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Influence of ILA and RTM on the Achievement of Students on the Topic: Cells and Simple Circuits

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Abstract:

The main purpose of this study was to compare the achievement of students 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, by three Physics- subject experts, was classified as 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 there was significant difference between ILA and RTM. The results of the study showed that ILA enhanced higher academic achievement in Physics compared to RTM.

Keywords: Physics, achievement, methods, assessment, learning, tests, students, county

1. Background to the Study

Physics skills and knowledge acquired at the secondary school level are the basis for use of many industrial and home appliances. Physics is an important science subject that could assist people to understand the horizon of the technological society because it involves the study of essential natural phenomena (Zhaoyao, 2002). A sufficient supply of professionals trained in Science and Technology is vital for ensuring that industrial and economic development is attained. Science is valuable in any country's socio-economic development as propagated through the sectors of Agriculture, Medicine, Manufacturing, Transport and Communication. The level of technology in Africa puts doubts on the tenability of this development when very few students have interest in Physics. In many countries the supply of science-based professionals was falling seriously and urgently needed to be addressed.

Vision 2030, in Kenya, is anchored on social, economic and political pillars. This policy document outlines programmes expected to propel industrialization among other areas of development in Kenya. The said pillars depend on Education for provision of skilled manpower and technology. One of the goals of Education in Kenya deals with the promotion of social, economic, technological and industrial needs of national development (Government of the Republic of Kenya, 2007). In Kenya there are many industrial and economic sectors which deal with the extraction of raw materials, refining, construction and manufacturing, distribution of manufactured goods, research, design and development of equipment. For Kenya to improve its industrialization process there is need to develop sufficient reservoir of trained indigenous manpower at all levels (Republic of Kenya, 1998).

Poor performance in Physics by students at the secondary school level has been a subject of much debate among teachers, politicians, parents and education officials. Interest in Science and Mathematics by secondary school students continues to be low. The performance by the students who study Physics has been generally poor. At the first World Conference on Physics and Sustainable Development that was held in Durban, South Africa it was found that too few individuals received sufficient training in Sciences and that Physics Education remained elusive in much of the world. The five hundred researchers whose studies were discussed recommended that Physics Education be improved (Moore, 2009). Policy makers, scientists and Educators have expressed growing concern about scientific literacy and competitiveness of its science and technology practices. Evidence available suggests that the levels of scientific literacy are low and improving them is a slow and difficult process. The slight improvement in public understanding of science by US adults indicates that there is much more to be done in improving the understanding of science concepts (US Laboratory, 2005).

Supporting practical work is almost non- existent or poorly handled. Given a chance most of the learners would opt out of science, particularly Physics. The situation of low enrolment in Physics and poor performance in the subject applies succinctly to the girls. This is of concern because half of the student population is locked out of participating in the attainment of Kenya's Vision 2030 through the study of Physics.

Interventions formulated in the recent past by various organizations include Forum for African Women Educationalists (FAWE), Strengthening of Mathematics and Science in Secondary Schools Education (SMASSE), United Nations Educational Scientific and Cultural Organization's Education for All (EFA) and Secondary Science project (SSP). There has been an attempt to bridge the skilled manpower provision by converting Secondary Technical schools into

Tertiary institutions. The percentage contribution by the manufacturing activities to the Gross Domestic Product (GDP) in 1998 was just fourteen percent. It was projected then that the above contribution would rise to about thirty percent by the year 2020 (Koech, 1981). These interventions and strategies have been undertaken to try and match the levels of technology demanded by the dynamism of culture and society.

Waihenya (2002) reported about "Alarming statistics on Mathematics performance at KCSE". The report presented the mean of the students' performance in Physics as 26.85% and 22.22% for boys and girls respectively in the KCSE of 2001. According to Munavu et al (2008), 57% of the teachers in secondary schools spend most of their time preparing students to master test taking skills in order to pass examinations.

The most important factors affecting academic achievement are related to students, teachers and school characteristics. The effort to improve student's academic performance should therefore be undertaken within school settings (Fuller, 1987). The interest in and about science can be improved if personal and societal interest in Science can be made the reference point. The opportunities that Science and Technology offer should be central to the curriculum intentions. Science education should move towards a real world, context-based approach to teaching and learning school science at all levels of the school curriculum (Fensham, 2008). According to Bin Harun et al (2004), Science learning can be enhanced if students are made aware of the ways they learn and if they are able to monitor and take responsibility of their own learning. Students can be made to develop scientific skills through involvement in hands-on and minds-on learning activities including discussions, doing observation and experiment in groups.

Ormed (1983) argues that success is associated with teaching-learning situations where affective outcomes are given due prominence through activities. He adds that affective outcomes should be nurtured carefully and given prominence during the teaching-learning process. From the foregoing discussion it is necessary to link psychomotor, cognitive and affective development during instruction if meaningful performance is to be achieved by learners. While the past interventions had done much concerning cooperative learning, manipulative activities and cognitive activities, little had been done on activities that enhance attitude. The gap created by lack of attitudinal activities for students is reason that Integrated Learning Approach (ILA) is being proposed for teaching Physics at secondary school. The ILA is expected to succeed in improving the handling of the study of Physics because it is holistic. It contains aspects of cognitive, psychomotor and the affective development.

1.1. Objective

Find out the influence of ILA and RTM on the achievement of students 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. Two 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.

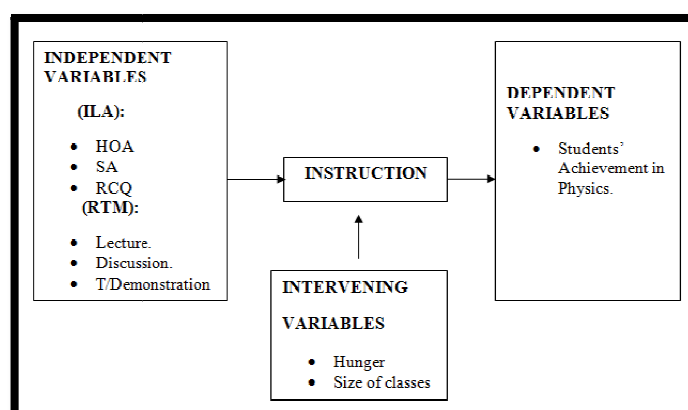


Figure 1: Conceptual Framework

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 is 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 involvement 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. 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	Posttest
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.

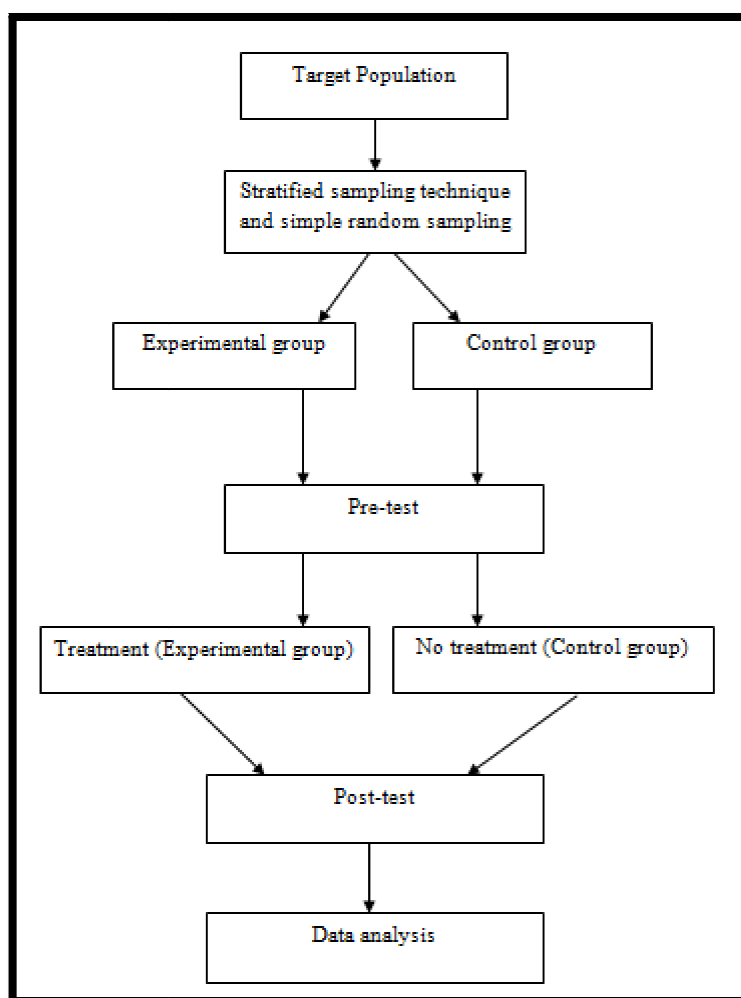


Figure 2: Operationalizing of the Research Design

2.2. 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.

2.2.1. 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

2.2.2. 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.

2.3. 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.

2.3.1. 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).

2.3.2. 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.

2.3.3. 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.

2.3.4. 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 3 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 3: Validation of the Instruments

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

2.3.5. Reliability of the Instruments

The PAT1 and PAT2 were tested for reliability using Cronbach's Alpha coefficient, r_{xy} by applying split-half 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.

2.4. 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.

2.5. 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 Pretest and Posttest were tested for statistical significance at the 95 % confidence level (Kothari, 2009).

3. Research Results and Discussions

3.1. Overall Comparison of Students' Achievement Using ILA and RTM

The respondents in both experimental and control groups were subjected to PAT 1 and PAT 2 to gauge their achievement. PAT 1 and PAT 2 were written tests administered to Form two Physics students in all the sampled schools.

Category	N	PAT 1 Mean (%)	Standard Deviation (SD)	t-test
Experimental	267	51.5	11.63	-3.730
Control	128	49.1	12.66	

Table 4: Students' Pretest Achievement in Physics Based on ILA and RTM

Both groups were subjected to the Pretest at beginning of the study. The mean score of the experimental group (51.5%; SD= 11.63) was greater than that of the control group (49.1%; SD=12.66). The values of SD among experimental and control were comparable at pretest. The t-test value (-3.730) and $p=0.479$ indicate there was no significant difference between the experimental and control groups. Thus, experimental and control groups of students started with comparable entry behaviour as shown by the mean scores in Table 4.

The results of PAT1 and PAT 2 are indicated in Table 5 below.

	Experimental (%)	Control (%)
PAT 1	51.5	49.1
PAT 2	56.6	50.2
SD	11.63	12.66
Gain	5.10	1.10

Table 5: Students Achievement in Physics at the Post-test and Pre test

The experimental group posttest mean score was 56.6% while that of the control group was 50.2%. The gain for the experimental group was 5.1% while for control group the gain was 1.1%. This shows that the experimental group outperformed the control group. The scores obtained by students in Posttest were higher than those in the Pretest. The t-

test results indicate that the mean score of the experimental group was greater than that of the control group. The students' results in the Experimental group were better than those of the control group.

3.2. 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.

3.3. Conclusion

There was a statistically significant difference between the academic achievement of students in ILA and RTM groups. ILA approach yielded higher achievement than RTM. ILA group obtained higher scores than the RTM group.

3.4. Recommendation

- 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

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