EXPOSITORY VERSUS SIMULATED LABORATORY IN TEACHING PROFESSIONAL COURSES

Department of Computer Engineering, Kaduna Polytechnic.
E-mail: paxnascent1@yahoo.com, isjamoye@yahoo.com, oizaohu201@yahoo.com

Abstract
In Nigeria Polytechnics, demonstrating theories through practical and laboratory experiments is an important approach to teaching, especially in engineering curricula. Often, lack of interest, resources and logistics problems makes this impossible. Evidence suggests that the expository laboratory, as used in engineering courses today, has lost its instructional value, while emerging technologies such as simulations can serve as robust replacements and teaching aid. Recently, several attempts to find an alternative to in-laboratory experiments have been proposed from many researchers. This paper, presents the application of both methods of laboratories experiments, using two electronic experiments, to implement and validate results. Finally, the results revealed significant conformity with theories for the simulated groups. The simulated laboratories were also perceived to be more open-ended, easier to use, easier to generate usable data, and require less time to complete than expository laboratories. The results suggest that the simulated laboratory can serve as a legitimate teaching aid, ‘a bridge’, and an integrated part of an engineering course or alternative to the expository, “hands-on” laboratory where facilities are not available. It also request that teaching methodologies should also be modified to guide students towards acquiring basic knowledge such as ICT tools, which are very necessary in the study and work world of today.

Keywords: Simulated Laboratories, Expository Laboratories, Frequency Response, Gain, Electronics, Experiments.

Introduction
Professional courses are course which gives the student, the theory and practical skill, needed to practice and may account for between 60-70% of contact hours .The teaching of the theory and practical work in professional courses should as much as possible be integrated. There should be a balance of 50:50 or 60:40 or the reverse (NBTE, 2001).

Laboratory experiment has been a central component of science instruction since the early 20th century (Singer, et. al, 2006). It has been used to teach experimental methods and techniques that clarify and or validate existing scientific principles and theories and has typically been considered expository in nature (Lagowski, 2002). Expository environment utilizes rote procedures which inhibit students from forming a genuine understanding of the connections between the data they collect and the theories the data describe (Eylon & Linn, 1988).

Today, in electronics and computer engineering laboratory, technology has reached a threshold where virtual or simulated (learner-centered) approaches can formidably meet or exceed the learning outcomes of expository (teacher-centered) approaches. And research suggests that simulated laboratories can dramatically impact learning in positive ways (Cheng, et al., 2010; Hessley, 2004; Huppert, et al., 2002; Kenneppohl, 2001; Mencer, 2002).

Today’s students are different; they differ from those of older generation in at least two respects; they have not tinkered, and thus if started in Electrical/Electronic Engineering through theory, have no idea where in practice, all this fits or why it is useful. Second they are impatience; they are used to immediate gratification (exemplified by their obsessive playing of computer game where they push a button and see “major results” right away). Telling these students that they will see “latter in the curriculum” why circuit analysis is useful does not work; two semesters down the road or even one, is too far into the future for them. Thus they lose motivation, develop frustration and many become passive learners. To avoid this, they need to be introduced to theory and practice in the same course (Yannis, 2010).

The roles of teachers and students are changing, and there are undoubtedly ways of learning not yet discovered. However, the computer and software
Similarly, Century learning deliverable in the -n activity which has that simulated laboratory teaching methodologies st-he). simulation With less laboratory time spent on It's however, 2002). It is often laboratory may work that the student life et.al, (2004), reported, the National and advanced laboratory experiment for this study. requires experience with Keith, 2002) In Engineering, the full laboratory, based on conformity of results, the last century in 2009). www.tran.real 8308. educational objectives of the experiment such as manually collecting data, students can focus on the technology. terms of laboratory goals, student needs, job skills, and changes that have occurred over laboratories are not as effective as manipulating the real equipment. Some institutions consider initially utilizing the remote (simulation) method to train the student before his/her use of the equipment for in-laboratory experiments purposes. Thus, students can also practice utilizing the devices in a tutorial mode, before they actually perform the experiments (Keith, 2003).

Pyatt, & Sims, (2007) stated that simulated laboratory can serve as a legitimate alternative to the expository, “hands-on” laboratory which is frequently used in science courses and the study also indicated that the simulated version of a “hands-on” laboratory may actually provide more freedom for students to explore and deviate from prescribed procedures. Such approaches are consistent with 21st Century learning environments whereby students construct their understanding of the expository world in learning environments that are active, digital, virtual, and online.

Towne, (1995) claims that simulations are motivating and can enhance transfer of learning and suggest that simulations can effectively serve the “hands-on” role of the traditional laboratory; an activity which has historically been cited as being motivating. While simulations are frequently used in research, they are rarely used in education (Zurn, et.al, 2003). The laboratory of the 21st century must embrace the changes that have occurred over the last century in terms of laboratory goals, student needs, job skills, and technology. With less laboratory time spent on manually collecting data, students can focus on the educational objectives of the experiment such as analyzing data (Sherry & Lord, 2002). It is often found that, at the end of a laboratory experiments, question been asked are the behaviors, characteristics and analysis of results, rather than the physical positions or handling of components. It’s however, not possible to substitute the work that the student performs during a practical class of laboratory (Rodrigo, et.al, 2002). Instead students should conduct both simulation and expository experiments and to make comparison on the outcome of the experiments (Miller, 2000). Similarly, teaching methodologies should also be modified to guide students towards acquiring basic knowledge (tools) such as ICT tools, which are very necessary in the study and work world of today (Onwuka, 2009).

Pearce et.tal, (2004), reported, the National Instruments ELVIS device allows the instructor to show circuit solutions in real time using real physical devices, with attendant uncertainties in component values, offset voltages, leakage currents, and noise. These demonstrations make the circuit behaviour real during lecture rather than being completely a mathematical calculation, a distinct advantage for that subset of students whose learning styles are more practically based rather than conceptual. Therefore, this study is designed to investigate the extent to which simulated laboratories can achieve learning outcomes as successfully as the expository laboratory paradigm and to serve as a teaching aid using the Multisim 8 software (Neshelkey & Boylestad, 2008). Concurrently, this study addresses the differences and similarities in possible student laboratory experiment, using a simulated and an expository laboratory. The results of the study provides insight into whether or not a simulated laboratory should serve as an effective bridge to the expository laboratory, based on conformity of results, flexibility, accessibility and availability of equipment.

**Methodology**

This study used a comparative methodology in which students performed laboratory investigations in an expository and a simulated environment. To carry out the test and acquire data; test was carried out based on the multisampling test method to get the exact value of quantity under measurement and for a better statistical treatment of data (Sawhney, 2005). Two criteria were used to select the laboratory experiment for this study. First, it was established that a “typical” engineering
laboratory should be integrated in the curriculum (Singer et al., 2006). Therefore the laboratory chosen for this study; characteristics of common emitter amplifiers and the frequency response of transistor amplifier, as recommended by NBTE (2001) are integrated in the Electrical/Electronic Engineering and Computer Engineering curriculum. Secondly, in the case of general Electronics courses, the laboratories chosen reflected the central theme of the Electronic Engineering curriculum. Specifically, the two laboratory experiments chosen for these studies are standard Laboratory: (1) the characteristics of common emitter amplifiers, (2) frequency response of common emitter amplifiers (Oroge, 2001). These experiments were chosen because they are easy to implement and they demonstrate important concepts presented in most of introductory courses of electronics.

Sample

Students of Higher national Diploma I and II classes of our department participated in this study and the students were randomly assigned to one of two groups: expository or simulated. After groups were assigned, a computer training session took place for all participants whereby the simulation software (Multisim 8 trial version) was introduced, and students directed to complete a simulated sampled laboratory. Two days were used with all experiments conducted within the scheduled three hours laboratory period on the departmental time table; students were assigned as shown in table 1.

Table 1: Distribution of Groups

<table>
<thead>
<tr>
<th>Laboratory</th>
<th>Group on day one</th>
<th>Group on day two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expository version of laboratory 1</td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
<tr>
<td>Expository version of laboratory 2</td>
<td>Group 2</td>
<td>Group 1</td>
</tr>
<tr>
<td>Simulated version of laboratory 1</td>
<td>Group 2</td>
<td>Group 1</td>
</tr>
<tr>
<td>Simulated version of laboratory 2</td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
</tbody>
</table>

The motive for having each group switch experience from expository to simulated or vice versa was adopted to ensure that comparative, attitudinal, and to obtain performance data from each student for each experience, and as well eliminate Hawthorne effects (Pyatt, & Sims, 2007).

Testing process

The present study is a pilot study, rather than conducting a thorough usability test evaluating all aspects of the possible laboratory test, emphasis was given on the conformity of the test approaches utilized. For the expository approach, the following equipment and materials were use: (i) power supply (dual source). (iii) Field effect transistor characteristic module (iv) connectors (v) auto range digital ammeters (xi) function generator (xii) Digital oscilloscope (xiii) standard digital voltmeters (x) auto range digital voltmeter and transistor module. While for the simulation approaches dell computers (250GB, 2.5GHz, 2GB of RAM) installed with windows XP operating software, and Multisim 8 Trial versions.

The circuit used as shown in fig. 1, produced the results shown in fig. 2-4, using the simulated experiment for observation under the conditions of; (i) an amplifier with decoupling capacitor (ii) an amplifier without decoupling capacitor and (iii) an amplifier with a load resistor. Fig.5 was obtained from both simulation and expository experiments to study the frequency response of the amplifier based on the gain formula in equation 1.
\[ Av(dB) = 20 \log \frac{V_{out}}{V_{in}} \] ..............................equation 1

where  \( Av = \text{gain} \)

\( V_{out} = \text{output voltage} \)

\( V_{in} = \text{input voltage} \) (20mV)
results and discussion

The results of experiment 1 (characteristic of amplifiers), as shown in fig. 2 to 4 reveals that the simulated approach could be used to demonstrate and confirm, the theory of amplifiers; the study shows, (i) the amplified signal is 180° out of phase with the input and has a gain of 80dB, (ii) the absence of the decoupling capacitor results in a lower gain of 26dB, (iii) The introduction of the load resistor reduced the output by half, hence the gain to 40dB. The results for experiment 2 (frequency response of an amplifier) as presented in fig. 5 shows that the frequency response of an amplifier (within the bandwidth of -3dB range) the gain is high in both the simulated and the expository experiments, although, the expository shows a little lower gain this may be associated with ageing of equipment, error in measurement, and connections, Thus it could be concluded that the simulated results reflect the true theory as being thought during lectures, and could be used as teaching aid in classrooms before and or during practical.

Conclusion

The present study tried to compare expository and simulated laboratory. Even though there was an initial inquiry of the principle theoretically, it was found that simulation approach reveals lesser deviation from the theory, but similar performance as the expository. The finding that student’s results, using simulated laboratories outperformed students who used expository laboratories suggests that there were learning differences between the two environments. Findings also showed that students can control the time, location, and pace of their interaction with the simulation than the expository. It also showed that the simulated laboratories can serve as a legitimate teaching aid and a ‘bridge’ to the “hands-on” laboratory and should be an integrated part of every professional course, not to substitute a practical laboratory. It is recommended that, a new approach, based on an open-access laboratory policy be introduce as this could extend the frontiers of modern engineering teaching tools, among which experimentation is an important component.

References


Ertugrul N. (2010); Towards Virtual Laboratories: a survey of Lab View-based teaching/learning tools and future trends; nesimi@eleceng.adelaide.edu.au, retrieved 20th September 2010.


The National Board for Technical Education, (2001); National Diploma and Higher National Diploma in Computer Engineering Technology; Curriculum and course specification. Atman Limited, C17 Rimi Road Kabala Costain off Constitution Road, Kaduna.


Yannis T.(2010); Teaching Circuits and Electronics to First Year Students; Department of Electrical Engineering Columbia University New York USA, Retrieved august 12, 2010