learners in Physics during classroom interaction.
4. Find out learners' attitudes towards Physics in general and specifically towards practical work, and the effect it has on their practical skill acquisition in Physics.

Research Design

The study adapted Descriptive survey research design. This design was chosen because it enabled the researcher to obtain students' and teachers' opinions on factors that affected performance in practical abilities during classroom interaction processes.

Wiersman (1985) says that any study that dealt with how people felt or behaved was considered a survey. Gay (1992) also supported this view by stating that a survey study could be used to assess personality variables such as attitude and opinion about events, individuals or procedures.

Descriptive research attempts to describe what was or what is in a social system such as a school. This is posited by Best and Kahn (1993) who asserted that a descriptive study utilized information concerning the current status of phenomenon and described *what existed* with variables or situations. A descriptive approach was

appropriate for finding factors that affected students' performance in Physics practical. According to Mugenda and Mugenda, (1999) qualitative research was advantageous in that it permitted research to go beyond the statistical results reported on quantitative research. Human behaviour or human phenomenon that could not be investigated by direct observation such as attitudes and their promotions was best studied using qualitative methods.

Sample Population

The sample of the study comprised of six schools, Form Three students in each school and twelve teachers of Physics from a selection of boys only, girls only and mixed secondary schools in the Division. One hundred and forty Form Three students and twelve teachers were selected to fill in the questionnaire. Two Physics teachers were observed while teaching a Form Three class in each of the six schools selected. Half the student sample in each school consisted of the best performers while the other half consisted of worst performers based on their school test scores.

Table 1: Sampling grid for Sample Population

Gender	School Number	Schools Sampled	Teacher Number	Teachers Observed	Students Participating
Boys	2	2	4	2	40
Girls	2	2	4	2	40
Mixed	10	2	4	4	60
Total	14	6	12	8	140

METHODOLOGY

The study adapted Descriptive Survey Research Design. Purposive (because there were only 2 each of single gender schools in the Division) and disproportional (again because of the limited number of single gender schools) stratified random sampling techniques were used to select the six sample schools.

There were different questionnaires; one for Physics teachers and one for Form Three students. The students' questionnaires consisted of five sections, each preceded by directions on how to complete it. Section one and two were open - ended and students were expected to study the questions carefully and respond to them appropriately. The questionnaires were issued to students to investigate different variables such as their recent score in Physics examination, their general view of Physics, and skills studied in school in general. This was to determine what effects these variables had on their practical skill ability. The questionnaire was thought to be the best instrument of data collection because they were free from the biasness of the interviewer's opinions. Answers were in respondents' own words and large samples were made use of and thus the results were dependable and reliable.

A lesson observation guide was used to collect data from the field. The guide was adapted from that developed by Magoma (1999).The researcher observed teachers in their respective classrooms during their Physics lessons using non-structured observations. Manifested behaviour by the teachers and students during classroom interaction were checked off on the lesson observation guide by the researcher. The

use of certain teaching methods and their effects on learners' practical skill development was observed alongside whether there was lack of or availability and use of equipment/apparatus during the teaching and learning process. The researcher also noted other behaviour related to the study manifested by the teacher and student, which was not on the lesson observation guide. The Likert scale (Likert, 1932) was used to measure the attitude of students towards physics.

RESULTS AND DISCUSSION

Demonstration, Class Experiments and Project Teaching Methods and Development of Learners' Practical Skills in Physics:

This was the first objective of the study that sought to investigate whether demonstrations, class experiments and project teaching methods had any influence on development of learners' practical skills in Physics in public secondary schools in Sirisia Division of Bungoma West Sub County. As a theme it was guided by indicators that were studied under the following sub-themes in effort to outline their influences on development of learners, practical skills in the sub county and subsequent influences to further studies related to Physics demonstrations, class experiments and project teaching methods in physic lessons.

Demonstrations Encourage Students' Participation in Practical Physics Lessons:

The study sought to establish whether Physics lessons taught through demonstrations encouraged students' participation in practical Physics lessons and the findings are shown in Table 2.

Table 2: Demonstrations encourage students' participation in practical Physics lessons

Level of response	Frequency	Percent
Strongly agree	40	31.3
Agreed	68	53.1
Disagreed	20	15.6
Total	128	100.0

Results from Table 2 revealed that majority of students (68 or 53.1%) in the study agreed that Physics lessons through demonstrations encouraged students participation in practical Physics lessons, followed by 40 (31.3%) that strongly agreed on the same whereas 20 (15.6%) declined.

The study followed a cross tabulation to indicate variables' relationship within the study by their categorical representation and the results were as presented in Table 3 with their subsequent χ^2 values.

Table 3: Influence/no influence on Physics demonstrations and learners participation in practical Physics lessons'

			Demonstration and learners encouraged participation in practical Physics lessons			Total
			strongly agree	agree	disagree	
Influence/no influence on lessons	yes	Count %	16 40.0%	44 64.7%	8 40.0%	68 53.1%
	No	Count %	24 60.0%	12 35.3%	12 60.0%	60 46.9%
Total		Count %	40 100.0%	68 100.0%	20 100.0%	128 100.0%

Results from Table 3 revealed that responses within strongly-agree acknowledged that the influence of Physics demonstrations had encouraged learners' participation in practical Physics lessons stood at 16 (40.0%) while 24 (60.0%) declined, 44 (64.7%) within agree acknowledged its influence while 24 (35.3%) in the same category declined its influence and lastly 8 (40.0%) within disagreed acknowledged the influence of demonstrations and learners participation in Physics whereas in the same category 12 (60.0%) declined.

When a χ^2 statistic was conducted to establish association between Physics demonstrations and learners' participation in practical Physics lessons, a χ^2 value of 7.813 at 2df drew a .020 likelihood of association, thereby showing significant relationship existed as this was below the $\alpha = .050$. Therefore Physics lessons through demonstration directly influenced learners' participation in practical Physics lessons. The findings of the study were also supported by Physics teachers who asserted that Physics lessons through demonstrations allowed students to fully participate in practical Physics lessons as it was learner centered; this was also true with the lesson observation guide.

Class Experiments in Physics and Students' Ability in Answering Practical Physics Questions:

The study sought to establish whether class experiments in Physics enhanced students' ability in answering practical Physics questions and the findings are shown in Table 4.

Table 4: Use of class experiments in Physics and students' ability in answering practical Physics questions

Level of response	Frequency	Percent
Strongly agree	59	46.1
Agreed	59	46.1
Disagreed	10	7.8
Total	128	100.0

Results from Table 4 revealed that majority of students in the study strongly agreed (59 or 46.1%) respectively in the subsequent level of response that the use of class experiments in Physics increased their ability in answering practical Physics questions:

The study followed a cross tabulation to indicate variables' relationship within the study by their categorical representation and the results were as presented in Table 5 with their subsequent χ^2 values to reveal the association and relationship.

Table 5: Influence/no influence on use of class experiments in Physics and students' ability in answering practical Physics questions

				Use of class experiments in Physics and students' ability in answering practical Physics questions			Total
				strongly agree	agreed	disagreed	
influence/no influence on	yes	Count	%	32	34	2	68
		within use of class experiments		54.2%	57.6%	20.0%	53.1%
	No	Count	%	27	25	8	60
		within use of class experiments		45.8%	42.4%	80.0%	46.9%
Total		Count	%	59	59	10	128
		within use of class experiments		100.0%	100.0%	100.0%	100.0%

Results from Table 5 revealed that responses within strongly agree that acknowledged the influence of class experiments on students' ability in answering practical Physics questions stood at 32 (54.2%) while 27 (45.8%) declined, 34 (57.6%) within agree acknowledged its influence while 25 (42.4%) in the same category declined its influence and lastly 2 (20.0%) within disagreed acknowledged the influence of class experiments on students' ability in answering practical Physics questions whereas in the same category 8 (80.0%) declined.

When a χ^2 statistic was conducted to establish association between class experiments and learners' ability in answering practical Physics questions, a χ^2 value of 4.916 at 2df drew a .086 likelihood of association, thereby showing significant relationship existed as this was below the α value of .050. Therefore there was no statistical difference between class experiments and learners ability to answer practical Physics questions. Majority of teachers were in agreement that during lesson development class practical activities allowed students to be actively involved in the teaching/learning process.

Relationship between Demonstrations, Class Experiments and Project Learning and Learners' Ability to Develop Practical Skills in Physics

The study further sought to determine the relationship between demonstrations, class experiments and project learning and learners ability to develop practical skills in Physics. To answer this sub theme, the respondents were asked to tick against their level of agreement using a Likert scale of SA = Strongly Agree, A = Agree, U= Undecided D = Disagree and SD = Strongly Disagree. Table 6 shows the study finding.

Table 6: Relationship between demonstrations, class experiments and project learning and Learners' ability to develop practical skills in Physics

STATEMENT	SA fofe	A fofe	D fofe	TOTAL N χ^2
Practical in Physics are often done	45	60	23	128
	48	55	25	.739
Students carry out projects in Physics	40	60	28	128
	48	55	25	1.147
Students are regularly tested in Physics practical's	45	55	28	128
	48	55	25	.485
Physics practical's have led to improved performance in Physics	50	60	18	128
	48	55	25	2.499
Continued use of demonstrations, class experiments and Physics projects has led to learners development of practical Physics skills	60	40	28	128
	48	55	25	12.36
TOTAL				17.228

As portrayed in Table 6, the result indicates that there was a significant difference between demonstrations, class experiments and project learning and learners ability to develop practical Physics skills in Sirisia Division of Bungoma West Sub County with a [χ^2 (18, N=128) = 17.228, $p < .05$]; the difference between observed and expected values under the null hypothesis were very inconsistent and therefore a large discrepancy resulted in a large value for χ^2 thus data did not fit the null hypothesis and the hypothesis was rejected in favour of the alternative hypothesis because there was statistically significance difference between demonstrations, class experiments and project learning and learners ability to develop practical Physics skills. Therefore, demonstrations, class experiments and project learning are relatively important in determining the learners' development in Physics. Physics is a practical subject, therefore exposure to various skills in Physics need to be employed as opposed to lecture method. Numerous practice exercises and hands-on-activities will certainly help the students test the skills they learn.

CONCLUSION

The study sought to investigate the effective practical work has on Physics students' performance in national examination in selected schools in Sirisia Division, Bungoma West Sub-County, Kenya. The research sought to determine whether the demonstration, class experiment and project teaching methods employed by teachers help develop the learners' practical skills abilities during classroom interaction and the findings that a significant relationship existed between demonstrations, class experiments and project learning. Therefore,

demonstrations, class experiments and project learning are relatively important in determining the learners' development in Physics. Physics is a practical subject, therefore exposure to various skills in Physics need to be employed as opposed to lecture method. Numerous practice exercises and hands-on-activities will certainly help the students test the skills they learn. The provision of class experiments, projects work and group work which should engage students in debates and lively discussions need to be encouraged. As Shuell (1986) aptly put it, that 'without taking from the important role played by the teacher, it is helpful to remember that what the student does is actually more important in determining what is learnt than what the teacher does'. According to constructivism, learners construct their own knowledge. The teacher's role therefore is to facilitate this process by creating the right environment.

REFERENCES

- Best, J., W., & Kahn, J.V. (1993). *Research in Education*. Allyn and Bacon, Boston, pp. 234-405
- Campbell, R. (2006). Teenage girls and cellular phones: discourses of independence, safety and 'rebellion'. *Journal of Youth Studies* 9,195-121.
- Freeman, T. (2012). The Lancet highlights role of Physics in medicine, medical Physics web, April 20, Downloaded from <http://www.IOP.org/mt4/mt-tb.cgi/4415>.
- Garwin, M. R., & Ramsier, R. D. (2003). Experimental learning at the University level: a US case study, *Education and training*, 45(5), 280-285.
- Gay, L. (1992). *Educational Research: Competencies for Analysis and Applications*, 4th edition. pp 421-424. New York: Macmillan.
- Hirschfeld, D. (2012). Interest in Science Careers wanes in Latin America, Science and Development Network, 4th January 2012.
- Judeviciene, P. A., & Karenauskaitė, V. (2004). Learning environment in Physics: the context of double paradigm shift, paper presented at the European Conference on Educational Research. University of Crete, 22nd-25th September.
- Kenya National Examination Council. (2013). Students' Performance Report Vol. 2: mathematics and science report. Nairobi.
- Kenya National Examination Council. (2014). The year 2013 KCSE Examination Report with question papers and marking Schemes. Vol. 2: mathematics and science report. Nairobi.
- Likert, R. (1932). A Technique for the Measurement of Attitudes. *Archives of Psychology*. 140: 1-55
- Magoma, S. (1999). *Teaching Methods*. Downloaded from <https://www.methodsofteaching.com>
- Manogue, K., & Krane, M. (2003). *Examination Trend*. Downloaded from <https://www.methodsofteaching.com>
- Masingila, J.O., & Gathumbi A.W. (2012). A collaborative project to Build capacity Through Quality Teacher preparation, Downloaded from <http://soeweb.syr.edu/> centres institutes in Kenya Partnership projects/default.aspx. Research
- Mugenda, O. M., & Mugenda, A. G. (1999). *Research Methods: qualitative and quantitative approaches*, pp (155-156). Nairobi Acts Press.
- Millar, R. (2004). The Role of Practical Work in the Teaching and learning of Science, paper prepared for the Committee: High School Science Laboratories: Role and Vision, National Academy of Sciences. pp 45-56 Washington, D.C.
- Oyoo, S. (2007). Rethinking Proficiency in the Language of Instruction (English) as a factor in the difficulty of school science. *The international Journal of Learning*. 14(4), 231-242.
- Sadiq, M. (2003). *Memorization of basic concepts and their reproduction in the examinations*. Downloaded from <https://www.memorizationofbasicconcepts.com>
- Scheckler, R.K. (2003). Virtual labs: a substitute for traditional lab? *Internal Journal of Developmental Biology*, 47, 231-236
- Semela, T. (2010). Who is joining Physics and why? Factors Influencing the choice of Physics among Ethiopian University Students, *International Journal of Environment and Science Education*, 5(30), 319-340.
- Sharma, R., Rohilla, R., Sharma, M., and Manjunath, T. C. (2005). Design and Simulation of Optical Fibre Bragg grating Pressure sensor for minimum attenuation criteria, *Journal of Theoretical and Applied Information Technology*, pp 515-530

- Shuell, T. J. (1986). *Cognitive Conceptions of Learning*. Review of Educational research. Oxford University Press.
- Stanley, H.E. (2000). Exotic statistical Physics: Applications to Biology, Medicine, and economics, *Physica A*, 285, 1-17.
- SMASE: Strengthening Mathematics and Science in Secondary Education Project. (2007): Enhancing Critical Thinking Skills of Learners in science and mathematics Lessons: Unpublished report, Case study of ASEI –PDSI, vol. 2, pp 56-60: CEMASTE. Nairobi
- Wambugu, P.W., & Changeiywo, J.M. (2008). Effects of Mastery Learning Approach on Secondary schools students' Physics Achievement, *Eurasia Journal of Mathematics, science and Technology Education*, 4(3), 293-302.
- Ware, S.A. (1992). The Education of Secondary Teachers in Developing Countries, PHREE Background paper Series, Document no. PHREE/92/68, December, pp6-9
- Wiersman, W. (1985). *Research Methods in Education*. London: Allyn Bacon Inc.
- Zhaoyao, M. (2002). *Physics Education for the 21st Century: Avoiding a Crisis*. Physics