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Application of Models in Teaching Modern Agricultural Engineering Practices: A Case Study of Laikipia North Technical and Vocational College

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Abstract

The efficiency and effectiveness of various teaching methods are key in the teaching and learning process. Teaching Agricultural Engineering requires high-cost machines and equipment normally accessible only on commercial farms. While the use of conventional approaches in teaching Agricultural Engineering is routine, this study establishes whether innovative approaches would yield higher efficiency and effectiveness in teaching. Two groups of learners are taught using one method, either conventional (lecture) or innovative (application of low-cost physical models) and are this study's focus. The learners under similar conditions attempt standard examinations post-teaching. Results show that learners taught using the conventional method have a relatively larger gap of 71 % between the highest and the least score and a mean score of 51.65 %. In addition, a majority of the learners in the conventionally taught group score between grades C plain to B Plain and thus are defined as Transitory Learners. Learners exposed to the innovative teaching methods scored higher with the highest score being 95 % and the least score being 45 % thus translating to a gap of 50%. Financially, innovative methods are affordable due to the absence of recurring costs such as power, printing, and internet connection costs. In conclusion, Teachers of Agricultural Engineering ought to adopt innovative approaches to teach modern agricultural engineering practices. Further policies and sensitization activities by institutions are also necessary to ensure teachers expose the transitory learners in their classes to models that reinforce learning. On the research front, the availability of models for use in cases of learners with special needs awaits.

Key words: ***Innovative teaching, transitory learners, teaching models***

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Introduction

Traditional teaching has been dominated by the role of the teacher in developing students' skills and attitudes (Pöntinen, Dillon & Väisänen, 2017). Teaching in Agricultural Engineering involves training in several core areas including; Engineering Survey, Workshop Practice, Farm Power and Machinery, Irrigation and Drainage, Farm Structures, and Farm Water Supply among other courses (Akudugu, 2017). Each area requires the availability of several real-world machines and equipment to ensure the learner comprehends the concepts.

Considering that teachers are generally taken through standard procedures to approach the delivery of skills, knowledge, and attitudes, learners are normally receivers with the responsibility of applying their methods to learn (Khalaf, 2018). The ability of a learner to comprehend a concept is dependent on a wide range of factors including; intelligence, age, and

the state of their physical senses (sight, smell, taste, hearing, and touch) (Pishghadam et al., 2020). Research has shown that one method of teaching and learning is insufficient for a majority of teachers and learners (Ndukwe & Daniel, 2020).

Statement of the Problem

The Government of Kenya through the Ministry of Education and more Specifically the State Department for Vocational and Technical Training embarked on an ambitious campaign to establish at least one Technical and Vocational Education and Training (TVET) institution in all constituencies of the Republic of Kenya (Plance, 2020). Laikipia North Technical and Vocational College (LNTVC) is one of the newly established colleges offering General Agriculture and therefore has students of Agricultural Engineering.

Agricultural Engineering as a discipline is rapidly evolving from the application of old techniques such as Conventional tillage to modern practices such as conservation tillage techniques (Chauhan et al., 2017). Kenya as a nation whose economy is driven by Agriculture is today a stage for the application of modern Agricultural Engineering Practices including Conservation Agriculture (Chen, Cai, & Li., 2021). Students of Agricultural Engineering at LNTVC have limited access to these machines for purposes of learning and teachers must innovatively bring these machines to class.

Objectives of the Study

It is with the above background that this study seeks to establish the efficiency and cost effectiveness of using low-cost physical models to impart competencies in modern Agricultural Engineering Practices. Specifically, this study attempts to:

1. Determine the efficiency and cost-effectiveness of the lecture method.
2. Determine the efficiency and cost-effectiveness of using low-cost physical models in teaching.
3. Compare the efficiency and cost-effectiveness of conventional and innovative techniques of teaching.

Significance and Limitations of the Study

The study shall expose the vast possibilities of imparting various competencies in challenging conditions. The methodology of this study is suitable for pedagogical studies however it assumes that the teacher applying the two teaching methods has non-variant delivery capabilities which is ideal and not real.

Literature Review

History of Teaching Methods

Historically, teaching methods applied variedly informed the practice of teaching and learning in ancient times. Ancient professionals including, Blacksmiths, Ironmongers, Dancers, Artists and Writers acquired and disseminated their skills through methods such as memorization, participation, recitation, continuous practice, and demonstration (Hadfield, Dimmock & Shinnet, 2016). The need to revolutionize the teaching and learning process is informed by the need to

survive natural disasters that included droughts, floods, disease, and pest attacks that diminished the food reserves (Aston & Spigarelli, 2020). Efficient and effective methods of learning enabled nations to establish mechanisms for surviving wars and food insecurity.

Conventional Teaching Methods and Modern Agricultural Engineering Practices

Conventional teaching methods for modern Agricultural Engineering Practices include the lecture method which relies on photos, videos, and literature prepared by foreign researchers (Yu, Gu, & Lai, 2021). Field trips are the most common approach by Kenyan TVET institutions in benchmarking for best practices and skills acquisition. While the field trips provide an avenue for the learners to acquaint themselves with the principles of modern practices, these trips are expensive and time-consuming.

Innovative Teaching Methods and Modern Agricultural Engineering Practices

Whenever a teacher is faced with a challenge in the classroom setting, they are called upon to use their innovative capabilities in establishing a mechanism that enables them to achieve their goals in every lesson (Wu & Wu, 2020). The use of models in teaching and learning is, therefore a standard practice but the application of low-cost physical models is innovative.

Efficiency and Effectiveness in Teaching

The methods a teacher employs in teaching modern technologies in Agricultural Engineering are informed by a raft of factors including the type of learner and most importantly, the available teaching aids, machines and equipment (Koutsopoulos & Kotsanis, 2016). Also, the efficiency of the method employed by the teacher is assessed by the performance of the learner during assessment. Effectiveness in teaching comes from the comparison of the quantity of resources needed to teach the same concept. (Koutsopoulos & Kotsanis, 2016).

Review of Related Studies

Researchers working on a comparison of the various ways of teaching focus on the conventional methods of teaching such as discussions, lectures, demonstrations, and presentations and definitely attempt to establish the best method amongst these conventional techniques (Creese, Gonzalez & Isaacset, 2016). These studies attempt to address the comparison of conventional teaching methods with innovative methods at a higher level that is general and not an explicitly defined study (Kember, 2003). Other researchers also working on comparisons of conventional and innovative teaching methods ignored the question of the effectiveness of the teaching methods under study (Kember, 2003).

Research methodology

Research design

A Schematic Depiction of this Reseach Work

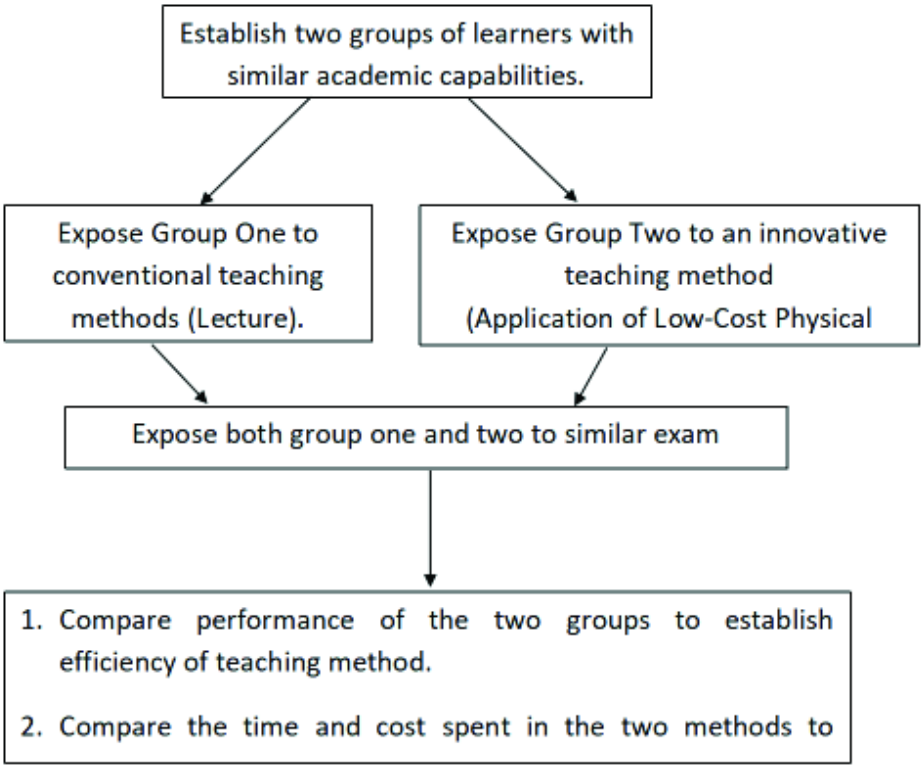

Figure 1: Research Design

Conventional Versus Innovative Teaching Methods

Conventional teaching Method. Using the conventional method (lecture) twenty learners (Group One) sat in class and were taught about Multi-crop Zero-till planter. Standard professional teaching documents including Scheme of Work, Lesson plan lesson notes, photos and videos were employed. For this particular session, the learners identified the various components of the Multi-crop Zero Till planter from the photo and watched a video of the machine in action to comprehend the function of its components.

Innovative Teaching Method. Another group of twenty learners (Group Two) of familiar academic capabilities were taught about the Multi-crop Zero-till planter. Standard professional teaching documents including Scheme of Work, Lesson plan lesson notes and a Low-Cost Physical model of the Multi-crop Zero-till planter were employed.

For this particular session, instead of having the learners watch a video, and analyse a photo, the teacher first listed the various parts of the Multi-crop Zero-till Planter while showing each part as depicted on the Low-Cost Physical Model. The teacher then pushed the physical model of the machine on a model strip of soil (acting as farmland) to demonstrate the functions of its various components. The Low-Cost Physical Model was fabricated using; pieces of wire, old tyre rubber tubes, used bottle tops, waste plywood, printer ink bottles and straws as the main input materials.

Planning and Administration of the Common Exam. Finally, the two groups of learners were examined on the Multi-crop Zero-till Planter's components and their functions. A standard exam testing three cognitive levels (Knowledge, Comprehension, and Application) was prepared and used to examine the learners. Standard professional examination documents including a scheme of work, lesson plan, question papers, answer sheets, envelopes, clock, and a class register were employed.

Population and Sample. The target population for this study was as described in the below criteria:

1. Be a student of the same level of Agricultural Engineering, Craft Certificate level.
2. Be of above-average performance i.e., to ensure similar academic capabilities.

Data Collection Instruments

Valid, reliable, reproducible, and verifiable data for this research work was collected using predesigned forms that were suitable for addressing the objectives of this study. A list of the forms used during data collection is enumerated in Table 1.

Table 1
Data Collection Instruments

Data	Instrument
Learner Biodata & Teaching method	Form I: Bio-Academic Data & Teaching Method Form
Examination Results	Form II: Examination Results Data Form
Financial Implication of both methods of teaching	Form III: Financial Data Form

Data Collection Procedure

Data for this study was collected as follows:

1. Letters of request to participate in this study were sent to prospective students.
2. The first group of twenty learners (Group One) who gave their consent were engaged in learning using the conventional method (Lecture). Bio-data and teaching method captured in FORM I.

3. The second group of learners (Group Two) who gave their consent were engaged in learning using the innovative method (Application of Low-Cost Physical Models). Bio data and teaching method captured in FORM I.
4. Both groups of learners were subjected to a similar exam and their results were recorded in FORM II.
5. Data on the time and money spent teaching in both cases were recorded in FORM III.

Data Analysis

Data collected from the student's exam results were taken through the standard data processing procedures as applied by Cantabella et al., (2019). The procedure is presented pictorially in Figure 4 below.

Findings

The grading scheme used for this study is shown below in Table 2. Globally, the class that was taught using innovative methods performed better than the class that was exposed to conventional teaching methods. The distribution of grades in the two classes was as detailed in Table 2.

Table 2
Grading System

Mark %	Grade	Conventional Teaching Methods = fc	Cumulative Frequency= cfc	Innovative Teaching Methods = fi	Cumulative frequency= cf
0-29	E	1	1	0	0
30-34	D-	1	2	0	0
35-39	D	1	3	0	0
40-44	D+	4	7	0	0
45-49	C-	3	10	3	3
50-54	C	1	11	0	3
55-59	C+	4	15	1	4
60-64	B-	0	15	3	7
65-69	B	3	18	2	9
70-74	B+	1	19	2	11
75-79	A-	0	19	4	15
80-100	A	1	20	5	20

Group taught by Conventional Teaching Methods

The highest score in this class was an A of ninety-one per cent (91 %) while the lowest was an E of twenty per cent (20 %) translating to a gap of seventy-one per cent (71 %) between the two extremes. In addition, the mean score for this class was fifty-one per cent (51%) translating to a mean grade of C plain, and the Standard Deviation was fifteen point two per cent (15.2 %).

Table 3
Results of the Common Exam

Student No	Marks Obtained in Exam % - Conventional Teaching Method	Marks Obtained in Exam % - Innovative Teaching Method	Grade for Conventional Teaching Method	Grade for Innovative Teaching Method
1	40	65	D+	B
2	44	72	D+	B+
3	55	75	C+	A-
4	35	78	B	A-
5	55	85	C+	A
6	66	95	B	A
7	71	62	B+	B-
8	44	63	D+	B-
9	47	78	C-	A-
10	51	59	C	C+
11	32	45	D-	C-
12	91	46	A	C-
13	36	80	D	A
14	57	76	C+	A-
15	66	74	B	B+
16	48	88	C-	A
17	20	45	E	C-
18	49	63	C-	B-
19	41	68	D+	B
20	55	86	C+	A
Mean Mark	51.65	70.15	C	B+
Highest Mark	91	95	A	A
Lowest Mark	20	45	E	C-
Standard Deviation	15.19300826	13.92219451		

In terms of grade distribution, twenty per cent (20%) of this class fell into the category of D+ while only five per cent (5%) got an A plain and above. Another category with many learners is the C+ group with twenty per cent (20%) of this class. Other grades take up the remaining numbers with both grade B and grade C making up to fifteen per cent (15%) of this class. With a figure of 15.3 % as the standard deviation of this classes' results, it is important to note that all the grades are approximately ±15 % of the mean grade. Find a Pie chart detailing the distribution of grades in Figure 2.

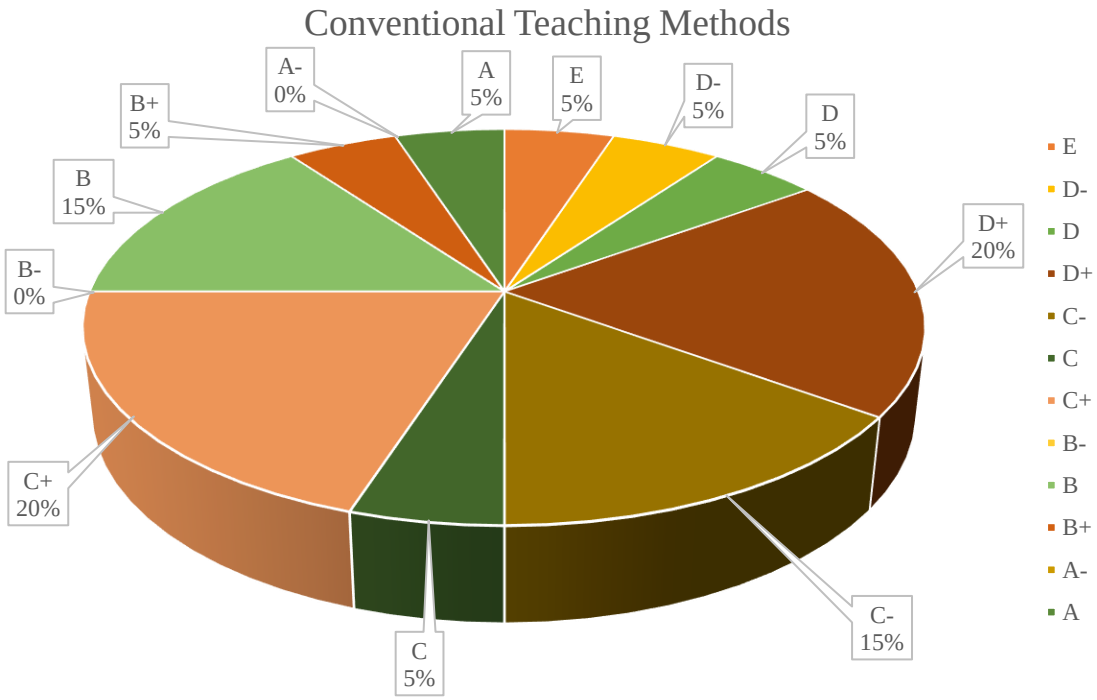

Figure 2. Grade distribution for the group taught using conventional methods

Group taught by Innovative teaching Methods

The highest score in this class was an A of ninety-five per cent (95 %) while the lowest was a C- of forty-five per cent (45%) translating to a gap of seventy-one per cent (50 %) between the two extremes. In addition, the mean score for this class was seventy point one-five per cent (70.15 %) translating to a mean grade of B+, and the Standard Deviation was thirteen point nine-two per cent (13.92 %). with a figure of 13.92% as the standard deviation of this class result, it is important to note that all grades where ±13.92% of the mean grade. The pie chart detailing the distribution of the grades is as presented in Figure 3.

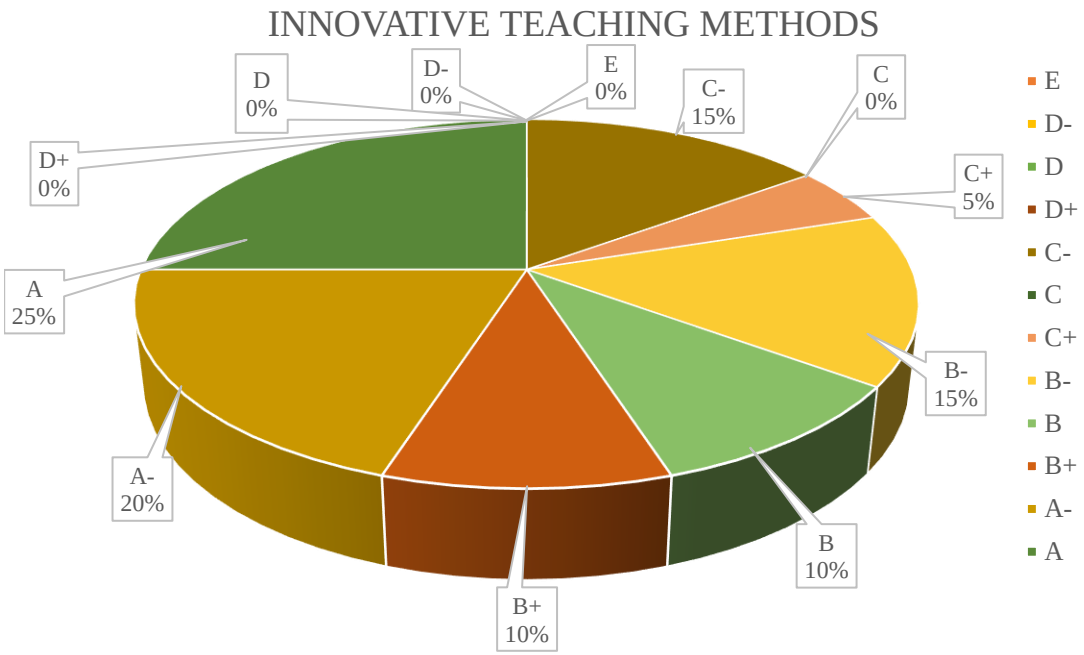

Figure 3: Distribution of Grades in the Group Taught by Innovative Teaching Methods

Analysis of The Financial Implications of Each Method of Teaching

Cost of conventional teaching methods. An estimate derived from the observation s of how this method works put s the financial implications at Kshs.100,620.00. See further details in Table 4.

Cost of Innovative teaching method. For the innovative teaching method, it was found that it would cost approximately Ksh. 0.00 as indicated in Table 4.

Table 4
Financial Implications of the Method

FORM III: FINANCES			
CONVENTIONAL TEACHING METHOD		**INNOVATIVE TEACHING METHOD**	
ITEM	**COST (Kshs.)**	**ITEM**	**COST(Kshs.)**
Laptop (Onetime Charge)	**50,000.00**	**Used Pieces of Wire (Recycle)**	**0.00**
Projector (Onetime Charge)	**50,000.00**	**Used Rubber Tubes (Recycle)**	**0.00**
Average Internet Cost Per Lesson (Recurring Expenditure)	**100.00**	**Used Bottle tops (Recycle)**	**0.00**
Average Power Costs Per Lesson (Recurring Expenditure)	**20.00**	**Waste Plywood (Recycle)**	**0.00**
Average Printing Costs To Show The Model (Recurring Expenditure)	**500.00**	**Straws**	**0.00**
Total Cost	**100,620**	**Total Cost**	**0.00**

Efficiency and cost Effectiveness of Innovative Methods of Teaching Vis a Vis Conventional Teaching Methods

Results presented in the above sub-section (Sub-section 4.1) have shown that for the group that was taught using the conventional methods of instruction, the gap between the best performing learner and the least performing learner is relatively wide i.e. 91 % - 20 %. In addition, the distribution of the marks shows that a majority of the learners are found around grade C which is generally a transition grade i.e. learners who score grades C are very capable of scoring even higher grades whenever they put more effort or they are exposed to teaching methods that increase their comprehension capabilities.

From this study, innovative methods of teaching are more efficient and effective in teaching modern Agricultural Engineering Processes, this is supported by the fact that the gap between the highest score and the least score was relatively smaller at 95% - 45%. The innovative method of teaching enables the weaker learners who would get lower grades to grasp concepts, know the methods of applying their knowledge and comprehend trends in their areas of expertise. Innovative teaching methods are key to making the learners ready for work tasks in Agricultural Engineering (Menon & Suresh, 2020).

Financial Implications of Employing Conventional Teaching Methods Vis a Vis Innovative Teaching Method

The authors find that the direct cost implications are higher in the use of conventional teaching methods while on the other hand, innovative methods of teaching have been found to do away with a significant number of the recurring costs as well as direct. Notably, other researchers such as Skinner, (2016) agree that the innovative methods of teaching are therefore more affordable for any institution.

Conclusion

In conclusion, it is a finding in this study that teaching Agricultural Engineering Practices using conventional teaching methods is not only less efficient and less effective, but it is also costlier. By continuing to employ conventional methods, the scarce resources that are available in the learning institution are strained. In addition, the learners in these institutions also end up being stuck as transitory learners who never move towards attaining higher grades. Transitory learners have also been defined in this study as learners who are scoring grades C- up to B plain because there is an inadequate reality to jog their minds and improve their comprehension levels. If these learners defined as transitory learners are exposed to models and innovative teaching methods, then they transition quickly to B+ or A as affirmed by Nilson (2016).

Recommendations

Teachers of Agricultural Engineering should employ the use of locally available materials to bring the big machines that can only be found on commercial farms to the student while in class.

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