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"EFFECT OF VIDEO BASED INSTRUCTION ON ACHIEVEMENT IN ELECTROMAGNETIC INDUCTION CONCEPTS IN SECONDARY SCHOOLS IN KENYA"

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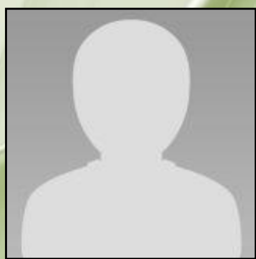

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Abstract

In the Kenya Certificate of Secondary Examination, KCSE, questions from Electromagnetic Induction feature prominently every year both in the theory and practical examinations. However, performance in this topic has been consistently low. Reasons for this low state of achievement in this topic point to the instructional methodologies employed. This research targeted the utility and influence of Video Based Instruction (VBI) as a technique of instruction as opposed to the Conventional teaching methods for this topic. A quasi experimental study entailing the pre-test, post-test non- equivalent group design was used. A total of 326 form four boys and girls from Sub County and County schools selected from Kakamega County participated in the study. The students were assigned into intact experimental and control class groups. The Test on Electromagnetism Essentials (TOEE) and Test on Electromagnetism Advanced (TOEA) were used as pre-test and post-test respectively. VBI resulted in higher achievement as it tended to demystify the topic. VBI should be integrated in teaching the topic and other topics in the Physics curriculum.

Key Words: Achievement, Electromagnetic Induction, Video Based Instruction and Conventional Teaching Methods

1. Introduction

The importance of science and technology in contemporary society is demonstrated by its unconscious use in people's daily lives (Yager, 1996; Dear, 2002). Structures and implements that are essential for humankind's working and living are heavily dependent on science and technology (OECD, 2012). Transportation of goods and persons around the world on land, across water and in the air by vehicles, ships and airplanes is the direct result of science and technology. Cellular phones, computers and a myriad of other electrical devices are derivatives of science and technology (Rosenbloom, 2012). When water taps are turned on, lightening arresters are installed or switches flipped, one is accessing science and technology. Modern societies are literally built on science and technology.

However, technology cannot exist without Physics. Technology is the application of basic science ideas for the benefit of making things to become useful in society (Wells, 1995). Physics is a major source of the ideas that are used in technology and engineering. Advances in Physics often translate into new technologies. Physics is a subject whose new ideas are often translated into new technologies. All types of engineering need a good knowledge of

Physics as a precursor to developing any device or machine (Lucas, 2014). Physics resonates with all technology for humankind's benefit.

There is a trickle down benefit for other science subjects, mathematics and philosophy emanating from developments in Physics. For example, advances in electromagnetism led directly to the development of a series of new products which have dramatically transformed modern day society (Balu, 2011). Implements such as television sets, computers and a myriad of domestic appliances have greatly transformed the standard of life throughout all countries. Advances in thermodynamics led to the development of motorized transport. Advances in mechanics inspired the development of the Calculus.

This study concentrated on electromagnetic Induction, one of the branches of electrical engineering which has its roots in physics topic of electricity. Electrical engineering generally deals with the study and application of electricity, electronics, electromagnetism, power engineering, digital computers, telecommunications, control systems and signal processing (WorldWide Learn, 2016; Rabari, 2007). Further, electrical engineering is concerned with issues associated with electric power transmission and electrical machines systems, integrated circuits and solid state devices, power and communication systems as well as computing and communication systems. All these utilize principles of electromagnetism and Electromagnetic Induction. The concept of how electricity is produced, transported and delivered to the consumer commands a major narration in electromagnetic induction theory and practice.

Electromagnetic induction is the production of electromagnetic forces (EMFs) and currents by the changing magnetic fields through a conducting loop (Guisasola et al, 2013; Chatterjee, 2002; Nelkon, 2008).Electric current is a result of a changing magnetic field as it passes through the circuit. Thus electromagnetic induction is employed in power generation and power transmission, which is basically the production and supply of electricity. Electricity is used in virtually all spheres of people's lives. That is why in Kenya, the Kenya Power and Lighting Company has set a target to connect as many households as possible to the national grid (Lewis, 2016; Lee et al, 2014; Borenstein &, Bushnell, 2015; U.S. Department of Energy report, 2010). This is expected to drive the economy and help in achieving Kenya's Vision 2030 (GoK, 2007) of becoming a middle income economy. But achieving this target will remain elusive in the short to medium terms due to mostly technical and economic challenges. The problem is that Kenya lacks a sufficient number of electrical engineers and technologists to provide expert knowledge and input for the production and supply of electricity. These engineers can only be trained from students who have qualified in physics as determined in the secondary school leaving examination, the Kenya Certificate of Secondary Education (KCSE). It is notable that many students shy away from taking this subject at higher secondary school (Amadalo et al, 2012; Besson, 2010). The perceived abstract nature of physics as well as the un-useful and un-insightful instructional methodologies adopted, especially among topics like electromagnetic induction have been variously blamed for this state of affairs (Aderonmu,& Obafemi, 2015; Stephen, 2015; Mbithe, 2008; Staune, 2006).

Due to the importance of several topics in Physics like electromagnetic induction (EMI), the Kenya National Examinations Council has made it a priority to test this topic in the KCSE almost on a yearly basis. A historical analysis of the pattern and trends of achievement in Physics and specifically in Electromagnetic Induction by KNEC reveals a worrying trend. According to KNEC reports between 2000 and 2013, questions from electromagnetism have been featuring consistently in secondary school leaving examinations all these years. Specifically, questions on EMI have featured in the following years: 2003, 2005, 2006, 2007, 2008, 2009, 2011, 2012 and 2013.The insistence on setting questions from this topic attest to its' importance and the desire to determine if efforts are being made to ensure its' essence is captured during instruction. The importance of EMI as a topic cannot be overemphasized (Duit and Confrey, 1996).

Despite this knowledge of persistent under achievement, no effort has been made towards improvement of teaching and hence learning of electromagnetic induction (Thong, 2008). The teaching of this topic has basically remained the traditional teacher-centered and learner-passive bent on content emphasis accumulation (Steenstrup, 2002). The disadvantage of this method of instruction is that it requires a considerable amount of unguided student time outside the classroom to enable understanding and to attempt long-term retention of content. But students are normally not willing to engage in this extra study, hence the consistent poor achievement in this topic. One method of instruction which has been given minimum attention, and which has shown success elsewhere is video-based instruction.

Video-Based Instruction (VBI) has been shown to be successful in enhancing students' ability to comprehend and enjoy instruction including problem solving (Donkor, 2011). It exposes students to situations that actively engage learners in reasoning, thinking and solving problems (Shyu, 2000). It is effective for high, medium and low achievers (Gambari et al, 2013). It is useful for newly introduced topics and content (Manley& Urness,2014).VBI has successfully been used in teaching practical skills during the delivery of technical and vocational education as compared to print- based instructional materials in Ghana (Donkor, 2011; Sherbon & Kish 2005; Jonnasen et al,1999). Similarly, this technic has been successfully used in general Chemistry (Harwood & McMahon,1997; Pekdag,2010; Gilbert & Treagust, 2009). Students who were exposed to VBI outperformed those who did not use it. Despite this knowledge, the Kenyan physics teachers have largely ignored the incorporation and use of VBI during their school physics instruction. One of the reasons could be the cost implications for the average Kenyan school. But the advantage is that videos can be used over and over again. They can also be used in areas where there is lack of experienced instructors (Armstrong et al, 2011). It is therefore against this backdrop that this study sought to find out if the integration of VBI can enhance the learning of EMI and hence achievement. It compared VBI and Conventional Instruction in EMI.

2. The Problem

The Kenya Government through the Ministry of Education has put several initiatives in place to improve students' learning and achievement in science. Physics has not been excluded. An important in-service programme has even been introduced for the benefit of all secondary schools physics teaching. The Strengthening of Mathematics And Secondary Science Education (SMASSE) overture has existed in Kenya for over ten years to date. Its thrust has been the review and introduction of effective technological and pedagogical instructional approaches and techniques in Science and Mathematics. Despite this initiative, the overall achievement in school leaving Physics examinations (KCSE) has remained persistently poor. The situation for topics like electromagnetic induction has continued to post dismal achievement. Promising techniques have continued to be avoided. In view of this situation, this study investigated whether Video Based Instruction can enhance achievement in Electromagnetic Induction compared to Conventional Teaching Methods.

3. Research Objectives

This study was guided by the following specific objectives:

i. To determine whether there is a difference in achievement in electromagnetic Induction between students taught using Video Based Instruction and those taught using Conventional Teaching Methods.
ii. To determine whether there is a difference in achievement in electromagnetic induction between students taught using Video Based Instruction and those taught using Conventional Teaching Methods in County and Sub-county secondary schools.

3.1 Research Hypotheses

HO1: There is no difference in achievement in Electromagnetic Induction between students taught using Video Based Instruction and those taught using the Conventional Teaching Methods.

HO2: There is no difference in type of schools achievement EMI between students taught using Video Based Instruction and those taught using the Conventional Teaching Methods.

4. Research Design

The study adopted a quasi-experimental research design of the pre-test, post-test non-equivalent with control form. The instructional techniques (VBI and CTM) were the independent variables. The students' achievement in the physics tests were the dependent variables for the two study objectives. In addition, for objective two, type of school (County and Sub-county) were co-independent variables.

Video Based Instruction (VBI) involved the students learning electromagnetism with direct reference to video media. The students were able to interact with the various concepts under instruction by interrogating video recordings of those concepts. In addition, practical sessions and formal theoretical aspects were utilized in instruction. The Conventional Teaching Methods (CTM) mostly included classroom teacher directed explanations of the concepts. There were some teacher demonstrations and occasional class experiments by the students. However, no video enhanced class sessions were utilized in this control group instruction

4.1 The Sample

The study involved form four students derived from County and Sub-County schools in Kakamega Central district, Western Kenya. A total of 326 students took part in the study. The

Experimental group was made up of 177 students, 62 students from County schools and 117 from Sub-County schools. The Control comprised of 149 students constituted of 57 and 92 students from County and Sub-county schools respectively. The experimental and control students from the Sub-County category of schools that participated in the study were 115 and 92 respectively. Similarly, the experimental and control sample from the county schools were 62 and 57 respectively. Table 1 indicates the details of the sample from the various schools categories.

Table 1: The Study Sample

Treatment Category	**County school population**	**Sub-County School population**	**Total**
Experimental	62	115	**177**
Control	57	92	**149**
Total	**119**	**207**	**326**

Five experimental schools took part in the study. Two were from the county and three from the sub-county schools categories. The number of Control schools was also five including two county and three sub-counties respectively. A total of ten schools participated in the study.

4.2 Research Instruments and Methodology

Two instruments were used to collect data in the study namely Test On Electromagnetism Essentials (TOEE) and Test on Electromagnetism Advanced (TOEA). TOEE acted as the Pre-Test and TOEA acted as the Post-Test. The Pre-Test had ten items which tested basic ideas on Electricity and Magnetism usually taught in forms 1-3 of the Kenyan secondary school physics syllabus. These topics form the critical input for studying electromagnetism. The Post-Test also had ten items which concentrated on aspects of electromagnetism taught mainly in form four of the Kenyan secondary school physics syllabus. The reliability indices using the Pearson’s Product Moment Correlation Coefficient (PPMCC) for the Pre-Test and the Post-Test were determined to be 0.856 and 0.892 respectively. These were judged to be adequate for the purposes of this study (Buda & Jarynowski, 2010; Kothari, 2004)

The Pre-Test was administered to both the Experimental and the Control groups at the start of the study. The test was given to two schools every day. It took one week to administer this test to all the ten schools that participated in the study. Every school provided either an Experimental or a Control group. During the study, the Experimental group was then taught, emphasis being placed in incorporating video media sessions in the instruction retinue. The students worked in groups of 3-6 and had a hands-on interaction with the videos. The class regular instructor, who had been in-serviced, provided guidance in operation of equipment and in leading the class and group deliberations. In addition after every session there was group review of the key concepts that were under study. The control group instruction was also timed to take an equal amount of time as the experimental group. The Conventional Teaching Method (CTM) was utilized. This involved teacher-led instruction in the derivation of the key concepts. Instances of teacher demonstrations were observed. In addition efforts were made to provide the students in this group with limited class practical sessions. The key difference was that the control group did not engage the students in video based interrogation of electromagnetism.

Whole classes were used in this study. Some of the classes had a sample size of less than 30. This low respondent sample size illustrates the unpopularity of studying physics in upper (ie form 3 and 4) Kenyan secondary schools. The whole instruction took four weeks or 8 hours per class. Both the Experimental and the Control groups were then post-tested. A similar duration to that utilized in the pre-test was observed.

5. Results and Discussion

5.1 The Pre-Test Findings

The Pre-test test (TOEE) yielded the findings for both the experimental and control groups. The group means and the Student's t-test calculated as well as tabulated values are indicated in table 2.

Table 2: Independent Samples t-test results of the pre-test scores on PAT1

Group	N	Mean	$t_{calculated}$	$t_{critical}$
Exptal	177	37.43	1.24	1.645
Control	149	39.03		

From table 2, the calculated t-value (t_{cal} =1.24) is less than the critical value (t_{crit} =1.645). This indicates that the difference between the scores of the two groups was not significant. The differences in the mean scores observed were by chance. Thus, the respondents' entry behavior was similar.

5.2 Effect of VBI and CTM on EMI achievement

In order to determine the effect of VBI on students' achievement in EMI, the students' pre-test and post test scores were compared. This was done for the experimental and control groups regardless of the school type the sample was derived from. The findings for both experimental and control groups are provided in table 3.

Table 3: A Comparison of Pre-Test and the Post-Test Achievement on EMI

Group	Pre-test mean	SD	Post-test mean	SD	Gain
Experimental(N=177)	37.43	11.92	60.89	10.52	23.46
Control(N=149)	39.03	11.21	44.76	12.21	5.73

From table 3, students from the experimental group attained a mean gain of 23.46, which is higher than the mean gain of 5.73 for the control group. It can also be seen that the mean scores for the experimental and control groups were different following administration of the TOEA, the post-Test. The mean score of the experimental group was much higher than that of the control group. There was a slight difference in the respective standard deviations in favour of the experimental group.

An independent samples' t-test was determined and analysed for any significant differences between the means. The results are shown in table 3.

Table 4: An independent samples t-test results on the post-test scores

Group	N	Mean	t_{cal}	t_{crit}
Experimental	177	60.89	12.62	1.645
Control	149	44.76		

From table 4, the means are statistically significant since the calculated t value (t_{cal}= 12.62) exceeds the critical t-value (1.645) at α =0.05. The null hypothesis (which stated that there was no significant difference in achievement between students taught using VBI and those taught using CTM) is rejected. It can be concluded that VBI on the overall produces better results than the CTM.

5.3 Effect of School Type and Treatment on EMI Achievement

In the second hypothesis, both school type as well as type of treatment was investigated and their impact on achievement determined. The findings are provided in table 5.

Table 5: Effect of school type and treatment on EMI achievement

School category	Treatment	Pre-Test		Post- Test		Gain
		Mean Score	SD	Mean Score	SD	
County	Experimental (N=84)	41.30	13.66	64.30	10.89	23.00
	Control (N=86)	28.02	13.71	40.84	13.87	12.82
Sub-County	Experimental (N=76)	33.07	11.41	53.47	9.96	20.90
	Control (N=80)	27.38	11.41	35.88	12.89	8.50

From table 5 above, the pre-test mean for control groups were 28.02 and 27.38 in county and sub-county schools, while for experimental group was 41.30 and 33.07 in county and sub-county schools respectively. The mean for students in all the experimental groups in the post-test was much higher than that for control groups (40.30 and 35.88 for county and sub-county school; and 64.30 and 53.47 for county and sub-county schools respectively). For all the experimental schools, there was an improvement in achievement from the pre-test to the post test after instruction using VBI. This is evident from the mean gains in table 5 above. Similarly, for the control groups in all the school types, there was an improvement in performance in the post-test after instruction using CTM. However the gain for both county and sub-county schools was markedly lower than that for the experimental schools. For the experimental county schools the gains for county school and sub-county schools were 23.00 and 12.82 respectively. The gains for the sub-county schools were 20.9 and 8.50 for the experimental and control schools respectively. Hence the method of instruction greatly affected achievement in EMI in all the school types.

A further analysis using the ANOVA was carried out to find out whether the differences in the mean scores are statistically significant at $\alpha = 0.05$ levels. The results are presented in table 6 below.

Table 6: ANOVA on the post-test scores

Variation	**SS**	**dF**	**MS**	**F-ratio**	**Table value**
Between groups	108221.7	1	108221.7	648.2	3.84
Within groups	54091.4	324	166.95		
Total	154313.1	325			

The results in table 6 above show that the F- ratio (648.2) is greater than the table value (3.84) for the groups. This implies that there was a significant difference in achievement based on school type.

5.3 Discussion of the Findings

The implication from the above results and interpretation, suggest that the level of achievement in learning Electromagnetic Induction is ranked higher when the students were taught using VBI than when taught using CTM. These findings agree with the findings of Laleye (2006) who reported that there was significant difference in the students' cognitive achievement and interest which was mostly enhanced by video-taped strategy during instruction than with the Conventional Teaching Methods.

These findings also agree with Martin and Songa (2011) whose findings show that interactive videos were very beneficial to students. This mode of instruction enabled stopping the video to allow attention to important details. This browsing enhanced learning, improved quality of discussion and introspection, hence promoted achievement. David and John (2004) felt that the teacher's presence, even though augmenting the video, significantly affected students' engagement and could substantially influence impressions of leadership effectiveness These findings also agree with Afolabi (2006)) who asserted that visual aids do not only enhance communication between learners and teachers, but also aid retention. Similarly, Ajelabi (2000) has confirmed that video instructional package and computer assisted instructional package have been as effective in enhancing students' performance in other subjects like social studies and Geography.

The findings from this study revealed that County and sub County students had a higher achievement in EMI when taught using Video Based Instruction as compared to their counterparts taught using CTM. These findings agree with the findings of a study on the comparison in achievement between different types of schools by Capell (1997) in seven different courses between students who were taught with closed circuit television and conventional manner. The results showed a significant difference between the school types and the achievements. These findings also agree with the findings of Richard (1997). Both results show that presenting novel and difficult science concepts to learners using media that involve both auditory and visual symbolic modes (such as VBI) resulted in more efficient learning and hence led to higher achievement than utilization of conventional modes of instruction.

However, these findings disagree with the findings of Dannenberg and Capell (1997) who conducted a study on the effectiveness of just in time lecture technology via video as a delivery mechanism. They found no significant difference in the achievement of students taught in the traditional classroom and those taught through video. The students taught through video complained of not having been able to ask questions immediately. These findings also disagree with the findings of Richard (2010) who found out that there were no learning benefits from any specific medium or mix of media over any other media. That study concluded that media, like VBI ,are mere vehicles for delivering content. The methodology is not the only determinant of good achievement for students in a physics class. Other factors come into play to influence student achievement.

6. Conclusion

The purpose of the study was to investigate the influence of VBI vis - a - vis CTM on secondary students' achievement in EMI. The research study had the following objectives: to determine whether there is a difference in achievement in Electromagnetic Induction between students taught using Video Based Instruction and those taught using the Conventional Teaching Methods; and to determine if VBI and CTM had a differential in achievement as far as County and Sub-County schools were concerned. The pre-test post-test non-equivalent group design was employed in the study.

The results showed that there was a significant difference in achievement between students in the control group, who were taught by CTM and those in the experimental group who were taught through VBI. Students in the experimental group achieved higher than those in the control group. The findings presented in schools under review show existence of significant differences in achievement between the control and experimental groups. Further, both experimental schools (County and Sub-County) outperformed control schools (County and Sub-County).

The available data from this study was inconsistent with the null hypotheses HO1 and HO2. In effect, the Null hypotheses were rejected. The experimental group exhibited a higher rate of achievement than the control group. The superior achievement displayed in general learning of the VBI content taught. This was due to fact that the EMI content was presented in a visual manner using VBI. These findings show that VBI enhances achievement among all students irrespective of the school category. On the basis of these findings, it is advanced that the use of VBI in EMI was the factor influencing the students' level of achievement.

7. Recommendations

i. VBI be considered as a method of instruction in abstract physics topics in Kenyan secondary schools.
ii. The ministry of education should produce video clips in as many Physics topics as possible. Training on use of VBI to be intensified.
iii. Video learning can be used to facilitate education in remote areas where lack of experienced instructors and educational equipment is most pronounced

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