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Teaching Methods and Gender as Determinants of Academic Achievement of Students in Agriculture Subject in Ndhiwa Sub County, Kenya

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Abstract

Purpose: This study attempted to determine if the three teaching techniques utilized in this study, namely the demonstration-teaching method (DTM), the lecture-teaching method (LTM), and problem-based learning (PBL), would have a substantial impact on student's academic performance dependent on their gender.

Methodology: The study used a quasi-experimental design. The researchers employed a non-equivalent control group for the pre-test and post-test. PBL and DTM were the treatments, while LTM served as the control. The sample size consisted of 779 pupils, out of 7124 students. Using stratified random sampling, 18 secondary schools and 18 agriculture teachers were selected. Each of the three methods of instruction was assigned to six schools. Agriculture achievement test was used to collect data from students. Descriptive statistics, the T-test, and covariance analysis were used as data analysis techniques.

Findings: The outcomes of the study revealed that female students fared better (51.356) than male students (48.852). Educators may better understand the advantages of PBL and DTM as teaching methodologies because the findings are that both are more successful at disseminating knowledge.

Unique Contribution to Theory, Policy and Practice: The findings may help higher education institutions to emphasize on the use PBL and DTM when they are delivering their lectures to students of education. This strategy will help students improve students' performance once they graduate and they are employed to teach agriculture subject.

Keywords: *Problem Based Learning, Demonstration Teaching Method, Lecture Teaching Method, Performance of students, Gender.*

1. Introduction

1.1 Introduction to the Problem

The bulk of the world's food and employment is provided by the agricultural sector, which also accounts for 6.4% of the global Gross Domestic Product (GDP) (Food & Agriculture Organization (FAO), 2016). Additionally, women account for 43% of the world's agricultural workforce, mostly in developing countries. In the same vein, more than half of the labour force is employed in agriculture, giving small-scale producers subsistence (FAO, 2016). According to data from the International Monetary Fund (IMF) (2013), 175 million people in Sub-Saharan Africa (SSA) directly depend on agriculture, with 80% of smallholder farmers making up this population. Women make up half of the labour force in this sector.

The basis of our economy is agriculture, which accounts for 27% of Kenya's Gross Domestic Product. Women contribute significantly to Kenya's agricultural output since they make up 86% of the country's small-scale farmers (International Labour Organization (ILO), (2015). Therefore, achieving food security in Kenya requires a strong focus on agricultural education. To make learners productive in the agricultural industry, it is crucial to provide students with the right tools for developing agricultural skills (Waiganjo et al., 2014). The majority of the time, a student's performance serves as a measurement of whether or not they have acquired the foundational knowledge and abilities required to develop the requisite proficiency. Because so many Kenyans depend on agricultural farms for their livelihood, achieving high academic standards is essential to the agricultural industry's sustainability (Waiganjo et al., 2014).

Kenyan secondary school teachers teach agriculture subject using different teaching strategies. Teachers should adopt teaching strategies that completely engage students (Miles, 2015). Students' academic performance will be significantly improved if that is successfully implemented. Teaching strategies that might boost students' academic performance should also encourage greater group interactions among the students to foster better social engagement. As a result, social interaction inside the classroom supports student teaching (Nguyen et al., 2012). Additionally, a welcoming environment should be provided for students for effective learning to take place.

The lecture method of imparting knowledge is widely accepted by many practitioners as a method of disseminating information quickly to students. Users have been cautioned against assuming incorrectly that students have been taught adequately, particularly when students are able to recall isolated concepts (Keshta & Harb, 2013). These misconceptions are discovered when students are tested at higher levels of learning and are found to have numerous misunderstandings about the subject they have learned. Additionally, Odundo and Gunga (2013) noted that the lecture approach is defined by the presentation of a large amount of content, which results in the learning of only a few concepts. Younger people show a gender divide in academic performance, with males outperforming women in some contexts while women outperform men in others (Ogweno, 2021).

Lauren (2012) noted that gender has a crucial influence on the learning environment; this is because teachers react differently to boys and girls in the same classroom. Filgonali and Sababa (2017) also observed that all students, regardless of gender, should get equal chances, the same degree of encouragement, and the same level of participation throughout teaching and learning. "Additionally, attaining gender parity in education is one of the Sustainable Development Goals (SDGs) of the United Nations, yet despite the great contribution that women make to national development, gender inequity in favour of the male child still exists (United Nations, Department of Economic and Social Affairs, 2023).

The academic performance of students is significantly influenced by gender, particularly in the study of science. The significance of examining how gender inequalities in school achievement connect to community behavioural differences between boys and girls is particularly essential (Adigun et al., 2015). In addition, Adigun et al. (2015) found that boys are assigned more challenging assignments than girls. As a result, the public perceives females as being of a weaker gender (Adigun et al., 2015). Adigun et al. (2015) study found no differences in academic achievement in computer studies by gender. Eshetu (2015) found no statistically significant gender difference in average results analyzed in a regional test. There was no statistically significant difference in the percentage of male and female students in the top and lower achieving categories. In multiple choice and short essay problems, Faisal et al., (2017) found no statistically significant difference in the academic performance of the two genders.

A study conducted by Mwihia (2020) concluded that students' academic performance is influenced by their gender. In terms of performance, male students outperform female students. Gender should no longer be a barrier to learning or a difficulty while teaching academic topics. A study by Van Hek et al. (2016) found that schools have very different effects on students, but it is important to note that given how well female students perform academically, gender differences in educational performance between boys and girls should be investigated. The focus in educational research nowadays has put tremendous emphasis on why girls perform better than boys in academic accomplishments (Van Hek *et al.*, 2016). Student examination achievement is often used to assess a school's educational progress (Narad & Abdullah, 2016). The academic performance of students is often taken seriously, especially in third-world countries, as the results are used to determine where students get placed in different courses at Colleges and Universities. Ibrahim et al. (2019) study observed that performance outcomes are also used as recruiting criteria in many organizations.

Problem-based learning (PBL) is one of the active learning approaches that aims to involve students. When using the problem-based learning approach, students are encouraged to engage in the learning process fully. PBL is efficient at improving students' performance, particularly in the subjects of biochemistry and bioanalytical chemistry (Mabrouk, 2007). In a related study, Abanikannda (2016) found that regular PBL use increased students' achievement in chemistry

when compared to traditional methods. Findings from Shikuku and Amadalo's (2015) study on linear programming abilities in Kenyan secondary schools demonstrated that PBL-taught pupils outperformed those who received standard lecture instruction. Problem-based learning (PBL) uses the problem as the driving force behind learning (Overton, 2010). In other words, developing new talents happens in the midst of challenges. PBL differs from problem solving in major ways (Overton, 2010). Students are presented with the difficulties in PBL situations before they get any useful information from any source. An outcome based on experience is produced through the investigative method. As a result, the teaching method requires that students use any materials they believe may be helpful to answer problems that are based on real-world situations.

Considering the context of the current study, incorporating a demonstration teaching method may improve students' cognitive skills, as well as, psychomotor skills especially when the students are allowed to follow procedures that were demonstrated by the teacher either individually or as groups (Daluba, 2013). Similarly, demonstration as a teaching methodology forms an integral part of agricultural education training because it provides for application of concepts taught in class, as well as, allowing transfer of acquired skills to real-life situations. Furo et al. (2014) claimed that the demonstration teaching technique is effective since it is straightforward, encourages student participation in class, and can be applied successfully in both elementary and secondary schools. In a different study, Inuwa (2018) reported that Nigerian secondary school students benefited from employing the demonstration teaching approach to raise their scores in financial accounting. Teaching through demonstrations increased students' comprehension of redox processes and electrolysis in chemistry (Basheer et al., 2017). The technique thereby helped the students perform better in chemistry, particularly with redox concepts.

1.2 Statement of the Problem

The pre-requisite to study a course in agricultural disciplines in colleges and universities in Kenya, a student must have sat in agriculture subject in the Kenya Certificate of Secondary Education examination (KCSE). Examination results findings are fundamentally intended to determine if a student is prepared to advance to the next level of study. There is a need to find out whether gender may be used to predict student's achievement in KCSE agriculture because student performance in the subject has been steadily declining in Ndhiwa Sub County. The input of poor KCSE results in the secondary education cycle has the potential to spill over into the next level of education. This situation would make it less likely for students to choose careers in agriculture, which would lead to a scarcity of skilled workers in the agricultural industry, as well as, jeopardise Kenya's Vision 2030 goals. The poor outcomes might be attributed to teacher-centred instructional practices, as well as, other factors that were not examined in this study. Therefore, different active teaching strategies, including problem-based learning and the demonstration teaching technique, have been employed in this study to determine if their use as teaching methods may affect students' performances in light of their gender.

1.3 Purpose of the Study

The purpose of the study was to ascertain if gender may substantially predict performance on the agriculture achievement test when various teaching strategies were applied.

1.4 Objective of the Study

The objective of this study was to determine the effects of Problem Based Learning, demonstration-teaching method, and lecture teaching method on the gender achievement of students in agriculture in Ndhiwa Sub County.

1.5 Hypothesis of the Study

The following null hypothesis was developed and evaluated in the study at a significance level of .05.

H0: There is no statistically significant difference in the achievement of male and female students when agriculture subject was taught through PBL, demonstration teaching, and lecture teaching methods, respectively in Ndhiwa Sub County.

2. Methodology

2.1 Research Design

The study utilized quasi-experimental design. In a quasi-experimental design, the researcher has minimal control over the selection of the study participants; as a result, the researcher is unable to assign individuals at random or guarantee that the sample chosen is as homogenous as intended (Leedy & Ormrod, 2010). The study used a quasi-experimental design with three groups of six schools. Two groups of schools each received treatment with problem-based learning and demonstration, with the third group serving as a control. Campbell and Stanley (1963) considered the non-equivalent Control Group Pretest-Posttest Design to be a reliable and widely used quasi-experimental design in pedagogical investigations (Ary et al., 2010).

Additionally, the design was appropriate for evaluating and confirming the results of comparisons between the PBL and demonstration teaching approaches. Classes were already in place at the school and continued to be there for the duration of the study, therefore a quasi-experimental design was used. Form Two classes were randomly assigned to treatment groups (PBL and DTM), with the Lecture teaching technique acting as the control. Secondary school classes are taught in whole groups. As a result, school administration was unable to agree to splitting up and rearranging classes to conduct scientific research (Franken & Wallen, 2000).

Sekaran and Bougie (2011) contents that using Non-equivalent Control Group Pretest-Posttest Design allows manipulation of the independent variable to determine the extent of its creative outcomes. Because it offered the best assurance of both internal and external validity, the design was considered robust. Because it was impractical to divide the study's participants into groups at

random, the design was an appropriate choice (Ary et al., 2010). Students were presumably less conscious of an experiment being done as a result of this than when students were withdrawn from classrooms and placed in experimental sessions, giving the design the benefit of controlling the reactive effects of experimentation, especially when entire classes were involved (Ary et al., 2010). This helped the findings be more broadly applicable and generalizable.

2.2 Target Population

The group from which the study's sample was drawn and to which its findings were ultimately generalized is referred to as the target population (Kothari, 2004). All secondary school agricultural students registered in Ndhiwa Sub County for the 2019 academic year, as well as all agriculture teachers in Ndhiwa Sub County made up the primary group in the current study. Both Form Two students choosing agriculture as a subject and certified agricultural educators made up the accessible population. Since practically most secondary school students take agriculture up to Form Two before choosing their favourite subjects in Form Three, therefore, Form Two students were chosen for the research. In Ndhiwa Sub County, there were 45 secondary schools with 7,124 students enrolled in agriculture classes. In Kenya, secondary schools are classified into Extra County, County, and Sub County schools.

2.3 Sampling Procedure and Sample Size

A sample is a subject or group drawn from the target population (Mugenda & Mugenda, 2003). Sampling is the process of selecting subsets from a larger collection in order to reach conclusions (Orodho, 2009). Secondary schools were chosen as the sampling unit rather than individual students since they function as whole groups (Gall et al., 1996). As a result, every school was seen as a cluster. The school registrations in Ndhiwa Sub County made up the sample frame. The researcher using data from the teachers' registration at the Sub County Director of Education office established the number of qualified teachers working in the schools. The schools were selected using purposive and stratified sampling methods. The schools were selected based on the student's gender. The researcher purposefully selected Form Two students and skilled and experienced instructors. 18 schools, out of 45 schools, participated in the research.

Using stratified sampling based on the administrative divisions in Ndhiwa Sub County, three schools were selected from each of the six wards, creating 18 schools. When a sample is required to be taken from a population that is not homogenous, stratified sampling is utilized (Etikan & Bala, 2017). According to Sekaran and Bougie (2011), purposive sampling is commonly used when the researcher can obtain data from the people or entities who are most likely to offer the required information. Because of the smaller number of schools in the Extra County and County category, a purposive sampling strategy was employed to choose at least one school from each of the Extra and County school categories that had both boys-only and girls-only schools to guarantee

that all school categories were represented in the sample. The schools in the Sub County category were chosen using a simple random selection method because there were so many of them.

To ensure that each school in this group had an equal and independent chance of being picked for inclusion in the research, this was done by randomly picking and folding numbered pieces of paper. The 18 institutions were further split into three equal groups of six schools for each of the three teaching methods. The PBL group, demonstration group, and lecture group consisted of two schools each for boys, girls, and coeducational students. The schools were sampled using the distribution of schools per category shown in Table 1. Data from simple random sampling may be utilized to draw generalizations, as Mugenda & Mugenda (2003) emphasized. Therefore, institutions with numerous Form Two streams were sampled using simple random sampling and only one stream was chosen to participate.

Table 1

Sample of Schools, Students and Teachers According to School Category

School Type	Boys only	Girls only	Co-educational	Total	Teachers	Students
Extra County	2	1	0	3	3	182
County	2	1	0	3	3	169
Sub County	2	4	6	12	3	428
Total	6	6	6	18	18	779

Source: SCDE office records, Ndhiwa Sub County (2017)

One instructor was selected from among them to work in each of the eighteen participating schools. When there were many agricultural teachers, a purposive sample was utilized to select the instructor with the most classroom experience. As gender was an aspect that needed to be looked at, six of these schools were for boys and the other six were for girls. The determination was based on the Sub County's category and school type. Large sample sizes have been favoured since they are more representative of the target population, which is what an ideal sample size should be (Tromp & Kombo, 2006). Based on the number of students enrolled in the schools, the sample size was calculated. The decision to select participating schools took into account the school's geographical position within the Sub County, the scope of its syllabus coverage, its capacity for collaboration, and its gender diversity. There were 401 boys and 378 girls in the sample of 779 students.

2.4 Instrumentation

In order to gather information from students, the researcher created an instrument called the Agriculture Achievement Test (AAT). Both the pretest and a post-test were administered to the students. McMillan and Schumacher (1997) defined a test as the intentional use of test results as research data. The agriculture achievement test was standardized by using a table of test specifications. This was done to guarantee the test's fairness, the identification of the achievement domains being evaluated, and the inclusion of a representative sample of questions. As a result, the test administration, scoring, and analysis were all consistent. The instrument was designed to enable the researcher to assess the student's level of achievement. Additionally, the Livestock Production (II) Nutrition topic from Form Two secondary agricultural syllabus served as the basis for the agriculture achievement test.

2.5 Data Collection Procedures

To secure research permission from the National Commission for Science, Technology, and Innovation (NACOSTI), the body that grants authorization for the study to be carried out in Ndhiwa Sub County. This allowed researchers to sample secondary institutions. The researcher visited various schools in a bid to persuade principals and agriculture teachers to be involved in the research. Six teachers in the experimental schools received three days of instruction in the PBL approach using a researcher-developed PBL training manual. The 12 additional teachers received a full day of training because they would be implementing the demonstration and lecture methods of instruction, which they were already familiar with from their prior preparation. To maintain uniformity in the chosen topic of instruction, the chosen teachers adopted similar schemes of work throughout the study period.

2.6 Data Analysis

Statistical Package for Social Sciences (SPSS) version 25 was used to carefully examine and analyze quantitative data. A section of the analysis included scoring and categorizing the scores. According to the teaching methodology used, the final score for each respondent were converted to 100%, inputted, and given a unique code identification. Notably, data cleaning was done after the data coding and transcribing processes to remove inaccuracies. Descriptive data such as the median, mode, standard deviation, and mean were included in the analysis. The software was utilized to process the frequencies, percentages, mean, and standard deviation, which were properly used to discuss the results. Chi-square, t-tests, analyses of covariance, and analyses of variance were among the inferential statistics utilized. The results were presented using tables and, in certain cases, bar graphs. The hypothesis was examined at the.05 level of significance, which was predetermined.

3. Results and Discussions

3.1 Gender composition of schools in Ndhiwa Sub-County

Table 2 provides information on gender characteristics of the studied schools. Unquestionably, the registration of co-educational schools were higher than other types of educational institutions. Unexpectedly, the schools are categorized as belonging to the Sub County category, where understaffing and inadequate resources frequently lead to poor student achievements (Institute of Policy and Research, 2008).

Table 2

Composition of Schools According to Gender in Ndhiwa Sub-County

Gender of schools	Number of schools	Percent	Number of students	Percent
Boys Only	4	22.2	210	27.0
Girls Only	6	33.3	253	32.5
Co-educational	8	44.5	316	40.6
Total	18	100.0	779	100.0

Student's respondents' gender

The gender of the respondents was determined using school records shown in Table 3.

Table 3

Gender Composition of the Respondents

Gender	Frequency	Percent
Boys	401	51.5
Girls	378	48.5
Total	779	100.0

The statistics demonstrate that both genders are fairly represented. The gender balance in Ndhiwa Sub County is reflected in the gender makeup of this group. In this study, there were more boys than girls overall. This demonstrates that there can be a little disparity in the proportion of boys and girls enrolled in school.

Academic Achievement of Students in Agriculture Subject

The participants in the study took a pretest. The test was graded out of a score of 100 percent. In the analysis that followed, the pretest results were taken into account as a covariate. The results are shown in Figure 1.

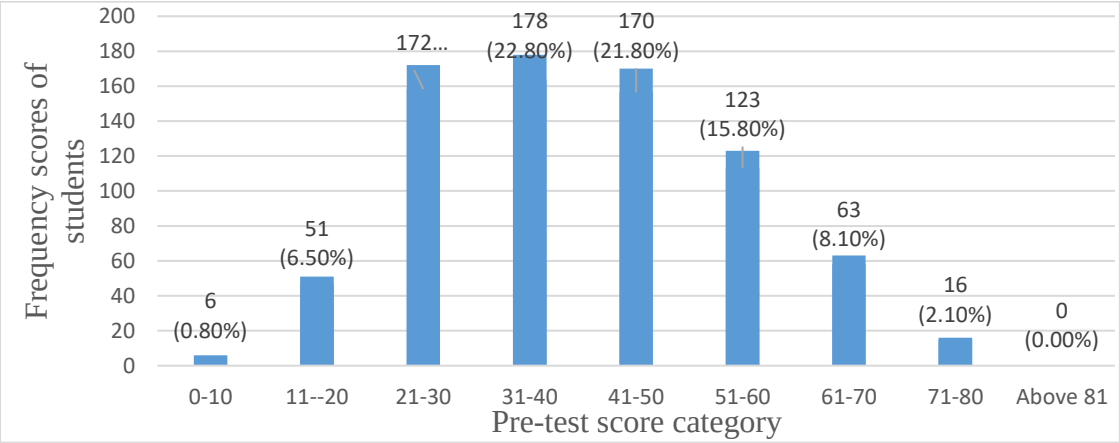

Figure 1. *Pretest Scores of Students Achievement in Categories*

Figure 1 shows that there were 178 students who scored in the 31–40 range on the pretest, which was greater than the other categories. Second-best were the 172 students representing 22.1%, who received a score between 21 and 30. The standard deviation for student performance was 12.01 and the average was 31.8. The results ranged from a score of 7 to a maximum of 73%. The students did poorly on the pretest since they had not received any instruction on the subject of nutrition before the test. This is because the students were not completely ready for the pretest. The students' poor performance was not unexpected given that they had not been taught the subject by their teachers and had only made a minimal effort to research the subject on their own. Thus, it was anticipated that students would perform poorly on the pretest.

To determine the actual divergence between the observed and predicted frequencies, the Chi-square (2) test was used to compare the observed pretest frequencies with the expected frequencies.

It was necessary to determine whether the observed frequencies of students' pretest scores occurred equally for the different score categories in order for the expected frequency distribution to contain the same score in each of the score categories, which is why the expected frequencies were similar (Table 4).

Table 4

Chi-Square Test on the Frequency Distribution of Students Pretest Scores

Score	Observed f_o	Expected f_e	Residual	Statistics
1-10	6	97.4	-91.4	X^2=372.82
11-20	51	97.4	-46.4	df= 7
21-30	172	97.4	74.6	p= .001
31-40	178	97.4	80.6	
41-50	170	97.4	72.6	
51-60	123	97.4	25.6	
61-70	63	97.4	-34.4	
71-80	16	97.4	-81.4	
Above 81	0	-	-	
Total	779			

The results also indicated that students who had low marks between 21 and 50 were statistically significantly (X^2=372.82, df 7, p.001) higher than the other groups. In comparison to its table value (X^2=4.322), the estimated chi-square value (X^2=372.82) was extremely high. This indicated that the divergence between expected and observed frequencies was significant, and thus the overall divergence. As a result, the student's overall performance in the subject was rated as poor. It may be inferred that because the exam was administered before teaching, thus, low results were to be expected.

Gender Differences in Secondary School Agriculture Academic Achievement among Students taught using PBL and Demonstration Teaching Methods

The objective of this study was to determine the effects of Problem Based Learning, demonstration-teaching method, and lecture teaching method on the gender achievement of students in agriculture in Ndhiwa Sub County.

Boys and girls academic achievement in secondary agriculture

The average achievement of the boys and girls across the three instructional techniques (or the grand mean) was compared. The results (grand mean, standard error, and 95 percent confidence intervals for the means) are reported in Table 5.

Table 5

Independent Samples T-Test for Boys and Girls Compared Using Grand Mean

	N	Mean	Std. dev.	df	t-value	p-value
Boys	401	48.852[a]	8.45	377	-4.26666	0.001
Girls	378	51.356[b]	7.93			

a. Covariates appearing in the model are evaluated at: Pretest score = 30.8903.

b. Covariates appearing in the model are evaluated at: Pretest score =32.8095.

The T-test analysis revealed a significant difference between boy's and girls' performance on the agriculture achievement test: t (*df* = 377) = -4.26666, *p* = 0.001, p< 0.05. According to Table 23, females' mean scores are higher (51.356) than boys' mean (48.852). Regardless of the instructional strategy employed, there is a statistically significant difference between the achievement of boys and girls.

These results supported research that discovered that females performed marginally better in classes than males did (Voyer & Voyer, 2014). This is a product of cultural and lifestyle factors that cause some parents to think that boys are more intellectually talented than girls and as a result, they should perform better. Therefore, parents are more inclined to mentor their girls and encourage them to put in their best effort in school. The results of this study Wangu's (2014) research on secondary school students in Kenya, revealed that boys outperformed girls in scientific and language classes. However, Goni et al. (2015) reported no major gender disparities in academic achievement in research that included Nigerian college students.

Table 6 displays descriptive statistics for the three teaching techniques for both genders, along with the interpretation of the students' outcomes for the three techniques (lecture, PBL, and demonstration).

Table 6

Posttest Mean Scores for Boys and Girls for the Three Teaching Methods

Gender of Student	Learning Methods	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Boys	Lecture	43.979[a]	.833	42.342	45.616
	Demonstration	47.699[a]	.719	46.286	49.112
	Problem Based Learning	54.879[a]	.545	53.808	55.950
Girls	Lecture	45.636[b]	.714	44.232	47.040
	Demonstration	48.785[b]	.611	47.584	49.987
	Problem Based Learning	59.648[b]	.840	57.996	61.300

Posttest data from the three methods of instruction for boys and girls showed that girls generally outperformed boys on the agriculture achievement test. In comparison to the mean results for boys (43.979, 47.699, and 54.879), girls scored mean scores in the lecture, demonstration, and PBL techniques of 45.636, 48.785, and 59.648, respectively. When compared to the demonstration and lecture teaching methods, it is evident that both sexes performed better when students were taught using the PBL strategy, with girls obtaining a mean score of 59.648 and boys getting a mean score of 54.879.

Students taught using the demonstration technique likewise did better than those taught using the lecture method, with the girl's mean score (48.785) surpassing the boy's mean score (47.699) in the demonstration method. This shows that girls perform better in the agriculture subject when using the PBL platform than boys do when using the same teaching strategy. This is possible because females are more inclined to be responsible in their academic work and attend class regularly. In addition, compared to the boys' participants, girls' posttest mean scores for all three teaching techniques were somewhat higher. Therefore, based on the results, girls were able to become familiar with the three teaching approaches more quickly than boys, which provided them an advantage in performance.

The findings of Hartley and Sutton (2013) are supported by this study, which shows that females outperform boys in terms of academic achievement, motivation, and self-control in school.

According to research by Miheso-O'Connor (2002), girls were shown to be enthusiastic and determined in their usage of interactive teaching methodologies. Results from the post-test showed that girls fared better than boys using all three teaching strategies. The study by Hannover and Kessels (2011) found no differences in student performance across genders. The study's findings demonstrate that, in Ndhiwa Sub County, gender has a major impact on educational achievement, notably in the discipline of agriculture. Girls do far better than boys in subjects like languages and the arts, according to second research that supported the findings (Chambers & Schreiber, 2004). Female students are more focused on their studies and less likely to skip class or get distracted by extracurricular activities.

The study's conclusions show that gender matters significantly for educational achievement, particularly in the subject of agriculture in Ndhiwa Sub County. Females perform significantly better than boys in subjects like languages and the arts, according to a second study that supported the findings (Chambers & Schreiber, 2004). Female students are less likely to skip class or be sidetracked by extracurricular activities, and they are more focused on their academics. The mean differences for boys and girls using the demonstration teaching approach were 3.149 and 3.72, respectively. Consequently, there was no bigger difference between boys and girls in the demonstration teaching approach. Voyer and Voyer (2014) provided compelling evidence in favour of this conclusion, demonstrating that females frequently outperform boys in a variety of fields of study and that this tendency has been observed across many countries since the early 20th century.

No standardized residuals were higher than ±3 standard deviations in any situation, demonstrating that no outliers were discovered in the test results. To ascertain if the variances of the learning intervention (LTM and DTM) and the control variable (homogeneity of variances or homoscedasticity), Levene's test was used. Additionally, no standardized residuals surpassed ±3 standard deviations in any circumstance, proving that there were no outliers in the test findings. The Levene's test (homogeneity of variances or homoscedasticity) was performed to determine if the variances of the control variable and learning intervention (LTM and DTM) were comparable. Levene's test of homogeneity of variance revealed no homoscedasticity or homogeneity of variance, as indicated in Table 6 (p =.090 for males and.100 for girls).

Table 7

Levene's Test of Equality of Error Variances for the Three Teaching Methods

Gender of Students	**F**	**df 1**	**df 2**	***P***
Boys	32.244	2	398	.090
Girls	62.623	2	375	.100

The test findings show that variances were homogeneous, as determined by Levene's test of homogeneity of variance (p =.090 and.100). Since the variances were identical and the Levene's test results were not statistically significant (p >.05), the homogeneity of variances assumption was fulfilled.

3.2 Hypothesis testing

There is no statistically significant difference in the achievement of male and female students when the agriculture subject was taught through PBL, demonstration teaching, and lecture teaching methods, respectively in Ndhiwa Sub County.

To test this hypothesis (the student's score before the intervention), an analysis of covariance was conducted after accounting for the pre-intervention scores for both secondary school girls and boys. The one-way ANCOVA was performed to assess if statistically significant gender differences continued to exist on the dependent variable after adjusting for the covariate. Table 8 displays the results of the analysis.

Table 8

Tests of Between-Subjects Effects on Boys and Girls

Gender of Student	Source	Type III Sum of Squares	Df	Mean Square	F	*p.*	Partial Eta Squared
Boys	Corrected Model	63329.50[a]	3	21109.836	343.687	.001	.722
	Intercept	16125.24	1	16125.245	262.533	.001	.398
	VAR00008	38490.610	1	38490.610	626.661	.001	.612
	VAR00007	10531.510	2	5265.755	85.731	.001	.302
	Error	24384.423	397	61.422			
	Total	1113447.00	401				
	Corrected Total	87713.930	400				
Girls	Corrected Model	60684.01[b]	3	20228.006	328.960	.001	.725
	Intercept	14010.398	1	14010.398	227.846	.001	.379
	VAR00008	46375.266	1	46375.266	754.184	.001	.668
	VAR00007	8754.633	2	4377.317	71.187	.001	.276
	Error	22997.519	374	61.491			
	Total	1040619.00	378				
	Corrected Total	83681.537	377				

a. R Squared = .722 (Adjusted R Squared = .720
b. R Squared = .725 (Adjusted R Squared = .723)
Dependent Variable: Post-Test Score

The PBL and DTM variables (VAR 00008 and VAR 00007) that deal with the intercept serve as controls for boys and girls. The findings reveal that, after adjusting for pre-intervention agriculture score, there was a statistically significant difference in post-intervention scores for boys and girls,

respectively, with $F(3, 397) = 21109.83$, $p < .001$, partial $\eta^2=.722$ for boys and $F(3, 374) = 20228.32$, $p <.001$, partial $\eta^2=.725$ for girls. In light of this, the null hypothesis is rejected. In conclusion, PBL and the demonstration teaching method had a statistically significant effect on gender differences in students' achievement in agriculture at the secondary school level.

The findings showed that PBL is a more effective teaching approach since students who participated in it did better than those who learned through lecture or demonstrations, respectively.

The findings corroborated research by Kehinde (2005) that revealed PBL-taught students performed much better than those who were taught using the lecture method. Shehu (2015) found that students who learned using the PBL method did better than those who learned using the lecture method. In a similar vein, Daluba (2013) discovered that in terms of improving learning outcomes alongside knowledge retention, the demonstration teaching strategy surpassed the lecture teaching technique. According to the author, using demonstration methods of instruction frequently increased the students' interest as well as their understanding of the subject leading to a high achievement rate.

Post hoc mean comparisons

The Bonferroni technique was used to analyze the findings of experimental data. Table 8 compares the mean pairings for problem-based learning (J) lecture teaching methods (I) and demonstration teaching methods (J) for both boys and girls. It also includes the statistical significance value (p-value and standard error) for the difference between groups I and J.

Table 9

Pairwise Comparisons for Girls and Boys

Gender of Student	Mean Comparisons: Lecture (I) minus-Learning method (J) (I-J)	Mean Difference (I-J)	Std. Error	P	95% Confidence Interval for Difference Lower Bound	Upper Bound
Boys	Demonstration	-3.720	1.098	.002	-6.360	-1.079
	Problem Based Learning	-10.899	.949	.001	-13.182	-8.617
Girls	Demonstration	-3.149	.963	.004	-5.465	-.833
	Problem Based Learning	-14.012	1.098	.001	-16.652	-11.372

The findings of the mean comparison for the mean pairs shown in Table 8 show that the Post-intervention scores for the Demonstration teaching technique and PBL were higher for boys and girls than for the Control (lecture) approach. Boys exhibited considerably bigger mean differences than girls for the demonstration teaching approach when the mean scores for the two groups were compared. -3.720 (95% CI, 6.360 to -1.079) %, $p < .002$ than the girls -3.149 (95% CI, -5.465 to -.833) %, $p < .004$. In comparing the mean differences for the boys and girls in PBL, the girls exhibited the highest mean difference of -14.012 (95% CI, 16.652 to -11.372) %, $p < .001$ than the boys -10.899 (95% CI, -13.182 to – 8.617) %, $p < .001$.

Univariate analysis using the F and Eta Squared tests

There were two univariate tests run by the researcher. Among these were the F and partial eta squared tests. The F test assesses how the teaching method affected post-test scores in the agricultural subject. The eta squared (n^2) or partial eta squared (n^2p) indices provide the effect size measurements for use in ANOVA with variance ranging from 0 to 1, where.01 is small,.06 is medium, and above >.14 is large. Table 9 displays the partial eta squared and the F test.

Table 10

Univariate Analysis for Girls and Boys

Gender of Student		Sum of Squares	Df	Mean Square	F	*P*	Partial Eta Squared
Boys	Contrast	10531.510	2	5265.755	85.731	.001	.302
	Error	24384.423	397	61.422			
Girls	Contrast	8754.633	2	4377.317	71.187	.001	.276
	Error	22997.519	374	61.491			

The study found that the effects of both the boys' and the girls were significant, with partial eta squared (n^2p) =.302 for boys and.276 for girls. These results show that the study and comparisons were accurate. The p values for boys and girls were.001, which is less than the alpha value of.05 and indicates that the PBL and DTM agriculture achievement test post-test results showed significant gender differences. Because (n^2p) =.302 for males and.276 for girls are both above.14. There was enough power to detect the effects.

4. Conclusions

i) The study's findings demonstrated that female students outperformed their male counterparts in all three instructional methods (Problem Based Learning, Demonstration Teaching Method, and Lecture Teaching Method) in both control and treatment procedures.

ii) The study determined that gender was a key factor in determining students' overall performance in relation to the instructional techniques utilized.

iii) It was determined that problem-based learning is the most effective approach for instructing students of either gender.

iv) The study found that there are statistically significant gender disparities between boys and girls on the agricultural achievement test, hence the null hypothesis was rejected.

5. Recommendations

i) The Ministry of Education, Science, and Technology should urge subject teachers to prevent gender discrimination throughout the teaching and learning process.

ii) The usage of the PBL teaching style should be stressed in the agricultural syllabus since it has been shown to provide better outcomes in agriculture than both demonstration and lecture approaches.

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