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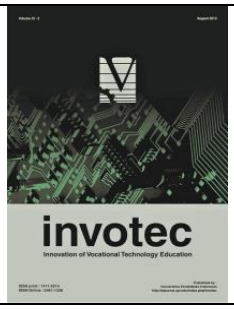

Technology-Enriched Learning and Retention of Abstract Concepts among First Year Electrical/Electronic Technology Students in Nigerian Universities

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ABSTRACT

Technology-enriched learning was integrated into the teaching of abstract concepts in electrical/electronic technology with investigation of its effects on students' academic performance and learning retention. A quasi-experimental design was adopted for the study. All 178 technical education students specializing in electrical/electronic technology from the 4 universities offering the programme in the south-west, Nigeria were involved in the study. The achievement test instrument used for data collection has a reliability coefficient of .92 obtained through test retest technique. Six research hypotheses were tested in the study. Data collected were analysed using analysis of covariance (ANCOVA) at 0.05 level of significance. The findings of the study established that technology enriched learning significantly improves students' academic performance ($F_{(1,\ 169)}$ = 12.707; p = .000) and retention ($F_{(1,\ 169)}$ = 94.097; p = .000) compared to traditional lecture method. It was recommended that the idea of technology-enriched learning should be adopted by university teachers to foster effective teaching of abstract concepts in science and engineering while traditional lecture method should be discouraged in the teaching of abstract concepts.

1. Introduction

Subjects dominated by abstract concepts are usually difficult for students to learn when traditional lecture method is employed. Students in sciences and technology-based programs have more abstracts to deal with going through the program (Sarac, 2018). One of the subject areas that has more abstract concepts in sciences is electrical and electronics. As designed for the universities, electrical/electronic technology program is expected to help learners develop abilities in the design, development, diagnosis and repairs of electrical components, equipment and machines (Bello & Shu'aibu, 2013). This professional field requires learning of multiple abstract contents ranging from structures of matter to electricity, semi-conductor devices and thermionic emissions, electromagnetism, oscillators and oscillation, radio frequencies and audio signals, radio waves and modulations, circuit theories, electronic amplifiers and transistors with some others (Adegoke, 2011). Also, students studying electrical/electronic technology are required to be versatile in handling complex calculations such as present in circuit theorem and Boolean algebra.

Naturally, students on this program of study requires higher order thinking to comprehend the concepts, however, the poor teaching practice with lack of good environment for facilitative learning may contribute to students poor understanding and performances (Gull & Shehzad, 2015). When there is lack of evidenced based teaching and active involvement in the knowledge construction, students in science programs may face challenges with comprehension, retention and expected academic performance (Chibabi, et al., 2018). Al-Hariri and Al-Hattami (2017) laid credence to this fact in that students tends to learn better with use of images, videos, animation among other learning enrichment properties of technology-enhanced learning facilitation compared to traditional lecture method.

Learning accompanied by expected academic performance is usually the major expectations of teachers and their students. This makes teachers focus more attention on helping their students learn new skills and knowledge, but due to their vulnerability such knowledge are easily forgotten (Lindsey, et al., 2014). Hence, the real learning process requires both knowledge acquisition and its retention which can influence performance and actual practice thereafter. Academic performance in the university is no doubt the measure of students' success which is usually presented in form of scores. Teachers would need to employ effective techniques which will go beyond mere passing of information but enhance retention (Raleigh, et al., 2018). Such technique are effective in developing high level thinking process, perceptual and manipulative skills, real and permanent learning and superior knowledge retention (Montero, et al, 2008; Chibabi, et al., 2018).

Lecturing being the predominant traditional teaching method generally adopted in the Nigerian education system does not actually prioritize student's pursuit of content knowledge and understanding. The system rather focuses on following and completing the structurally-rigid curriculum through authoritative teaching and passive learning (Abd-El-Aziz, 2014). The teacher-centered, teacher-active, learner-passive and content emphasized teaching method makes learning of abstract concepts in sciences very difficult with evidence of poor student performances in such subjects. Science students often misconceive information about abstract concepts and thus develop poor understanding that usually results to poor academic performance (Elangovan & Ismail, 2014; Chibabi, et al., 2018). Oladipo, et al., (2010) explained that lecture method cannot impart students with requisite knowledge and skill obtainable in a subject; hence, teachers should adopt more suitable teaching approach for student's effective learning. The experience of science students over the years with poor understanding when traditional teaching method is used makes most of them to resort to rote memorization of learned concepts (Freeman, et. al., 2014).

Usually, the knowledge developed through memorization of scientific concepts last for a short period, most often till examination is over. Some researchers argued that students' misconception may not reduce with teachers' continuation to facilitate scientific concepts with traditional method of teaching (Lari, 2014; Aktas & Yurt, 2017). Hence, students' academic performance and retention in an abstract based course like electrical/electronic may be drastically affected (Freeman et al., 2014). However, facilitating effective teaching and learning in the 21st century classroom, whether in sciences or other fields, has been linked to appropriate use of technology in the design as well as presentation of concepts (Trepule, et al., 2015). Trepule, et al., (2015) established that for students to learn appropriately with performance improvement and retention capabilities, the learning approach must change from traditional teacher-directed to learner-centered techniques. Noesgaard and Orngreen (2015) suggested that students' poor understanding of scientific concepts can be better corrected with employment of educational software programs, simulation of concepts and other effective technology-based teaching applications.

Technology adoption and usage in the education system has grown over the years with further introduction of more flexible and students friendly educational software, learning interface and online platforms for convenient learning. This laid credence to the claims of Al-Hariri and Al-Hattami (2017) that the use of technology to enrich teaching and learning activities has been established as a better alternative to the traditional knowledge delivery system. The latter is revealed to enhance student's poor learning and performance across different subjects (Elangovan, & Ismail, 2014) but is still the most extensively used teaching method in Nigeria higher institutions. Integration of technology into the classroom setting in most Nigeria schools including higher institutions is still at a growing stage. Al-Hariri and Al-Hattami (2017) pointed out that a new degree of responsiveness and flexibility has

been established in the educational processes with the incorporation of different technological applications. Having technology in the classroom, information can easily be accessed and distributed, learning content can be standardized and updated while students' instructions can be personalised (Al-Hariri & Al-Hattami, 2017). Improving the level of adoption and effective utilization of technology in the classroom activities has potentials to enhance better content comprehension, retention and skills development of students in electrical/electronic technology. In essence, electrical/electronic technology students can easily develop analytical reasoning with creative thinking and also exhibit improved information appraisal with problem solving ability (Moktar, et al., 2016). Invariably, when the full potentials of technology are established in the classroom, students learning and performance may be influenced (Aktas & Yurt, 2017). Moreover, the level of learning retention and sustenance of content information at the end of the programme could be improved compared to the traditional system of teaching when technology is effectively introduced (Harris, Al-Bataineh &Al-Bataineh, 2016).

Technology enriched learning in this study simply implies the use of varieties of technological applications to simplify the presentation of learning content into simple, realistic and understandable units. According to Lari (2014), technology enriched learning captivates the interest of the students by motivating and attracting their attentions with effective ways of knowledge transfer in a more convenient manner. There are varieties of teaching technologies which could be employed for learning enrichment most importantly with regard to the concept to be taught. Some of these technologies include PowerPoint slides, Microlearning, Animation, simulations, video games among many others (Almara'beh, et al., 2015). Based on the focus of this study in enhancing effective learning of abstract concepts, three major technological applications were employed in the lesson facilitation. These include PowerPoint presentation, microleaning and simulation. Lari (2014) described Microsoft PowerPoint as a powerful and comprehensive presentation program through which teachers can package a professional-looking presentation on any concept with multimedia enrichment to aid adequate understanding and retention of information. In practice, Ozaslan and Maden (2013) reported improved students learning with use of PowerPoint presentation that is richly presented with visual tools, making the learning content more appealing to the learners. Wang (2011) ascertained that multimedia technologies such as PowerPoint has visual effects which is captivating and helps students with mastery of basic skills which may influence their retention of learned concepts. In addition, Raiyn (2015, p.115) explained the effectiveness of lesson presentation with visual materials such as PowerPoint which "helps students to develop visual thinking, which is a learning style whereby the learner becomes better to understand and retain information better by associating ideas, words and concepts with images". However, Wanner (2015) explained that PowerPoint can be used beyond just presentation but in engaging the students actively.

On the other hand, microlearning is an innovative practical or realistic tool for permanent learning. It has potentials for enriched learning presentation with easy adaptation to support learning needs of individuals in relation to learning contexts (Mohammed, et al., 2018). Microlearning presents varieties in designing and organizing units, structure and sequence of learning content as well as the use of the generated content (Giurgiu, 2017). More importantly, it can be efficiently used in drawing student's attention to important information on learning concept (Ozdamli, et al., 2016). The efficacy of microlearning is established in providing information on learning concept in smaller units which can be understood without supplementary information. This teaching technique facilitates practical problem solving as applicable in sciences and develops students' metal structures through social and explorative interactions. Giurgiu (2017) pointed out that short contents presented through microlearning helps to create interaction between learner and information which is crucial for learning retention. Experimentally, Mohammed, et al., (2018) found the use of microlearning teaching method highly effective in improving students learning ability with long term retention capability. This laid credence to the findings of Wakil, et al., (2017) who established enrichment of learning using technologies in the classroom. Another technology incorporated into the technology enriched learning of abstract based concepts is multimedia simulation. Simulation is basically a teaching approach which aims at presenting artificial representation of a situation to the learners (Raleigh, et al., 2018). The use of simulation in the classroom presents students with opportunity of learning in a more realistic way which will facilitate true knowledge of concepts and enhances effectual practice

with problem solving skills (Moktar, et al., 2016). The influence of simulation was established by Akhu-Zaheya, et al., (2012) on knowledge acquisition and knowledge retention among students. Moreover, Wakil, et al., (2017) found electronic games with elements of simulation to positively influence student's achievement and learning retention.

A variety of advantages have been established with use of technology in the classrooms. The inclusion of technology seems to make the demanding teaching and learning activities easier. With technology as a tool, the roles of teachers is changed (Trepule, et al., 2015) as well as the face of the learning environment making students to learn more actively and appropriately. Although, gender differences has been an issue of concern with involvement of technology across different professional areas including education. Recently, Goswami and Dutta (2016) reported mixed results based on extensive literature review on gender differences in use or acceptance of technology. This is an indication of unstable level of preference, acceptance or use of technologies by both genders. Also, the issue of academic abilities among students usually generate argument in literature with respect to employing new teaching methodology most especially technology-based methods. Literature documents variation in students' abilities which may in turn influence the effect of technological applications on their learning (Adeyemo, 2010; Al-Zoubi, 2015; Meenu, 2016). The inconsistency in research reports regarding gender and ability issues with reference to technological applications makes its investigation in this study a necessity. Irrespective of gender and ability level, Harris, Al-Bataineh and Al-Bataineh (2016, p.370) established that "technology has allowed the dissemination of knowledge to be dispersed instantly and it allows for quicker and more effective communication".

Various technology-based teaching techniques are emanating based on teachers creativity and expertise in determining a better method for content facilitation among different groups of learners. A number of studies reported the effectiveness of technology supported learning in improving students' academic achievement in science subject (Saraç, 2018). Using computer aided animation, Dikmen and Tuncer (2017) found that students' academic achievement is largely influenced through technology enriched learning. Batdi (2015) as well as Dincer (2015) established that computer based instructions improves students' academic performance. Moreover, Ayaz, et al., (2016) experimented and reported positive effect of teaching technologies on students' performance. Also, Elangovan and Ismail (2014) employed multimedia simulation into teaching of an abstract concept in biology which positively enhanced students' academic achievement. However, electrical/electronic course area with dominance of abstract concepts is yet to be investigated with inclusion of technologies most especially with focus on learning retention which can influence actual practice. The first year students of this course area are engaged in the study because of their newness in the program which enhances higher level of misconception with relation to abstract concept.

2. Purpose of the Study and Hypotheses

Generally, the purpose of this study was to investigate the academic performance of first year electrical/electronic technology students before and after the experimentation of the technology-enriched learning and to determine the level of learning retention of abstract concepts after some weeks of the experiment. The following hypotheses which are equivalent to the research questions raised in the study were specifically tested:

1. Technology-enriched learning will improve the academic performance of first year electrical/electronic technology students in the experimental group.
2. There will be no gender difference in the academic performance of first year electrical/electronic technology students based on exposure to technology-enriched learning.
3. Technology-enriched learning will improve the learning retention of first year electrical/electronic technology students in the experimental group.
4. There will be no gender difference in the learning retention of first year electrical/electronic technology students based on exposure to technology-enriched learning.
5. There will be no interaction effect of gender and ability level on academic performance of first year electrical/electronic technology students exposed to technology-enriched learning.

6. There will be no interaction effect of gender and ability level on learning retention of first year electrical/electronic technology students exposed to technology-enriched learning.

3. Method

3.1. Design of the Study

The quasi experimental design was employed for this study. The study specifically adopted the pretest, posttest, non-equivalent control group design. The subjects were not randomly assigned to treatment groups because of the non-flexible school calendar which will be interrupted if attempted. Hence, intact classes from each adopted schools were engaged in the conduct of the study.

3.2. Participants of the Study

Purposive sampling technique was used in selecting universities in the South-west region of Nigeria and hence the participants for this study. The participants of this study were 178 first year technical education students specializing in the electrical/electronic technology education option in south-west, Nigerian universities. There are four universities in the south-western part of Nigeria that offers Technical Education programmes with option in electrical/electronic technology option among others. The entire population of 178 students studying the program participated in the study. Two of the universities involved in the study were randomly assigned to the treatment group and the remaining two schools were assigned to the control group. The students in both the experimental and control groups have similar characteristics, each are in their first academic year in different universities. The treatment group has 92 students from two schools; 44 students from the first school and 48 students from the second school. However, the treatment group has 73 males and 19 females who participated in the study. The control group has 86 students with 45 students from the first school and 41 students from the second school. Meanwhile, there were 74 males and 12 females in the group.

3.3. Teaching and Learning in Experimental and Control Groups

There were five major abstract-based concepts selected for the purpose of this study which were successfully taught within the first 8 weeks of the second semester among the first year students. The topics include structure of matter, thermionic emissions, electrolysis, electricity and semi-conductor devices. The experimental groups were taught these 5 concepts with technology-enriched instructional approach designed with microlearning, PowerPoint presentation and multimedia simulations. The control groups were taught the same concepts using the usually adopted traditional lecture method.

3.4. Instrument for Data Collection

Standardized tests covering the scope of the five concepts examined under the study obtained from the Joint Admission and Matriculation Board (JAMB), a national examination board in Nigeria, was used for data collection. The test instrument consisted of 25 multi-choice test items with four options. The instrument contained 5 items on each concept taught which measures the cognitive knowledge of each participant before and after the technology-enriched learning experiment.

3.5. Reliability of the Instrument

The stability of the instrument was determined through test-retest trial testing on 30 electrical/electronic technology students who are not part of the study. The retention test was administered to the same set of students 2 weeks after administering the achievement test. The reliability of the instrument was determined using Pearson Product Moment Correlation. A reliability coefficient of .92 was established.

3.6. Experimental Procedure

Prior to the application of the treatment to the experimental group, the two groups were pretested to ascertain the homogeneity of the groups. Thereafter, the semester based teaching schedule was followed with application of varying innovative technological mediums considered suitable for enriching students learning of each concept for the experimental groups. Meanwhile, the usual teaching pattern, traditional lecture method, was maintained in the two schools involving the control groups. Moreover, the first five abstractive concepts which were among the first 8 topics in the semester curiculum were focused on in this study. These topics were monitored and were successfully completed across the four institutions at the eighth week of the semester. At the completion of the teaching exercises covering the scope of this research, the post-test administration was conducted a week after, which provided the post treatment data for the study. The same posttest performance test was administered to the students the second time a month after the previous administration. The administration of the test at the second time provided data for student's retention on the learned concepts.

3.7. Data Analysis

With the SPSS, inferential statistics was employed in testing generated hypotheses in this study. Data collected for the study was analysed using analysis of covariance (ANCOVA) at 0.05 level of significance.

4. Results

4.1. Hypotheses 1-3

The results of hypotheses 1 to 3 are presented in Table 1.

Table 1: Test of between-subject effects for dependent variable: Post academic performance test scores

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2179.702[a]	8	272.463	20.046	.000
Intercept	600.795	1	600.795	44.203	.000
Pretest	1664.296	1	1664.296	122.448	.000
Group	172.710	1	172.710	12.707	.000
Gender	.293	1	.293	.022	.883
Abilitylevel	29.865	1	29.865	2.197	.140
group * gender	.581	1	.581	.043	.836
group * abilitylevel	.826	1	.826	.061	.806
gender * abilitylevel	23.598	1	23.598	1.736	.189
group * gender * ability level	1.873	1	1.873	.138	.711
Error	2297.023	169	13.592		
Total	98961.000	178			
Corrected Total	4476.725	177			

a. R Squared = .487 (Adjusted R Squared = .463)
significant at F < .05

On hypothesis 1, Table 1 established the F-value for the effect of technology enriched learning on students' academic performance as 12.707 with its significance at .000. This result indicates a significant difference in the performances of students taught abstract concepts in electrical/electronic technology and those taught the same concepts with traditional lecture method. Regarding hypothesis 2, Table 1 reveals that the F-value for the effect of technology enriched learning on students' academic performance with reference to gender is .022 with significance at .883. The result shows that male and female students exposed to technology enriched learning do not differ significantly in their academic performance. The result of hypothesis 3 on Table 1 shows that the F-value for the interaction effects of gender and ability level on students' academic performance in electrical/electronic technology course with exposure to technology-enriched learning is 1.736 with

its significance at .189. The result indicated no significant interaction effects of student's gender and ability level on their academic performance with exposure to technology enriched learning.

4.2. Hypotheses 4-6

The results of hypotheses 4 to 6 are presented in Table 2.

Table 2: Test of between-subject effects foe dependent variable: Post learning retention test scores

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2471.969[a]	8	308.996	29.144	.000
Intercept	1212.454	1	1212.454	114.356	.000
Pretest	559.866	1	559.866	52.805	.000
Group	997.662	1	997.662	94.097	.000
Gender	.299	1	.299	.028	.867
Abilitylevel	28.050	1	28.050	2.646	.106
group * gender	2.643	1	2.643	.249	.618
group * ability level	1.403	1	1.403	.132	.717
gender * ability level	43.921	1	43.921	4.142	.063
group * gender * abilitylevel	28.020	1	28.020	2.643	.106
Error	1791.812	169	10.602		
Total	79973.000	178			
Corrected Total	4263.781	177			

a. R Squared = .580 (Adjusted R Squared = .560)
significant at F < .05

The result of hypothesis 4 on Table 2 shows that the F-value for the effect of technology enriched learning on students learning retention is 94.097 with its significance at .000. This result indicates a significant difference in the learning retention of students taught abstract concepts in electrical/electronic technology compared to those taught the same concepts with traditional lecture method. On hypothesis 5, Table 2 reveals that the F-value for the effect of technology enriched learning on students' learning retention with reference to gender is .028 with a significance of .867. The result shows that gender do not influence the level of learning retention among the students with exposure to technology enriched learning. The result of hypothesis 6 on Table 2 establishes that the F-value for the interaction effects of gender and ability level on students learning retention of abstract concepts after exposure to technology-enriched learning is 4.142 with its significance at .063. The result indicated no significant interaction effects of student's gender and ability level on their learning retention after exposure to technology enriched learning.

5. Discussion of Findings and Conclusion

The focus of this study was to employ technology-enriched learning in facilitating student's instruction with purpose of measuring its effects on both students' academic performance and learning retention. The results presented in this study established a significant difference in the academic performance of students taught abstract concepts with technology-enriched learning and their counterparts in the traditional lecture room. The difference in the level of learning retention is significantly different between students taught with technology-enriched learning and those taught with traditional lecture method. The differences are as a result of the influence of technology-enriched learning which improves students' academic performance and retention in the experimental groups. Moreover, the study established no significant differences based on gender among the students both in academic performance and learning retention in relation to their experience of learning with varieties of technology. Also, the interaction effects of gender and students' academic abilities do not significantly influence the performance and learning retention of students taught with technology-enriched learning. These results show that the technology-enriched learning method is neither gender nor academic ability biased. The technology-based learning method seems to take care of individual differences with relation to gender and students' academic level.

The findings of this study justify the position of many researchers who have recommended technology-based teaching method as a better alternative to the traditional lecture method. For example, Dikmen and Tuncer (2017) established huge influence of technology enriched learning on students' learning and achievement. Also, Batdi (2015) and Dincer (2015) confirm the positive effects of computer-based instructions on students' academic performance. In the same vein, Ayaz, et al., (2016) and Elangovan and Ismail (2014) reported applications of teaching technologies and multimedia simulation respectively in facilitating students' learning with resultant improvement in students' performance. Mohammed, et al., (2018), Saraç (2018) and Wakil, et al., (2017) all found effective improvement on students learning, performance and retention with learning enrichment through technologies.

The findings of this study clearly indicates that students would most likely learn better with a change from the traditional teacher-directed lecture method to an engaging technology-enriched learning method (Trepule, et al., 2015). The depth of science teaching with predominant abstract concepts may no longer be a challenge as usual to most university teachers as technology has provided templates for simulating real situations; hence, concepts can now be presented as realistic as possible. Technology-enriched learning in this study attempted to reduce the abstractive nature of most concepts to help students imagine the reality of the operations of presented scientific concepts. In essence, the new knowledge learnt by the students is more established and hopefully retained longer compared to their experiences when traditional means of learning was usually employed. Artificial, picture and simulation evidences of the realities of scientific concepts through technological presentations in this study enhanced students learning with evidence of improved academic performance and retention. This study, like others, found reduced students' performance in scientific concepts (Al-Hariri & Al-Hattami, 2017) with use of traditional teaching method; this is established through marginal improvement compare to those who learned the same concepts with technology. This seems to justify the unattractiveness of the learning environment (absence of technology) which could not support realistic learning. The situation of learning discovered in this experimental study confirms the claim of Freeman, et. al., (2014) who objected that poor performances and retention among students are inevitable without evidenced-based teaching method. In the same vein, the position of Hariri and Al-Hattami (2017) may be justified that effectiveness of the use of pictures, videos among others in establishing learning is what improves and retain learning most especially where abstract concepts are involved.

In this study, technology-enriched learning as predicted seems to aid better presentation of scientific concepts which in turn helps students to learn appropriately irrespective of gender and academic ability. Literature already suggested possibility of improved academic performance when students are actively involved or engaged in their knowledge creation when effective teaching methods are adopted (Chibabi, et al., 2018). Hence, technology-enrichment of learning concretizes both male and female students' knowledge of abstract concepts which by implications reduces possibility of forgetfulness (Lindsey, et al., 2014). The learning method do not establish disparity in gender or ability level. Overcoming forgetfulness with appropriate retention of learned concepts will be a pointer to actual practice of learned scientific concepts in the future. Chibabi, et al., (2018) argued in support of the findings of this study that learning beyond the surface provides superior knowledge-retention which will inform effective practical applications of the classroom lessons. In addition, Raleigh, et al., (2018) reiterated that teachers who approached teaching objectively enhance students learning and retention with potentiality of improving the students' academic and practical performances.

The employment of technology-enriched learning into the classroom will help science teachers to prioritize students understanding of subject matter rather than completing the scheduled curriculum without successful learning. In the classroom where technology-enriched learning is employed, students misunderstanding of concepts will be minimized (Aktas & Yurt, 2017) and students may no longer require rote memorization of concept to pass (Freeman, et. al., 2014). Also, the efficacy of technology deployment into science classroom seems to take care of concepts misunderstanding especially with reference to academic abilities among science students (Noesgaard & Orngreen, 2015). It has been established that technology application in the classroom deepens teaching-learning activities with implications on knowledge acquisition and overall

performance (Al-Hariri & Al-Hattami, 2017). These researchers opined that effective use of technology-enriched learning could enable students develop creative and analytical reasoning with problem solving ability. Invariably, teachers who fully explores and apply the potentials of technology in the classroom may likely influence students learning and performance productively (Aktas & Yurt, 2017). Moreover, when compared to the impact of traditional lecture teaching method, students learning retention and performance are better improved with appropriate technology integration in the classroom setting (Harris, Al-Bataineh &Al-Bataineh, 2016).

Furthermore, students' performance and retention may have been improved based on the level at which the technology enriched learning captivates the interest of the learners compared to what is obtainable in the traditional classroom (Lari, 2014). Multimedia enrichment in adopted technology applications for teaching of scientific concepts may be responsible for optimal influence on students learning and performance (Lari, 2014) as well as retention of learning knowledge thereafter. The finding in this study laid credence to that of Ozaslan and Maden (2013) and Wang (2011) who expressed that technology based learning makes learning more appealing and understandable to learners with outstanding academic performance at the end of the course. In this study, it was noted that students' performance is effectively influenced because their learning is simply structured and presented in logical sequence using technological applications (Giurgiu, 2017). With student's attention successfully drawn to important information on learning concepts, their learning becomes effective with increase possibility of retention (Giurgiu, 2017). The efficacy of technology-enriched learning is established in providing information on learning concept in bits which can be understood without additional information. In relation to science students, technology-enriched teaching technique facilitates practical problem solving with appreciable development of students' metal structures.

This study conclusively established that the integration of technology-enriched learning into teaching of abstract concepts in electrical/electronic technology education positively impacts students. This new method of teaching aids effective learning among the students with evident improved academic performance and retention. Technology-enriched learning helps electrical/electronic technology students to visualize and understand difficult abstract concepts including structure of matter, thermionic emissions among others through infographics and simulation.

6. Recommendations

It is recommended that the idea of technology-enriched learning be adopted by university teachers to foster effective teaching of abstract concepts in science and engineering course areas. The use of traditional lecture method should be discouraged for teaching abstract concepts in the university. Hence, Science and engineering teachers should be trained in technology-based instructional development for effective teaching. Curriculum planners should advocate for inclusion of technology-based instructional training in the pre-service teachers education in order to start producing technology-efficient science teachers. Furthermore, it is recommended that subsequent studies should investigate other factors which may influence performance and retention among students and also employ mixed research paradigm with exploration of the teaching learning process.

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