

Effects of an E-Learning Module on Students' Attitudes in an Electronics Class

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Abstract

Research has shown that students exhibit negative attitudes towards Electronics especially when they are taught using the conventional method. This is in addition to poor instructional methods that do not promote individualization of instruction or make learning interesting. The purpose of this study was to design an e-learning module in "Transistors" – a topic in the Electronics course - and determine its effects on students' attitudes in Kenyan Polytechnics. The Solomon-three quasi-experimental, non-equivalent control group research design was used for the study. A sample consisting of 103 first year Electronic Engineering students from three Polytechnics were randomly assigned to three groups; one experimental, E and two controls; C₁ and C₂. A self-administered Students' Attitude Questionnaire (SAQ) with a calculated Cronbach-alpha reliability coefficient of 0.88 was used for data collection. The data was analysed using t-tests and the analysis of covariance (ANCOVA) statistical test at an alpha level of significance of 0.05. The results of the t-test revealed that the differences in gain from pre-test to post-test between groups E and C₁ were significant in favour of group E. Further results using ANCOVA revealed that there were statistically significant differences in post-test scores for students' attitudes between groups E and C₂ in favour of group E. This showed that the presence of a pre-test had a significant effect on students' attitude towards the topic being taught irrespective of whether they were taught using the e-learning module or the conventional method. The findings of the study shall be useful to Electronics students and lecturers, curriculum developers, e-learning practitioners and educational policy makers in Kenya.

Keywords: *e-learning, conventional method, attitudes, electronics, transistors, student*

1. Introduction

Teaching and learning worldwide has gone through a transformation that has seen traditional delivery of learning material augmented by the use of Information and Communication Technologies (ICT). This has led to the adoption of e-learning as a delivery option in the teaching and learning process. The teaching of science and technology within Kenya's education system is the starting point in the country's efforts towards industrialisation. Thus, the need to incorporate modern teaching and learning techniques is in line with the government's vision to become industrialised by 2020 (Republic of Kenya, 1996) and achieve a middle-income country status by 2030 (Republic of Kenya, 2008).

The underlying notion of learning is a match between the external structure of the subject matter and the internal cognitive structure of the learner (Bruner, 1960). The implication of emphasising the structure of a subject is to give the student as quickly as possible a sense of the fundamental ideas of a discipline. This view supports the use of e-learning to teach any subject in the curriculum. Similarly, by developing highly effective instructional resources (whether in books or computers) then we can free some of the teacher's time to work on the social, moral, psychological and emotional development of the learner (Reiguluth, 1983).

Unwin (2008) in a survey of e-learning in 2007 confirms that there is considerable enthusiasm for e-learning in Africa and that it has potential across the entire educational spectrum, not only for schools and universities, but also for vocational training, for lifelong learning, and for marginalised groups such as street children and those with disabilities. This enthusiasm however, does not seem to be accompanied by implementation strategies that would reap the maximum benefit from e-learning endeavours. As such, research would help determine the conditions necessary for the successful deployment of e-learning in Africa.

The purpose of the study was to determine the effects of an e-learning module on students' attitudes towards the topic "transistors" in Electronics. It sought to establish whether there were any significant differences in attitudes between students taught using the e-learning module and those taught using the conventional method. This is because research has shown that students face difficulties in studying the underlying principles of operation of a transistor (Kola & Taiwo, 2014; Husain, Misran, Arshad, Zaki & Shauri, 2012; Lundgren & Jonsson, 2005). It is therefore important to study transistors in ways that appeal to most learners as well as allow learners to apply what they have learned to new situations.

In this study, the conventional method of teaching is defined as one that predominantly uses chalk-and-talk with little or no accompanying audio or visual teaching aids. The e-learning module on the other hand was packaged as a compact disc (CD) with interactive learning material. The CD consisted of six lessons on the topic “Transistors”, namely: Operation of a Transistor, Transistor Configurations; Transistor Characteristics; Transistor DC Load Lines; Analysis of Bias Circuits and Transistor Ratings according to the established curriculum in Kenya (Ministry of Education, 1992). The CD was designed for teaching in order to reduce teaching and learning costs and increase teaching effectiveness by improving learners’ retention rates, allow self-pacing, minimize both instruction time and teachers’ preparation time among other advantages. Learners’ individual differences were taken care of because they had some degree of control over their learning activities.

Aiken (2000) defines attitude as a ‘learned predisposition to respond positively or negatively to a specific object, institution or a person’. A student’s attitude towards a subject of study is affected in various ways depending on the teaching method employed. Yushau (2006) argues that attitude affects students in everything they do and in fact reflects what they are and hence a determining factor of their behaviour. This makes the issue of students’ attitude critical to education since most educators define learning as ‘a change in behaviour’.

In a classroom situation, computers either enhance or interfere with effective learning (Geer, White and Barr, 1998). A student with a negative attitude towards computers may not pay attention to anything to do with computers. Similarly, a student who is a computer enthusiast may pay attention to any program that is computer-based and this may influence their attitude towards the subject of study. However, Freire (1970) argues that the advancement of technology has condemned many people especially the less well off to a rigid conformity regarding their views on education and training. Therefore, when in an e-learning environment learners must develop a new awareness which will free them to be more than passive objects responding to uncontrollable educational change.

In Kenya, the most prevalent method of teaching at all levels of education is the conventional method. This method is also used in teaching Electronics at the Polytechnics. Therefore, a method that improves students’ performance, fosters positive attitudes towards Electronics, and retains students’ interest should be adopted.

This study is based on Spiro’s theory of cognitive flexibility (Spiro, Feltovich, Jacobson, & Coulson, 1999). This is a learning theory that enables teachers to promote the use of educational technologies in the learning process. Therefore, the theory was used to guide the instructional design of the e-learning module in the topic ‘Transistors’. Kearsley (2000) sums up the principles of cognitive flexibility theory into four; (i) Learning activities must provide multiple representations of content; (ii) Instructional materials should avoid oversimplifying the content domain and support context-dependent knowledge; (iii) Instruction should be case-based and emphasise knowledge construction and not transmission of information; and (iv) Knowledge sources should be highly interconnected rather than compartmentalised. Thus, cognitive flexibility theory encourages the learner to integrate various aspects or perspectives of knowledge to different learning contexts.

Boger-Mehall (2003) observed that the way students are taught has a significant influence on the type of cognitive structures they create and that encouraging cognitive flexibility requires a flexible teaching environment. This is because it can provide the variability needed to present complex and ill-structured knowledge domains and to help students explore more than one perspective on a topic or issue (Swain, Greer, & van Hover, 2001). The study tested one null hypothesis at an alpha level of significance of 0.05 which states:

H₀₁: There is no statistically significant difference in attitudes towards the topic “transistors” between students taught using the e-learning module and those taught using the conventional method.

2. Methods

2.1 Research Design

A quasi-experimental design, the Solomon-three non-equivalent control group design, was used. This design is usually used to assess the effect of treatment and the pre-test on the post-test as well as the interaction between pre-test and treatment conditions (Mugenda & Mugenda, 1999). Three groups consisting of one experimental group, E and two control groups C₁ and C₂ were used; each from a different Polytechnic. In quasi-experimental research designs random assignment of research participants to experimental and control groups is not recommended because the practice is unethical (Coolican, 1994). Therefore, in this study, all the students from the selected classes participated in the study. The tests and treatments that were administered to each group are illustrated in Table 1 as follows:

Table 1
 Solomon-3 Control Group Design

Groups	Steps		
Experimental (E)	O ₁	X	O ₂
Control (C ₁)	O ₃		O ₄
Control (C ₂)	X		O ₅

Source: Koul (1984, p.470)

Key:

- X : Treatment (e-learning module)
- O₁ and O₃ : Observations before treatment
- O₂, O₄, and O₅ : Observations after treatment
- : non-equivalent groups

Two classes, constituting the experimental group E and the control group C₂ had their learning experiences augmented by the e-learning module while the other class constituting the control group C₁ was taught using the conventional method only.

2.2 Study Location

The study was conducted in three of Kenya’s four National Polytechnics. These were Mombasa Polytechnic (Now, Technical University of Mombasa), Kisumu Polytechnic, and the Eldoret Polytechnic.

2.3 Sampling Procedure and Sample Size

Two-stage sampling was used to select the subjects to participate in this study; the first stage was to select a Polytechnic while the second stage was the selection of a class within the Polytechnic. Simple random sampling was used to select both the Polytechnic and the class within the Polytechnic. In total, three Polytechnics were selected together with the associated first year class of Electronic Engineering students. The groups were then randomly assigned to the experimental group E and control groups C₁ and C₂. The number of students in each group were E = 40, C₁ = 31, and C₂ = 32 resulting in a total sample size of 103.

2.4 Instrumentation

The e-learning module in “Transistors” was designed using DHTML, Circuit Maker 2000, JavaScript, CorelDraw and Dreamweaver. It was used to teach the Experimental group, E and Control group C₁. The Students’ Attitudes Questionnaire (SAQ) had 25 five-point Likert type questions and was used to measure students’ attitudes towards the topic “transistors”. The scores awarded for each choice were: 5 = strongly agree; 4 = agree; 3 = undecided; 2 = disagree and 1 = strongly disagree. The reliability coefficient of SAQ was calculated using the Cronbach - alpha formula (UCLA, 2003) and yielded a reliability coefficient of 0.88. It was therefore found suitable for data collection (Santos & Reynaldo, 1999). The SAQ was validated for use by 5 lecturers in the Department of Curriculum, Instruction and Education Management of Egerton University.

One week prior to the study lecturers and students in group E and C₂ were trained in the fundamentals of computing for 5 hours of hands-on computer operations. In the following week, group E and C₁ received the pre-test. This constituted the participants filling in the SAQ. The data collected was used to obtain the entry behavior of the respondents in attitudes towards the topic transistors. In the following three weeks, group E and C₂ received the treatment, that is, the e-learning module in the topic Transistors while group C₁ used the conventional method to learn. And finally, at the end of the three-week Transistors topic, all the three groups received the post-test.

Both descriptive statistics and inferential statistics were used to analyse the data. The effects of the treatment on the post-test were determined by comparing the post-test mean scores of the experimental group E and control group C₁. The difference in the two means showed the extent to which post-test means can be attributed to the treatment alone while excluding the effects of the pre-test. Comparing the post-test means of group C₁ and those of group C₂ helped to determine the effect of pre-test on post-test means. A t-test for independent samples was used to test for any significant differences in the students’ pre-test mean scores for groups E and C₁ and hence determine if the two groups were homogeneous at the point of entry.

ANCOVA was used to test for significant differences among the students' post-test attitude scores. The covariates used were the students' average score in a cluster of three subjects, namely: Mathematics, English and Physics at Kenya Certificate of Secondary Education (KCSE) that are a prerequisite for one to be admitted into the TEP Diploma course in Electronics. The maximum score is 12 corresponding to a candidate scoring grade A in all three subjects while the lowest score is 3 - corresponding to a candidate scoring grade E in all three subjects. All tests of significance were done at an alpha (α) level equal to 0.05.

3. Results

3.1 Respondents' Entry Behaviour

The independent sample t- test was used to determine whether there were any significant differences in the entry behaviour of the students in groups E and C₁.

Table 2
 T-Test for Students' Pre-Test Scores on Attitude

Group	N	Mean	S.D	t-value	df	p-value
E	37	97.0811	18.1863	1.353 ^{ns}	69	0.181
C ₁	34	102.2353	13.30996			

Critical values: (t = 1.645, df = 69, p = 0.05)
 Calculated values: (t = 1.353, df = 69, p = 0.18)
 ns = The mean difference is not significant at 0.05 level.

The results of the t- test for students' attitudes as shown in Table 2 reveal that there were no statistically significant differences in the pre-test means of the two groups. This implies that the two groups were homogeneous at the beginning. Therefore, any differences in post-test mean scores after teaching cannot be attributed to initial differences among the students but to the e-learning module or the conventional method of teaching.

3.2 Effects of the E-learning Module on Students' Attitudes

An independent sample t-test was used to establish whether the differences in students' gains in attitudes from pre-test to post-test were significant.

Table 3
 Differences in Gain for Students' Attitudes

Students' Mean Scores in Attitudes							
Group	N	Pre-test	Post-test	paired difference	df	t-value	p-value
E	40	97.0811	104.7568	7.6757	69	10.345(*)	0.000
C ₁	31	102.2353	92.7647	-9.4706			

Critical values: (t = 1.645, df = 69, p = 0.05)
 Calculated values: (t = 10.345, df = 69, p = 0.000)

*The mean difference is significant at the 0.05 level.

The results in Table 3 show that the gain in the mean score for attitudes; the gain being the difference between the students' post-test mean scores and pre-test mean scores. The gain in students' mean scores for E = 7.6757, was higher than the gain for C₁ = -9.4706; this higher mean being attributed to the treatment (the e-learning module) only. Further, the results of the t-test reveal that the differences in gain from pre-test to post-test were significant, where, $t_{(0.000, 69)} = 10.345 > \text{critical } t_{(0.05, 69)} = 1.644854$ in favour of the experimental group, E. This implies that the e-learning module had a positive effect on students' attitudes towards the topic 'Transistors'.

3.3 Testing the Hypothesis for Students' Attitudes

Table 4 shows the descriptive statistics for the three groups E, C₁ and C₂ for students' attitudes at post-test. It shows the number of subjects in each group (N), mean, standard deviation (SD) and the standard error of the mean for each group.

Table 4
 Descriptive Statistics for Students' Post-Test Scores for Attitudes

Group	N	Mean	S.D.	Std. Error
E	37	104.7568	17.70814	2.91120
C ₁	34	92.7647	20.51172	3.51773
C ₂	32	98.3438	15.10097	2.66950

The results in Table 4 show that the mean score for the experimental group, E was higher (104.7568) than both the means of the control group C₁ (92.7647) and control group C₂ (98.3438). The higher difference in the post-test mean scores for groups E as compared to C₁ was expected because group E received the treatment while C₁ did not. However, the difference in post-test mean scores for groups E and C₂ was unexpected because both received the treatment, which implied that their post-test means should be somewhat the same. The reason for this difference could probably be attributed to the presence of a pre-test for group E and none for group C₁. These mean scores were adjusted using the average students' scores in Mathematics, Physics and English at KCSE as covariates in SPSS. Table 5 shows the resulting estimated marginal (adjusted) means for the post-test scores for the three groups (and their standard errors) and the grand mean (and its standard error).

Table 5
 Estimated Marginal Means for Students' Post-Test Scores

Group	Mean	Std Error	Grand Mean	Std Error
E	104.7568 ^a	17.70814	98.872 ^a	2.034
C ₁	92.7647 ^a	35.52735		
C ₂	99.0690 ^a	21.55369		

Dependent variable: Post-test scores for students' attitudes

a = adjusted

Covariates appearing in the model are evaluated at the following values: Points in KCSE = 7.0609

The Analysis of Covariance (ANCOVA) was used to test the hypothesis of the study. The ANCOVA results are shown in Table 6.

Table 6
 ANCOVA Table for Students' Post-Test Attitude Scores

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	4278.939	2	2139.469	3.115(*)	0.049
Error	65943.296	99	686.909		

Critical values: (F = 3.0718, df = 2/99, Sig. = 0.05)

Calculated values: (F = 10.531, df = 2/99, Sig. = 0.049)

* The mean difference is significant at 0.05 level

The results reveal that there were statistically significant differences in post-test scores for students' attitudes where, $F_{(0.049, 2, 99)} = 3.115 > \text{Critical } F_{(0.05, 2, 99)} = 3.0718$. The hypothesis was thus rejected at an alpha level of significance of 0.05. However, at this point it was not possible to determine the pairs of groups where the differences were significant. Therefore, further analysis by pair wise comparisons using SPSS's Scheffe test was carried out to determine which pairs of means had statistically significant differences as shown in Table 7.

Table 7

Pair Wise Comparisons Based on Estimated Marginal Mean Scores in Students' Attitudes

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig. ^a
Post-test scores for Attitudes	E	Vs C ₁	5.850	4.519	0.199
	E	Vs C ₂	12.224(*)	4.350	0.006
	C ₁	Vs C ₂	6.374	4.591	0.168

* The mean difference is significant at 0.05 level

The results of the pairwise comparison test in Table 7 show that statistically significant differences exist in students' attitudes between E and C₂ (12.224*) in favour of group E. No significant differences however, exist between the groups E and C₁ and between C₁ and C₂. These results are rather surprising for groups E and C₂ because both were exposed to the treatment condition yet their post-test mean scores differed significantly. The only difference between groups E and C₂ was that group E received the pre-test while C₂ did not. In effect, this means that the presence (or absence) of the pre-test was solely responsible for significant differences at post-test.

On the other hand, the mean scores at post-test between groups C₁ and C₂ did not differ significantly. It would have been reasonable to expect significant differences in post-test mean scores for these groups because students in group C₂ were exposed to the treatment while those in group C₁ were not. This means that, in terms of improving students' attitudes towards the topic on "Transistors" it does not matter whether one uses the e-learning module or the conventional method to teach. However, it is worthy to note that group C₁ received a pre-test while C₂ did not. This means also that the presence (or absence) of the pre-test had no effect on the post-test mean scores in this case.

For groups E and C₁ the results show that no significant differences exist between these two groups at post-test. It would also be reasonable to expect significant differences in the post-test mean scores because group E received the treatment while C₁ did not. The only reason why there would be no significant differences between the groups is because both groups received a pre-test.

4. Conclusion

This study established that there were statistically significant differences in students' attitudes towards the topic "Transistors" in one out of three pairs of student's groups being examined. The differences were surprisingly found to be between groups that had both been taught using the e-learning module. This showed that it is probably the presence of the pre-test that had a significant effect on students' attitude towards the topic being taught irrespective of whether they were taught using the e-learning module or the conventional method. Despite the fact that the remaining two groups were taught using the e-learning module and the conventional method respectively, there were no statistically significant differences in students' attitudes between them. Statistically significant differences between these groups were expected owing to the different techniques used for teaching the groups being compared. The difference in gain from pre-test to post-test was found to be significant in favour of one group that was taught using the e-learning module as compared to the group that was taught using the conventional method.

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