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Influence of ILA and RTM on the Achievement of Boys and Girls in Physics on the Topic: Cells and Simple Circuits

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Abstract:
The main objective of this study was to compare the achievement of boys and girls in Physics when Integrated Learning Approach (ILA) and Regular Teaching Methods (RTM) are used on the topic: cells and simple circuits. The study was quantitative, utilizing quasi experimental design of pre- test, post- test, and non-equivalent groups. A sample of 395 respondents from ten secondary schools was selected using multi stage and simple random sampling techniques. Two Physics Assessment Tests (PAT) were used to gauge students' achievement in Physics: PAT 1 and PAT 2. The validity of the items was good. The reliability coefficients of 0.803 and 0.791 were obtained for PAT1 and PAT2 respectively. Data analysis utilized t- test and ANOVA. The results obtained show that there was significant difference between boys and girls. The results of the study showed that ILA enhanced higher academic achievement for boys and girls in Physics compared to RTM.

Keywords*: performance, gender, teaching methods, physics*

1. Statement of the Problem

There are rapid changes taking place in the manufacturing Industry, Communication, Agriculture and Medicine. The Education sector is a major player in the envisaged industrialization in Kenya by 2030. The curriculum offered at secondary school is expected to address industrialization as a central and cross-cutting theme. Science is instrumental in bringing about changes through the advancement of technology and industrialization. The number of students who enroll to study physics at forms three and four in secondary schools in Kenya is low. For those who enroll, the performance at the end of secondary school leaving Examination is dismal. Poor performance in sciences affects economic, social and political pillars of development. The students generally show little interest and motivation to study Physics. This is despite many efforts by stakeholders aimed at restructuring the curriculum and attempts at prolonged in-service programmes for teachers that are supported by interested stakeholders. The challenge has been to find and apply methodologies that excite the learners. This should lead to motivation to enroll and continue studying Physics throughout the secondary school cycle. Meaningful methodologies should engage learners in cognitive development. In addition, skills that concern psychomotor development should be addressed. This study proposed to investigate the Integrated Learning Approach which targeted cognitive skills and attitudinal development. The study targeted students' learning of cells and simple circuits. The study compared learning developments due to ILA and RTM.

1.1. Objectives

Find out the influence of ILA and RTM on the achievement of boys and girls in Physics

1.2. Scope

Only form two students participated in this study. The study investigated the achievement of students in two Physics Assessment Tests (PAT1 and PAT2). The first test (PAT1) was set on the relevant Science content taught in standard eight and form one. The second test (PAT2) was set on cells and simple taught during the study period. The tests required respondents to write their responses in spaces provided on question papers.

1.3. Theoretical Framework

This study was guided by Gagne's Conditions of Learning Theory. Gagne's theory deals with three aspects of learning namely: conditions of learning, processes of learning, and outcomes of learning. The conditions of learning are further concerned with external and internal factors of learning. External conditions of learning are caused by other people through motivating or arousing the learner by asking questions in tests, assignments and any other challenging situations in order to determine the level of understanding of that which was taught.

Outcomes of learning are concerned with motor skills and cognitive strategies such as: verbal formation which is useful in writing, discussion and dramatizing; intellectual skills in the ability to discriminate and classify things; cognitive strategies that entail remembering; attitudes exemplified by values, dislikes, fears and needs; motor skills like printing, writing, using rulers typing and driving. The theory outlines the factors essential for learning as: circumstances in which

learning occurs, the acquisition of motor skills, cognitive abilities, organization of information, insightfulness, thinking, acquisition of attitudes, learner arousal by use of asking questions through assignments, and tests. Learning outcomes also include verbal formation which is useful in writing, discussing and dramatizing. The motor skills include printing, using rulers, typing and driving lead to the development of attitudes such as responsibility, curiosity and cooperation.

Gagne's theory identified various key types of learning: problem solving, rule learning, concept learning, discrimination and verbal association, simple chaining, S-R learning and signal learning. It is important that students' attention is drawn to the important aspects of a lesson. The teacher was to provide learners with examples or models of behavior expected of them during learning situations. It is suggested that to enhance retention and transfer, students should be given more than one example during a lesson. The content was reviewed in small amounts and related the current information to the previous concepts learnt.

Educational implication of Gagne's theory was that it presented insights which required that learners master concepts presented to them. Constant revision, discussion and assignments based on the topic covered were used to help strengthen learning.

1.4. Conceptual Framework

Arising from the theory on Conditions of Learning, this study was formulated to find out the effect of Integrated learning Approach (ILA) and Regular Teaching Methods (RTM) on performance, skill acquisition and attitude development in Physics. ILA activities included application of concepts, hands- on activities, short assignments, research cards, taking responsibility, cooperation, classification, drawing conclusions and curiosity. These activities were to lead students towards ownership of the learning experiences hence bring about behavior change. The schematic diagram below shows the conceptual framework envisaged for this study.

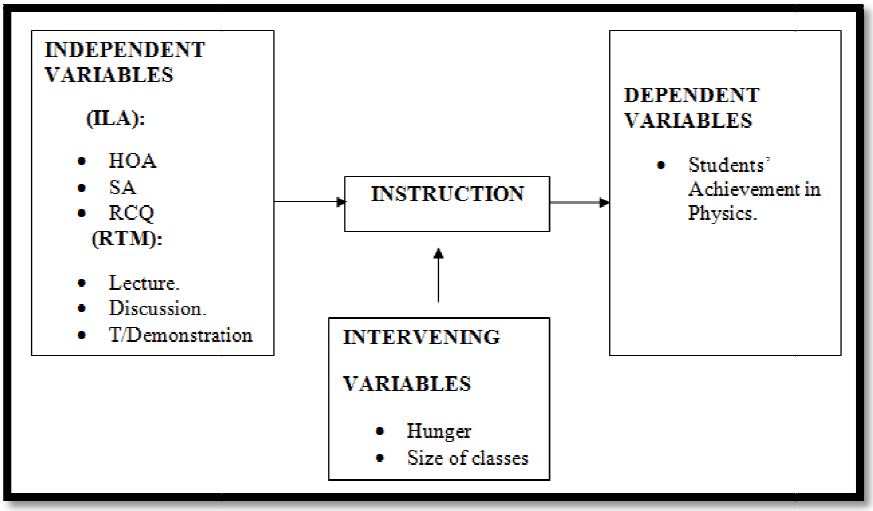

Figure 1: Conceptual Framework

The Integrated Learning Approach (ILA) had the activities that included hands on activities, short answer questions, research card questions and skills. The hands-on activities (HOA) included drawing diagrams, recording data, manipulating apparatus and instruments. These HOA entailed the use of hands in doing experiments, demonstrations and other activities that make use of hands. The short answer questions (SA) are meant to remind the respondents to the content they handled during the teaching-learning process. The respondents therefore go over the day's content in answering SA. Research card questions (RCQ) require the respondents to search for information from various sources. RCQ have the effect of encouraging respondents to do independent reading and enhancing better understanding of concepts.

The Regular Teaching Method (RTM) was envisaged to include popular activities like lecture, discussion and demonstration. Lecture activities that entailed the teacher presenting content with very little respondent involvement. Discussion was an activity where the respondents give their points of view concerning a given topic. Demonstration was the activity where the teacher performed most of the activities while the respondents remained passive.

2. Instructional Techniques Used In Physics

Knowledge that is acquired without sufficient structures to tie it to knowledge that is likely to be forgotten. Physics Education is not a constant but a variable. It changes in direction in relation to the developments in society (Lijnse, 1983). In a study on grade ten students, it was established that the teaching styles were major determinants of students' attitude towards science.

The students did not appreciate the contemporary practice of copying a teacher's notes. The students preferred taking an active role in the learning activities (Ebenezer and Zoller, 2006).

Allison and Yang (1998) showed that 52% of the students interviewed sometimes ignored text reading assignments because they had difficulty making sense of what they read in Physics textbooks. 40% of the students agreed that they had

difficulty in identifying the main points of a text. However, the students agreed that note-taking from textbooks could assist learning.

The baseline survey conducted by SMASSE on students' performance in science subjects and Mathematics found out that teachers used inappropriate methodology in teaching at the secondary school level. Most of the lessons presented to students are teacher-centred (SMASSE, 1998). The performance of students in Examinations reveals that the standard of teaching students is low. Lecture method is the most popular mode of teaching Physics at the secondary school level. However, this method makes students passive learners (Munavu et al, 2008).

A study done in three districts of Lagos State on 78 teachers and 500 junior secondary school students, established that teacher-centred activities dominated the lessons at the expense of student involved in science lessons. Another startling statistic was that about 50% of the 80-minute lessons were used by the teacher in demonstrations, explanations and taking notes; only 16% of the lessons were devoted to group-based lessons (Ogunmade, 2005). In Tanzania teachers still use the traditional lecture method in teaching Physics at the secondary school. The results also show that the teachers rarely provoke students to ask questions and there is very little interaction between the teacher and the students. In another study it was found that 62% of the secondary school teachers use lecture method in teaching Physics. Students taught by the lecture method consistently demonstrate poor student motivation and achievement in the Physics programme. This is because the lecture method does not provide students with opportunity to comprehend apply and analyze Physics problems. The data obtained from the study show that students taught by lecture method performed poorly in higher cognitive hierarchies. On the converse it was found that students taught by laboratory method performed better than those taught by the lecture method (Ali, 1980).

A workshop held at University of Cape Coast in Ghana was informed that Physics teachers need to come up with interventions and methods addressing the difficulties that dodge the teaching of Physics. Participants discussed the need to improve the teaching and learning of Physics in order to stem fears about the study of the subject. Policy makers need to consider mandating science education to move towards a real world and context- based approach in the teaching/learning process of school science at all levels (UNESCO, 2003).

Field trips, problem solving, inquiry method, cooperative learning, Project method and guided discussion are recommended for use in teaching Physics at secondary school level in Nigeria. This method was recommended because it results in high student- scores. Project work is rarely used because it is thought to be expensive on resources and also takes a lot of time (Omowunmi and Ojo, 2007). ILA intervention suggested could help the dilemma of instructional strategies by using a battery of strategies that could be used to cover the whole spectrum of teaching/learning process in Physics.

2.1. Gender and Physics Learning

A study done on performance in Science by a tenth-grade group found the following factors that relate to gender differences: subject matter, student ability level and frequency of hands-on laboratory opportunities. There was evidence that high school students believed that Physical Science was more masculine than Biological Science. Girls were thought to be more concerned with the human dimension of Science than the abstract scientific principles, experiments or instruments of Physics. The laboratory based physical sciences were often rejected by girls because they could not make effective links between those subjects and what the girls cared about. The Physics course is optional at high school and acts as a critical filter that blocks students' entry into future technological science disciplines. Gender differences emerge because society has varied cultural social expectations for the boys and girls. The students have issues with the development of their attitudes, motivation, spatial abilities and interests. The other notable cause of gender differences revolves around different teacher expectations of their students (Burkham et al, 1997).

Female Education in Mathematics, Science and technology Africa (FEMSA) in a study on girls found out that had negative attitudes towards Science and the household chores they done at home alienated them from Science. The causes of the above state of affairs were family background, socialization, stereotyping roles, lack of enough role models and peer group influence. The reasons for students' choice of Science-based careers vary due to a host of factors that are associated with their peers, social set up at home and the activities done in school. Stereotyping was one of the factors that affected the choices made to take science or art-based courses. The school community helps students to make the appropriate career choices during their studies at the secondary school level (Dlamini et al, 2004).

Boys differ from girls in terms of their achievement, attitude, aspirations and expectation in Science. In most societies, girls express more negative attitudes towards Physical Sciences than the boys (Twoli, 1986). Girls in single sex schools excelled because there was no one to intimidate them. The article added that girls from mixed schools felt intimidated by their male counterparts, distracted or fell victim to the widely held stereotypes like Sciences for men and Arts for women.

3. Research Design

The investigation was quantitative in nature. Quasi-experimental research design was employed in this study. The pre-test, post-test nonequivalent groups design was used. This was done because the classes were used as intact groups in the study.

Group	Pretest	Treatment	Post-test
A	O_1	X	O_2
B	O_3	C	O_4

Table 1: Pre Test Post Test Nonequivalent Groups Research Design
Key: O- Observation, $O_1$and O_3 Pre-Tests, X-Treatment/Manipulation, O_2 and O_4 Post-Tests, C- Control.

According to Best (1981)the pre-test, post-test nonequivalent groups design is suitable for classroom experiments when experimental and control groups are naturally assembled as intact groups.

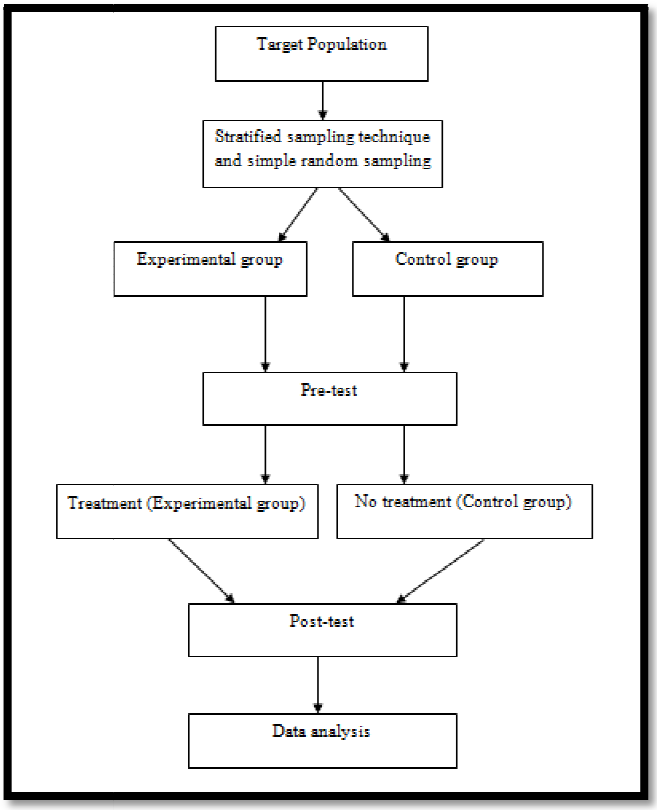

Figure 2: Operationalizing of the Research Design

3.1. Sampling Procedures and Sample Size

Multi stage sampling technique was applied to the target population to obtain the sample from the schools. The study used stratified sampling technique to select ten secondary schools. The strata were boys and girls; county and sub county schools. Simple random sampling technique was then applied on the strata to obtain experimental and control groups of students. The experimental and control groups were drawn from different schools. This was to reduce the chance of interaction among the groups of respondents.

3.2. Sampling Frame Based on Type of School

Five schools in the experimental group were given a set of activities that made the ILA intervention. The other five schools constituted the control group which used an approach that is mainly teacher-centred. The experimental and control groups had three classes of boys and two for girls. The sample of respondents consisted of six classes of boys and four of girls.

Gender	Experimental Group(Classes)	Control Group(Classes)	Total (Classes)
Boys	3	3	6
Girls	2	2	4
Total	5	5	10

Table 2: Sample of the Schools by Gender

3.3. Sample Size

The (RTM) control group was made up of 66 girls and 62 boys while the ILA (experimental) group had 202 boys and 65 girls. The sample of boys and girls had a total of 395 respondents distributed as per table 3 below.

Gender	ILA (Experimental)	RTM (Control)	Total (%)
Boys	202(51.1)	62(15.7)	264(66.8)
Girls	65(16.5)	66(16.7)	131(33.2)
Total	267(67.6)	128(32.4)	395(100.0)

Table 3: Sample Size of Respondents by Gender

The total number of respondents (boys and girls) in the sample was 395. The respondents were made up of the experimental group (ILA) with 267 (67.6 %) while the control group (RTM) was made up of 128 (32.4 %) respondents. The number of boys in the study was 264 (66.8 %) while that of girls was 131 (33.2 %) as shown in table 3.3 above.

3.4. Research Instruments

The instruments used in this study were: Physics Assessment Test (PAT 1) for pre test, Physics Assessment Test (PAT 2) for post test.

3.4.1. Physics Assessment Test 1(Pat 1)

The PAT 1 was based on the topic: cells and simple circuits. This content was that learnt by students during the study of Science in standard eight and Physics in form one. The PAT 1 was used in establishing the entry behaviour of the students. The test consisted of seven structured items on cells and simple circuits. The PAT 1 was marked out of twenty-five marks then converted to percentage.

The items included listing fundamental quantities measured in Physics and stating the SI units of quantities. Respondents stated examples of conductors and insulators and also gave the names of instruments used in measuring quantities. Other items required the respondents to state the type of connections in simple circuit diagrams. The instrument had an item on drawing a simple cell in an electric circuit (KIE, 1999; Singh, 1992).

3.4.2. Physics Assessment Test 2 (Pat 2)

The PAT 2 was a test on the topic: cells and simple circuits covered during the treatment period. The researcher used PAT 2 as a post test for both experimental and control groups. This instrument consisted of six items that tested various abilities. The respondents attempted an item where they were to draw a complete circuit showing a cell, an ammeter, a voltmeter, a variable resistor and a bulb. They attempted an item where they were to draw a labeled diagram of a simple cell. PAT 2 had an item on the difference between primary and secondary cells while in another item respondents were expected to bring out the difference between the electrolytes used in a simple cell and a dry Leclanche cell. The instrument had an item on the care and maintenance of secondary cells. In other items the test needed the respondents to define the ampere and also state the SI unit of an electric current. The test was marked out of twenty-five marks then converted to percentage.

3.4.3. Pilot Study for the Instruments

The questionnaire was pilot tested in two schools in Nandi County that were not used in the main study. The pilot study was used to establish the adequacy of time, space provided for answers to questions, the level of language use and the appropriateness of the items that made up the instruments.

3.4.4. Validity of the Instruments

The instruments were checked for face and content validity by experts in questionnaire, test and the skill checklist construction. The validation of PAT 1, PAT 2, AQ and SOC was recorded in Table 4 below.

Experts	Instruments	Face Validity	Content Validity	Average	Comments
Expert(1)	PAT1 (10)	8	8	8.0	Good
	PAT2 (10)	7	7	7.0	
Expert(2)	PAT1 (10)	7	7	7.0	Good
	PAT2 (10)	8	8	8.0	
Expert(3)	PAT1 (10)	8	9	8.5	Good
	PAT2 (10)	8	8	8.0	

Table 4: Validation of the Instruments

The validity for each instrument was scored out of ten (10). From the values in table 3.5 above, the experts rated the instruments as good. Expert 3 awarded PAT 1 the highest score of 8.5 out of 10.

3.4.5. Reliability of the Instruments

The PAT1 and PAT2 were tested for reliability using Cronbach's Alpha coefficient, r_{xy} by applying split-halt method. The value of r_{xy} was calculated for each instrument. The coefficients of reliability for PAT1 and PAT2 were 0.803 and 0.791 respectively.

3.5. Data Collection Procedures

The researcher pre-tested the instruments in two secondary schools in Nandi County before implementation of the study. Physics teachers participated in the study as research assistants. Half of them taught their regular form two classes using ILA. The other half used RTM.

The researcher distributed PAT1, administered and the results collected from all the schools at the beginning of the study. The post test (PAT 2) was answered by students at the end of the final week of the study. The results of PAT 2 were collected during the final visit to the schools.

3.6. Data Analysis Techniques

The data collected from instruments was coded to make it suitable for analysis. The data was analyzed using the statistical package for social sciences version 21 (SPSS-X). Descriptive and inferential statistics were used to analyze the data obtained. The t-test statistic was used to establish differences in the means of PAT 1 and PAT 2. ANOVA test was also used to find out the difference in the means of types of schools and gender in relation to Experimental and Control groups. The means of PAT 1 and PAT 2 were compared for Experimental and Control groups. The difference between the means of the scores of Pre test and Post test were tested for statistical significance at the 95 % confidence level (Kothari, 2009).

4. Research Results and Discussions

4.1. Students' Achievement in Physics based on Gender

In this section, findings are presented to show the effect of ILA and RTM on the students' academic achievement based on gender. The findings of the analysis of PAT 1 and PAT 2 scores are shown in Table 5 below.

Category	N	PAT 1 Mean (%)	Standard Deviation (SD)	t-test
Boys	265	50.0	12.21	0.542
Girls	130	49.2	14.30	

Table 5: Students Achievement in PAT1 based on Gender

Table 6 above shows that the mean achievements of boys (50.0%) and girls (49.2%) at PAT 1 were comparable. Their entry behavior of the boys and girls was almost the same and therefore comparable. The level of significance (0.588) is shown below in Table6.

	Levene's Test for Equality of Variances		t-Test for Equality of Variances		
	F	Sig	t	df	Sig (2 tailed)
Equal variances assumed	4.061	0.045	0.542	393	0.588

Table 6: T-Test for Students Achievement in PAT1 Based on Gender

The computation of t-test gives a value of 0.542 and significance of p=0.588. The value of ANOVA shows that there was no statistically significant difference between the mean achievement of boys and girls at 95% confidence level. This shows that the achievement of boys and girls was comparable at pre test.

Gender	Experimental group		Control group	
	Mean (%)	SD	Mean (%)	SD
Girls	52.6	12.72	49.5	17.53
Boys	57.9	15.58	50.8	16.77

Table 7: Students' Achievement in PAT 2 based on Gender

The mean score of boys (50.8%) was higher than that of girls (49.5%) in the Control group. The mean score of the Experimental group of girls (52.6%) was higher than for the girls (49.5%) of the Control group with an SD=17.53. Boys in the Experimental group posted a higher mean score (57.9%) than the girls in the Control group (49.5%) with an SD=16.77. Similarly, the boys in the Experimental group had a higher mean score (57.9%) than girls (52.6%) in the same group. The mean score of the boys in the Experimental group (57.9%) was higher than that of boys (50.8%) in the control group. The mean score of the girls in the Experimental group (52.6%) was higher than that of boys in the control group (50.8%). The variability in the values of SD was comparable (15.58 and 16.77) among boys. But the values of SD among girls had higher variability (12.72 and 17.53).

	Sum of Squares	df	Mean Square	F	Sig.
Between groups	1770.537	2	885.268	3.485	0.032
Within groups	99577.878	392	254.025		
Total	1011348.415	394			

Table 8: ANOVA for Students Achievement in PAT2 by Gender

The ANOVA value obtained above shows that there was statistically significant difference between the experimental and the control groups at 95% confidence level. This indicates that ILA posted better mean scores than the RTM. Students' achievement based on type of school was discussed in section 8 below.

4.2. Discussion of the Achievement of Students in Physics Based on ILA and RTM

The fact that PAT 2 had a higher mean than PAT 1 indicates that ILA was a better approach than RTM. The findings from previous studies are in agreement with the fact that ILA was a more suitable than RTM for teaching Physics at secondary school level. This is because ILA approach puts the learner at the centre of the lesson activities so that the teacher plays the role of facilitator.

Munavu et al (2008) reported that lecture was popular among teachers yet it made students passive due to little participation in the teaching- learning process. According to Ali (1980) lecture method did not motivate students to comprehend, apply and analyze Physics problems. The converse is that students taught by the laboratory method perform better than those who utilize the lecture method. Osokoya and Akuche (2012) in their study found out that the location of the school had significant effect on the cognitive achievement in Physics. A survey by SMASSE on students' performance showed that teachers used inappropriate methodology in teaching Mathematics and science subjects at the secondary school level.

Notable causes of gender differences include the view that science is a male domain, perceived gender stereotypes and different teacher expectations. (Burkham et al, 1997). The results obtained in this study indicate that there was a difference in the performance of boys and girls in Physics. In Kenya, Physics has been made an optional subject hence the students think that it may not be very important. Girls are more concerned with the human dimension of science than the abstract scientific principles, experiments or instruments that are handled in Physics.

Eryilmaz and Ates (2011) established that students taught by the method of hands- on and minds-on activities performed significantly better than those taught by the traditional methods. From the results of this study there was significant improvement in students' performance in Physics when they learn by hands-on and minds- on activities. Musasia et al (2012) found out that practical work helped to improve the performance of girls in Physics. The study also established that the girls in the experimental group outperformed those in the control group.

SMASSE (1998) reports that some teachers use inappropriate methodology that is mainly teacher centred. The findings above are also in agreement with Munavu et al (2008) who argued that the performance of students depends on the standard of teaching-learning achieved by teachers and students.

Berson (1993) and Colliver (2000) in their studies did not find any significant evidence that activity-based learning was superior to the traditional learning method of teaching. Similarly, Gallagher and Stephen (1996) did not find any significant difference between activity- based learning and the traditional method of teaching.

4.3. Conclusion

The boys obtained higher scores than the girls on both PAT 1 and PAT 2.

4.4. Recommendations

- The teachers should adapt a closer but friendly assessment model for both laboratory and other learning processes suggested in this study.
- Physics teaching – learning will be interesting if learners are engaged in short activities rather than full blown experiments. Materials for short activities will be affordable for schools yet provide the manipulative skills.

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