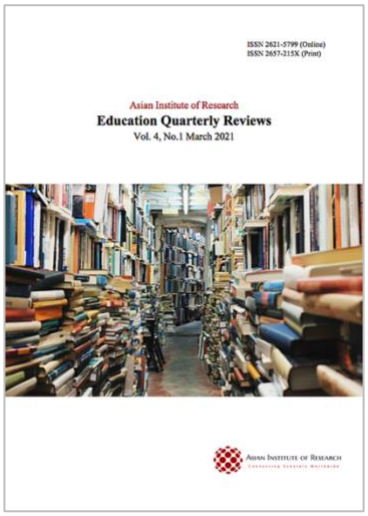

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Effects of Problem Based Learning Method and Lecture Teaching Method on Academic Achievement of Students

Peter Oyier Ogweno[1], Nephat J. Kathuri[2], Agnes Oywaya[3]

[1] Department of Agricultural Education and Extension, Egerton University, Nakuru, Kenya
[2] School of Education & Social Sciences, Kenya Methodist University, Meru, Kenya
[3] Department of Agricultural Education and Extension, Egerton University, Nakuru, Kenya

Correspondence: Peter Oyier Ogweno, Department of Agricultural Education and Extension, Egerton University, P.O Box 536-20115, Egerton, Njoro, Kenya. Tel. +254 723454941, E-mail: peter.oyier60@gmail.com

Abstract
The research examined the effects of Problem Based Learning (PBL) and Lecture teaching method (LTM) on students' achievement in agriculture subject. This research was necessitated by consistent poor performance of students in agriculture subject in the national examination, Kenya Certificate of Secondary Education (KCSE). The aim was to determine and compare the achievement of students in PBL and LTM. Quasi-Experimental design, following a Non-equivalent Control Group Pre-test-Post-test was adopted. PBL was the treatment, while LTM group was control. All the students of agriculture and teachers of agriculture formed the target population. Stratified random sampling was used to sample 12 schools. Six schools were subjected to PBL while the other six schools followed LTM. The sample size was 484 Form Two agriculture students and 12 teachers of agriculture. Data were collected through agriculture achievement test. Descriptive statistics and analysis of covariance (ANCOVA) was used to analyse the data. The results established that PBL has the greatest potential in improving students' achievement in agriculture compared with LTM. The PBL method significantly ($p<.05$) improved the student performance in agriculture. A statistically significant difference was found between students of PBL and LTM. The effects of PBL were more noticeable, therefore, the results are robust enough to inform practicing teachers to adopt PBL method because it has demonstrated its effectiveness in delivering content. The results may inform education experts at tertiary institutions and universities in Kenya on the benefits of implementing PBL method to pre-service teachers.

Keywords: Problem Based Learning, Lecture Teaching Method, Poor Performance, Agriculture Achievement Test, Students Achievement

1. Introduction

1.1 Introduction to the Problem

Agriculture is one of the sectors that contribute to eradication of poverty, hunger and malnutrition and by extension promotion of sustainable development. Equally, the sector is central to unlocking new developments in the various

fields of science, technology, innovations and entrepreneurships. Notably, economic growth resulting from agriculture has played significant roles in poverty eradication which has led to tremendous economic growth in both Latin America and several Asian countries. However, the action plan used in these countries have not functioned well in Africa (Diao & Yanoma, 2003). This is due to poor implementation of strategies geared towards agricultural revolution, as well as, falling behind in factor productivity in African agriculture compared to other global economies.

In Kenya, agriculture is the mainstay of the economy contributing about 60 percent of the Gross Domestic Product, as well as, offering direct and indirect employment to millions. However, the full potential of the subject has not been unlocked in the whole country. In Ndhiwa Sub-County of Homa Bay County in the Republic of Kenya, the dismal performance of students in the agriculture subject in the national examination at Kenya Certificate of Secondary Education (KCSE) has been generally unsatisfactory (Kenya National Examination Council, 2016); a trend that points to some theories whose veracity this paper investigated in-depth. Educators to some extent have established that students learning outcomes are determined by a myriad of intertwined factors interacting with each other. The factors include school-based factors, social factors as well as, economic factors. The underlying circumstances in which these factors interact may be the cause of poor performance of students in Ndhiwa Sub County. Substantive studies have pointed out that poor results in agriculture subject in Kenya could possibly be associated to teaching methodology that absolutely fail to stimulate retention of knowledge and gaining of practical competence.

The study adopted Constructivist Learning Theory which combines Cognitive Development Theory, Piaget (1972) and Sociocultural Theory, Vygotsky (1978). Piaget's theory sees the teacher as a facilitator or a guide who provides a rich environment for students to explore their inquisitiveness. Therefore, the teacher should desist from answering students' questions. Vygotsky's theory emphasized that teachers' responsibility is to make sure that students are active in constructing their own knowledge through social interactions. The active role of the student is useful in building understanding, asking questions and appropriate use of information.

It is worth noting that PBL teaching method is not used in Kenya secondary schools as one of the teaching methods, therefore, research findings would be useful in informing teachers and education managers to utilize PBL as a teaching method to improve student's achievement in agriculture in schools within Ndhiwa Sub County. This would make education administrators within the Sub County to take corrective measures aimed at improving students learning outcomes in agriculture subject. Teachers, likewise, would also benefit from the findings by implementing the use of PBL which eventually would lead to improved academic achievement of students.

The Kenya National Examination Council (2016) has reliably reported that performance of students in agriculture subject has been increasingly poor over the years in the Kenya Certificate of Secondary Education (KCSE). Actually, national performance in the subject has always remained below 50% (KNEC, 2016). It is regrettable that the unsatisfactory achievement in the subject has persisted despite availability of numerous learning platforms, such as agriculture lessons, Young Farmers Clubs and school farms. Indeed, this unfortunate situation is attributable to a combination of a series of factors, which includes but not limited to teaching methods. From this perspective, it was imperative to find methods of teaching that may help increase students achievement as a whole. Therefore, PBL method, being an active teaching method, was included in the research because its usage has proved productive in refining and enhancing students' achievements. A number of studies have been done in Kenya investigating the connection and apparent linkage between students achievement and teaching methods in a variety of subjects. Nevertheless, there are insufficient studies, if any that have examined the relationship between PBL as a teaching method and students' achievement in agriculture subject in secondary schools in Kenya. Therefore, the research was carried out in Ndhiwa Sub County because the achievement of students in this Sub County has persistently remained poor.

In recognition of the fact that teaching using predominantly lecture method promotes lower students achievement in agriculture, Kenya National Examinations Council (KNEC, 2013) volunteered practical advice to teachers of agriculture to take advantage of methods of instruction that support students to acquire practical knowledge in conjunction with preservation of what has been learnt. From this perspective, it was acknowledged that active

methods of instruction are effective in providing assistance to students in solving problems (Kibett, 2002). In a separate report, teachers of agriculture were called upon to infuse readership culture to empower students to develop clear understanding of the principles and practical applications used in agricultural production (KNEC, 2013). It is within this context that PBL which is an active instructional method was applied to strengthen students' achievement in agriculture subject. Nationally, the general performance index of students in agriculture subject has been ordinarily inadequate as pointed out by Kenya National Examinations Council (2016) report. The unsatisfactory performance is to a large extent associated to instructional procedures, as well as, other factors not investigated in this research. The use of PBL may help in improving students' achievement. This research in particular has endeavoured to identify suitable method that may support efficient and valid learning between students, subsequently, strengthening students' interactions, as well as, increasing students learning outcomes in the subject. In the past, there has never been particular research carried out on the effectiveness of PBL in secondary school agriculture in Ndhiwa Sub County. Therefore, this research had the intention of filling this knowledge gap. The research provides reliable practical evidence on the effects of PBL on students' achievement in secondary school agriculture.

Impressive academic results are an outright indication of excellent establishment of good teaching practices. For this reason, the good results are a prerequisite for supporting faster social and economic development. The economic and social progress must be anchored on quality education, which regulates the growth of human resources required for quick advancement in a country. In this regard, Akanle, (2007) demonstrated that capital investment in education frequently influence societal and economic growth. To attain this high level of development, teaching personnel should be prepared to employ dynamic teaching strategies that may foster achievement of satisfactory performance. For this reason, classification of teaching methods fall into two general groups, specifically, expository, as well as, heuristic methods.

The expository method involves direct instructional strategy which encompasses use of lectures. Interpretation and understanding of educational aims coupled with knowledge of students' needs is key for effective teaching. According to Cascio (2015) accurate translation of educational aims and objectives often results in good teaching, as such, discovering significant factors that have serious implications on students' performance at any education level by the teachers becomes an easy task. In another research, Charlton (2006) observed that giving instruction using lectures predominantly supports the delivery of information in a unilateral way. In many instances, there is less participation of learners. The process effectively renders students to transform themselves into inactive and unresponsive listeners (Marmah, 2014). Productive and efficient use of lectures is only viable if teachers supplement its usage with interactive instructional practices that could reduce the deficiencies and weaknesses associated with the use of lectures, for example, limited retention of knowledge, creating inappropriate environment where students are inactive and reducing exploitation of cognitive activities in students (Fry et al., 2009). Lecture teaching method has been associated by reduced action by students; essentially, this scenario promotes cramming which theoretically forms the basis for learning (Wachanga & Mwangi, 2004).

Similar studies have documented that using methods that do not inspire creativity in students in most situations produces poor students' outcomes in examinations, this state of affairs have been typically observed in various subjects (Adunola, 2011). In the light of this confirmation, Auwal (2013) prominently pointed out that excessive dependence on teaching techniques that are teacher-centered make cramming as the main method of learning which is characterised by repetitions and replication of facts culminating into rote learning. Notably, the outcome of such methods of teaching leads to poor academic performance in science subjects as observed in Nigeria. In acknowledging the significance of teaching using methods that are student centered, Auwal (2013) impressively cited (Achor et al., 2009), candidly emphasized the importance of using didactical methods that stimulate participation of students, at the same time, underscore the need for knowledge retention.

Problem Based Learning is a teaching method where applicable real-life problems emanating from the students syllabus are presented in the initial phase of teaching sequence. The problems supply the background and incentive for the acquisition of knowledge thereafter (Michael, 2004). Therefore, students must be actively involved through collaborative engagement amongst themselves for self-directed learning to occur (Michael, 2004). For this reason, PBL provides an opportunity for learners to completely benefit from the interaction amongst the students as they

tackle the learning issues. This productive engagement of learners places PBL as a method that uses problems as the primary focus for student learning (Khairiree & Kurusatian, 2009). Accordingly, PBL has emerged as one of the most powerful instructional method with the potential to allow for dramatic mainstreaming of innovative ideas resulting into attainment of skills vital in finding solutions to problems (Hmelo-Silver, 2004). Against this background, (Mabrouk, 2007) gave evidence suggesting that PBL have a great potential in improving students learning outcomes. This was demonstrated in some topics in analytical chemistry and biochemistry. Similarly, Abanikannda (2016) research established that learning performances of students' greatly improved under PBL method in chemistry in comparison to lecture teaching method. In a similar fashion, (Shikuku & Amadalo, 2015) research on linear programming skills in Kenya, concluded that PBL students posted impressive results in mathematics as they were selectively compared to students that received instruction through lectures.

1.2 Objective of the Study

The aim of the research was to determine and compare the effects of Problem Based Learning and Lecture Teaching method on students' achievement in secondary school agriculture subject.

1.3 Hypothesis of the Study

The null hypothesis was tested at significance alpha level of .05. The hypothesis was stated as;
H0: There is no statistically significant difference in achievement in agriculture between students taught through PBL and those exposed to lecture teaching method.

2. Methodology

The research adopted Quasi-Experimental Design, which followed Non-equivalent Control Group Pre-test-Post-test Design (Campbell & Stanley, 1963). Quasi-experimental was applied because it was impossible to carry out true experiment on human beings. Non-equivalent Control Group Pre-test-Post-test Design was considered vigorous and powerful design popularly used in educational research (Ary et al., 2010). Moreover, the design proved appropriate for testing and confirming the precise effects of PBL method and the classes remained intact during the research (Borg & Gall, 1989; Fraenkel & Wallen, 2000). Ndhiwa Sub County, Kenya had a total of 40 secondary schools with a population of 7124 students. The researcher used 12 secondary schools with six schools using PBL while the remaining six schools followed LTM which acted as control. There was random assignment of Form Two classes to PBL and LTM respectively. The design allowed the possibility of manipulating independent variable in order to determine the degree of its casual effect (Sekeran & Bougie, 2011). Certainly, using the design gave valid assurances on internal and external validity. The design had the convenience of controlling reactive effects of experimentation in intact classes, thus making students probably unaware that a research was being undertaken than in situations where participating students are chosen from classes and placed into experimental sessions (Ary et al., 2010). As such, the researcher was able to apply and generalise the findings because the design was found appropriate for monitoring and controlling any viable threats to internal validity. The experimental group and control group undertook pre-test and post-test resulting into four observations that were vital for estimating the effect of experimental treatment as compared to control variable. Pre-test was given to students before instruction. The design adopted, allowed comparison of the final post-test results between experimental and control groups to ascertain the effects of treatment (PBL), Flick (2006). The research was done in February to March 2019 which lasted for six weeks, after which the post-test was administered to the two groups as shown in Table 1.

Table 1: Non-Equivalent Control- Group Pretest-Posttest Design

Group	Pre-test	Treatment	Post-test
Experimental group	O_{1D}	X_D	O_{2D}
Control group	O_{1K}		O_{2K}

Where:
O_{1D} were experimental pre-test scores for PBL method

O_{2D} were experimental post-test scores for PBL method
X_D were treatment for PBL method
O_{1K} were control pre-test scores
O_{2K} were control post-test scores

The research employed stratified random sampling method to specifically select the schools in accordance to school category. The unit of sampling was secondary schools as opposed to individual learners (Borg & Gall, 1989), since secondary institutions function as intact groups with varying students' numbers per class. Thus, every school was taken as one group, therefore twelve schools were duly selected to participate, with 280 students in six experimental schools and 204 students in six control schools. There were 249 boys and 235 girls in the sample size of 484 students. Therefore, the sample used were adequate in making generalization of research results. The list of schools constituted sampling frame which was established from Ndhiwa Sub County Director of Education records (2017). Selection of schools was based on students' gender including boy's only schools, girl's only schools and mixed schools. Purposive sampling became handy in the selection of trained teachers and Form Two students. There was further sub-categorisation of schools depending on teaching method adopted. Thus, each of the control and experimental categories were composed of two boys 'schools, two girls 'schools and two co-educational schools respectively, totalling to 12 schools. Sampling took into account the number of schools per category. Twelve trained teachers were purposefully selected for the research. Therefore, six teachers were trained on PBL methodology while the remaining six were trained on lecture teaching method. Determination of sample size was based on students' enrolment during research. Certain considerations, such as, school location in terms of divisions within the Sub County, syllabus coverage, willingness to cooperate and gender balance were used. According to recommendations by Fraenkel and Wallen (2000) at least 30 subjects per group are adequate for research purposes. Therefore, the 12 participating schools had at least 30 students in Form Two. All the 484 students in participating schools were involved in the research process since students' classes cannot be dismantled and reconstituted for research purposes, rather, they remained intact during the research (Fraenkel & Wallen, 2000). The sample used were actual students that were present in Form Two in the 12 schools.

Agriculture Achievement Test (AAT) was the principal research instrument used in administration of pre-test and post-test respectively. Therefore, test scores were deliberately used as data (McMillan & Schumacher, 1997). The test scores were obtained from marking of students scripts after administration of pre-test and post-test. The AAT were standardized and validated for face and content validity to examine the appearance and representativeness of the content studied (Netemeyer et al., 2003). This was done by subject specialist teachers and a panel of experts in the Department of Agricultural Education and Extension at Egerton University. The designing of the instrument was done with the aim of determining achievement levels of participating students. Specifically, the contents of agriculture achievement test was adapted from the Livestock Production II (Nutrition) topic in Form Two secondary agriculture syllabus. The researcher modified the instruments based on experts' recommendations. Pilot test was conducted with 50 Form Two students in a school in another Sub County other than those included in the sample. Piloting helped in evaluating the instruments content and format by allowing students engaged in the process to provide valuable feedback on the ease or difficulty of taking and completing the items. Comments and suggestions received from piloting touching on unclear and ambiguous questions were used to review the items. Reliability was established using test-retest method that yielded reliability coefficient of .78. This implied that the instruments were reliable and therefore suitable in making accurate group inferences (Fraenkel & Wallen, 2000). Students were not allowed to write their names on the question papers to guard against their confidentiality. Teachers were also assured that results from the research were to be used only for research purposes. This particular approach enabled the researcher to establish good relationship between the teachers and students.

Scores obtained were organized into categories. Therefore, descriptive statistics (mean, mode, median and standard deviation) and inferential statistics (t-test, chi-square, ANCOVA and ANOVA) were systematically used to tabulate the data at .05 level of significance. The advantage of using ANCOVA was to statistically control for a third variable known as a confounding variable. Statistical Package for Social Sciences (SPSS) version 25 software were employed in data analysis.

3. Results

In a nutshell, the researcher had to control the known confounding variables, for example, time difference in administering pre-test and post-test and topic to be covered. This helped the researcher to make accurate deductions of the effect of treatment (PBL).

3.1 Performance of Students in Pre-test Examination

The results shown in Table 2 captures how the students performed in pre-test before any learning intervention.

Table 2: Achievement in Categories for Students Pre-test Scores

Score Categories	Frequency	Percent	Mean	Median	Mode	Standard deviation
Below 10	6	1.2	31.8	30	30	12.01
11-20	41	8.5				
21-30	105	21.7				
31-40	109	22.5				
41-50	103	21.3				
51-60	67	13.8				
61-70	45	9.2				
71-80	8	1.8				
Above 81	0	-				
Total	484	100.0				

The results in Table 3 shows the outcome of students' performance after exposure to treatment (PBL).

Table 3: Distribution of Scores for Students taught through PBL Method

Score in Categories	Frequency	Percent	Mean	Median	Mode	Standard deviation
21-30	6	2.1	57.47	57	60	13.19
31-40	24	8.6				
41-50	53	18.9				
51-60	84	30.0				
61-70	68	24.3				
71-80	33	11.8				
Above 81	12	4.3				
Total	280	100.0				

Results from Table 3 showed that students who learnt agriculture through PBL method attained 57.47 in terms of mean score with a standard deviation of 13.19. The highest score obtained by the students was 89 percent with a minimum score of 22 percent.

Notably, Table 2 presents the achieved mean scores and standard deviation for students in pre-test, while Table 3 successively gives a clear picture of achievement of students in post-test for students who received instruction through PBL teaching method. Pre-test mean score of 31.8 was obtained (Table 2). However, there was a marked increase in mean (57.47) and standard deviation of 13.19 in post-test scores under PBL method (Table 3). In comparing post-test scores with pre-test scores, it is crystal clear that PBL post-test mean score of 57.47 was higher than pre-test mean score of 31.8. There was a mean difference of 25.67 realized due to administration of PBL treatment. Thus, the finding established that using PBL positively increased students' achievement in agriculture subject. Chi square analysis was performed to show the distribution of students score as seen in Table 4.

Table 4: Chi-Square Test Performed on the Frequency Distribution of Students Score

Score	Observed N	Expected N	Residual	Statistics
21-30	6	40.0	-34.0	$\chi^2 = 128.35$
31-40	24	40.0	-16.0	$df = 6$
41-50	53	40.0	13.0	$p = .001$
51-60	84	40.0	44.0	
61-70	68	40.0	28.0	
71-80	33	40.0	-7.0	
Above 81	12	40.0	-28.0	
Total	280			

The chi- square results (Table 4) revealed that students score between 51 and 60 which was high (or good) were statistically and significantly (χ^2=128.35, *df* 6, *p*.001). This was found to be higher than the other categories in the score distribution. As such, the overall performance of students in this topic in agriculture was rated good. This increased positive indicator in performance is agriculture subject in the Sub County may be due to the type of teaching method utilised by the teachers in this research. In other words, students increased performance confirms that PBL is a robust teaching method that inspires students to improve their learning outcomes in a significant way.

3.2 Hypothesis Testing

Testing the hypothesis in this research required the use of Analysis of Covariance (ANCOVA) which was performed to determine the effect of lecture teaching method (control) and Problem Based Learning (treatment) on post-intervention agriculture score after controlling for pre-intervention. Therefore, the unadjusted and adjusted means for the lecture teaching method and PBL method based on the covariate (pre-intervention score) are shown in Table 5.

Table 5: Adjusted and Unadjusted Means and Variability for Post-intervention Score with Pre-intervention Score as a Covariate

		Unadjusted		Adjusted	
Teaching methods	N	Mean	Standard deviation	Mean	Standard Error
Lecture	204	43.76	10.40	44.36	.549
Problem Based Learning	280	57.47	13.19	56.81	.469

Typically, the results displayed in Table 5 shows unadjusted mean ± standard deviation. The research established that students' scores achieved as a result of Problem Based Learning intervention (57.47 ± 13.19) were statistically higher compared to lecture teaching method scores (43.76 ± 10.40). Basically, the adjusted means (means adjusted for the covariate) were lower than the unadjusted means.

The performance of Levene's test did not find data with outliers. The Levene's test for PBL (treatment) and LTM (control) had equal variances as shown in Table 6.

Table 6: Levene's Test of Equality of Error Variances

F	*df1*	*df2*	*p*
77.279	2	445	.220

Results indicated that there was homogeneity of variances, as assessed by Levene's test of homogeneity of variance (p = .220). Therefore, Levene's test results was not statistically significant (p >.05) meaning that the assumption of homogeneity of variances was not violated. The one- way ANCOVA test in Table 7 confirmed whether there were any statistically significant group differences on the dependent variable after adjusting for the covariate.

Table 7: Tests of Between-Subjects Effects

Source	Type III Sum of Squares	*df*	Mean Square	F	*p*	Partial Eta Squared
Corrected Model	20019.978[a]	1	20019.978	194.778	.001	.412
Intercept	6552.320	1	6552.320	63.749	.001	.187
Control (Pre-test)	20019.9780	1	20019.978	194.778	.001	.412
Intervention	.000	0	-	-	-	.001
Error	28573.847	278	102.784			
Total	973539.000	280				
Corrected Total	48593.825	279				

Dependent variable: Post-test score
a. R Squared = .412 (Adjusted R Squared = .410)

Post-Hoc mean comparisons

The comparisons were done using Bonferroni post-hoc tests for the mean pairs in PBL and LTM at 95 % confidence interval for the difference between group I and J is summarized in Table 8.

Table 8: Pairwise Comparisons of the Means Using the Bonferroni Post Hoc Test

Comparison between Lecture (I) and Problem Based Learning (J) method	Mean Difference	Std. Error	*p*	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
(I-J)	-12.45	.723	.001	-14.189	-10.721
(J-I)	12.45	.723	.001	10.721	14.189

Dependent variable: Post-test score for PBL

In order to find out the means which were statistically significant from each other, the researcher performed post hoc mean comparisons using Bonferroni test. The pairwise comparisons for the mean pairs shown in Table 8 clearly indicate that post-intervention score for the Problem Based Learning method were statistically and significantly greater than the lecture teaching method (control) with a calculated mean difference of 12.45 (95% CI, 10.72 to 14.18) %, p < .001).

Univariate analysis using the F and Eta Squared tests
The variances in Table 9 ranges between 0 and 1, where .01 is small, .06 medium, and above > .14 is large.

Table 9: Univariate Analysis

	Sum of Squares	***df***	**Mean Square**	**F**	***p***	**Partial Eta Squared**
Contrast	20019.973	1	5265.755	194.778	.001	.412
Error	28573.847	278	102.784			

R Squared = .412 (Adjusted R Squared = .410)

4. Discussion

The results of PBL are significant in informing education administrators' and teachers of agriculture in Kenya to embrace the use of PBL as a teaching method in agriculture subject, since the method has clearly demonstrated that it is more effective as a teaching method as compared to lecture teaching method. Similarly, educators at tertiary institutions and universities in Kenya has been informed on the need to train pre-service teachers about the use of PBL method. This is because PBL is not among the popular teaching methods used in Kenya.

The findings in Table 5 indicated that PBL teaching method is superior to lecture teaching method. Students who were taught through PBL posted higher learning outcomes with post-test mean score of 57.47 while their counterparts in the lecture teaching method had a mean score of 43.76. The impressive results realized under PBL method is in agreement with Strobel and van Barneveld (2009) study that found that teaching students through PBL enhanced students' ability to retain desired knowledge and skills that was acquired through learning experience. Therefore, the reason for high achievement of students under PBL method was due to uniqueness of PBL in enabling students to sufficiently retain what they were taught. Therefore, teaching through PBL enabled students to strategically apply a variety of skills, such as, independent research, application of knowledge in concrete situations by utilizing creativity in a manner that helps them in analysing situations. These skills were essential in helping the students to post higher achievement in PBL method as opposed to students who were taught using the lecture teaching method.

The results in Table 7 further confirmed that adjustment that was done for pre-intervention agriculture scores, produced a statistically significant difference in post-intervention scores between the interventions, F (1, 278) = 194.778, $p < .001$, partial $\eta^2 = .412$. This necessitated rejection of null hypothesis. For this reason, the research ascertained that there were statistically significant differences on achievement of students in agriculture for the groups of students who were specifically instructed through PBL than those who were taught through lectures. The differences established could explain the robust nature of PBL in delivering content which in turn improved students' achievement in agriculture. Similar results were observed in construction engineering courses where significant learning differences in the learning gains were established between students instructed through PBL and lecture methods (Rodríguez & Fernández, 2016). The students taught through PBL had over 30% increase in their average grade as compared to students taught through lecture teaching method.

The improved results was attributed to the fact that PBL lessons involved learners through small group discussions on actual real problems inherent in agriculture. PBL method allowed sharing of ideas and different viewpoints between students in the process of resolving problems under investigation. Therefore, there was continuous reconstruction of meanings about the learning issues which allowed for high retention of what has been discussed. The method gave students an opportunity to develop a range of skills, in addition to independent learning that occurred with minimum guidance from the teacher. The findings are in agreement with Bilgin et al. (2009) study that established that students who were exposed to PBL in learning conceptual gas concepts performed exceptionally well compared to students who received instruction through lectures. However, the research study did not establish substantial differences in students' achievement between PBL method and lecture teaching method in quantitative gas concepts.

5. Conclusions and Recommendations

Given the fact that learning is a process that involves several mental activities, such as, investigation and authentic reasoning that requires use of good strategies in solving problems. Teachers, therefore, should be cognisant of the fact that students achievements increases if they are able to solve problems rather than remember isolated facts. A learning environment where use of lectures is the main teaching method in most instances fail to promote proper engagement and participation of learners nor develop problem-solving skills in students. Problem solving skills are better developed when meaningful engagement among students occurs during learning. PBL improves the academic achievement of students in agriculture subject. The teaching method has demonstrated superiority over lecture teaching method by posting higher mean scores than lecture method in agriculture subject. PBL method as a teaching method is not a regular teaching method in Kenya as compared to other teaching methods, therefore,

PBL method should be introduced in teaching of agriculture subject in Ndhiwa Sub County to improve students' achievement. PBL use may remedy the persistent poor achievement of students in agriculture subject in this Sub County. The Ministry of Education, Science and Technology through Kenya Institute of Curriculum Development should incorporate PBL as a teaching method in the secondary school agriculture syllabus for teaching of agriculture subject. Universities and Teacher Training Colleges in Kenya should equip pre-service teachers by using PBL in teacher preparation programmes. Use of lecture teaching method should be discouraged to improve students learning outcomes.

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