VIRTUAL LABORATORY PACKAGE FOR CONDUCTING NIGERIAN SECONDARY SCHOOL PHYSICS EXPERIMENTS: HOW NOVEL, HOW INTERACTIVE, AND HOW FRIENDLY?

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Abstract
This study was carried out to examine the novelty, interactive and user-friendly features of virtual laboratory package meant for conducting selected Nigerian secondary school physics experiments. Descriptive survey research was adopted and three research questions guided the study. Purposive sampling technique was employed to select 57 respondents (comprising 22 instructional design experts and 35 computer experts) who assessed the package in terms of the aforementioned features using questionnaire. The questionnaire was subjected to validation and reliability checks prior to usage for data collection. Data gathered were analyzed using Mean and Standard deviation. Findings revealed that experts considered the package novel and user-friendly but not interactive. Based on these findings, it was recommended that awareness on novel learning technologies should be created in schools, and that, developers should ensure learning packages possess interactive features that will enhance communication and improve their chances of being selected and utilized in teaching and learning process.

Keywords: Virtual laboratory package, Interactive, Novelty, User-friendly, Virtual learning

Introduction
Innovations involving the integration of information and communication technologies into teaching and learning process continue emerge. Presently, artificial learning environments such as simulations are increasingly becoming widespread and have proven to be effective in teaching difficult and complex subjects at all levels of schooling, particularly in teaching and learning of difficult science-based concepts (Babateen, 2011; Falode, *et al.,* 2016). Computer simulation is a computer-generated version of real-world objects or processes. When integrated into teaching and learning process, computer simulation can provide students with the opportunity to engage in activities that may not be possible ordinarily in a classroom setting, it can enhance academic performance and learning achievement levels of students, and it can also provide close to real-life hands-on laboratory experiences (Michael, 2000).Through simulation, virtual laboratory,a computer-based learning environment where learner is able to simulate experiments completed in traditional laboratory through the use of computer can be developed (Onyesolu&Eze, 2011).

Virtual laboratory provides students with tools and materials set on computer in order to perform experiments saved on CDs or on web site which can be supported by discussion fora, video demonstrations, hyperlinked glossaries, and e-mail lists (Babateen, 2011; Falode, 2014; Nunn, 2009; Scheckler, 2003). Virtual laboratory is usually developed based on learners' needs and in line with constructivism theory of learning. In constructive learning, the standard classroom procedure is changed as there are no lectures but students engage in activities through which they develop skills and acquire knowledge while navigating through an interactive learning environment (Cooperstein & Kocevar-Weidinger, 2004).

Selection and adoption of virtual laboratory package by stakeholders in teaching and learning process is dependent on so many factors which include the usefulness, newness (novelty), friendliness and interactive attributes of the package (Falode, 2014). A novel invention becomes useful when it offers significant improvement on prior art. Novelty deals with the newness of technologies and it has been discovered to aid learning. According to Duzel (2006), exposure to new experiences motivates learners to explore the opportunity provided and improves memory performance as human brains responds better to novelty than to familiar experiences. Virtual laboratory package, if novel, should be interactive and friendly to teachers and students for them to maximally benefit from its usage in teaching and learning of physics.

Interactivity of a learning technology entails the interaction between learner and learning materials, other learners and the teacher while using the technology in teaching and learning process. Babateen (2011) was of the opinion that virtual laboratory package should be distinctively interactive and have unique sorts of interaction better than traditional multi-media. In other words, learners should be able to navigate without stress and should be able to engage in useful communication while completing the learning task presented by the package (Falode, 2014). Once learners are able to interact and navigate, they will derive satisfaction in the usage of the package and consider it friendly.

User-friendliness focuses on the ability of learning technology to be of interest to a learner while carrying out learning task. For instance, a learner, during the cause of using virtual laboratory package to conduct physics experiments, should be able to navigate through the task in simple to complex manner, find buttons and icons easy to use, find instructions and procedures easy to comprehend and find the learning tasks suitable to his/her learning needs (Falode, 2014). Dillion (2007)therefore concluded that, quality in teaching and learning through technology can only be achieved if learning resources and activities pose new challenges, are distinctively interactive and interesting to learners particularly in science-based subjects of which physics is an integral part.

Physics as a discipline is one of the core components of science, and it is essential for the technological growth of a nation. The discipline has proven its benefits to mankind as almost every human activity and virtually every profession involves some elements of Physics. The fields of medicine, engineering, communication technology, architecture, geophysics, biophysics, material sciences, nuclear physics, agronomy among several others, are based on the fundamental principle of physics (Okoro, 2003). Therefore, physics is included in the Nigerian senior secondary school science curriculum to build strong technological foundation for students.

One major aspect of physics is mechanics. The importance attached to mechanics topics in physics as underscored by Chief Examiner's Reports of West African Examinations Council from 2002-2005 indicated that, more than 30 percent of senior secondary school physics examination questions were from mechanics, and that, the poor performance in physics recorded on the concepts of mechanics is partly in the areas of elasticity properties of solid, kinetic theory, simple harmonic motion, simple mathematical computation, interpretation of expressions and equations (WAEC, 2002-2005).

To provide a lasting solution to students' poor performance in these mechanics components of physics, the development of virtual laboratory package became necessary. Falode (2014) developed a virtual laboratory package for conducting simple pendulum, Hooke's law and momentum experiments in Nigerian secondary school physics curriculum. The effectiveness of the developed package was determined in a study by Falode and Onasanya (2015) andit was found to have improved students' achievement in physics. Furthermore, the cost effectiveness of the package and its accessibility to Nigerian secondary school students was investigated and found satisfactory as reported in a study by Falode and Gambari (2017).

However, despite the positive findings regarding teaching, learning and cost effectiveness of virtual laboratory package, no study was conducted to examine the novelty, interactive and user-friendly attributes of the package. Except these attributes are investigated and findings implemented, teachers and students may not adopt the package in teaching and learning of physicsand this may hinder the actualization of the rationale for the development of the package. Hence, this study was carried out to examine the novelty, interactive and user-friendly attributes of virtual laboratory package for conducting Simple pendulum, Hooke's law and Momentum experiments in Nigerian secondary school physics curriculum.

Research Questions

The study provided answers to the following research questions:

1. How novel is the developed virtual laboratory package meant for teaching and learning selected Nigerian secondary school physics concepts?
2. Is the developed virtual laboratory package for learning selected Nigerian secondary school physics concepts interactive?
3. Does the developed virtual laboratory package on selected Nigerian secondary school physics concepts possess user-friendly attributes?

Methodology

This study adopted a descriptive type of survey research. It entails the use of questionnaire to elicit needed information from instructional design experts and computer experts based on their opinions and views regarding the novelty, interactive and user-friendly attributes of virtual laboratory package.

The study population consists of instructional design experts and computer experts in Nigeria. For the purpose of this investigation, a total of 57 experts, comprising 22 instructional designers and 35 computer specialists were purposively selected from six Federal Government Colleges in south-west, Nigeria based on their relevance.

One research instrument, named Questionnaire on Virtual Laboratory Package Attributes (QVLPA) was used for data collection. It consists of four sections (Section A, B, C &D). Section A was designed to collect respondents' demography, Sections B, C and D were respectively designed to collect data regarding the novelty, interactive and user-friendly attributes of the package. There were 13 items in all, and a 4-point scale was used in weighing experts responses in which, Strongly Agree, Agree, Disagree and Strongly Disagree were awarded 4, 3, 2 and 1 point respectively. A decision rule was set, in which, mean score of 2.50 was considered Agreed while a mean score below 2.50 was considered Disagreed.

The questionnaire was subjected to validation and reliability checks. Two computer experts and three instructional design experts validated the questionnaire while a pilot study was conducted in which, the questionnaire items were administered once on a randomly selected respondents who were part of the sample population, but that were not selected for the main study. Reliability coefficients ranging from 0.90-0.93 were obtained using Cronbach alpha formula.

The developed virtual laboratory package was developed by Falode (2014). It was developed using Adobe Flash CS6, Actions script 3.0, Adobe Fireworks CS6, Box2D and CamStudio software was used in recording the embedded video tutorial. The package is meant for conducting three secondary school physics (simple pendulum, Hooke's law and momentum) experiments. The entrance menu of the package consisted of introduction/student's registration edifice, list of practical lessons (Lessons 1, 2 & 3) and exit button. The main menu is divided into three sections, namely, lesson note section, where the learner is able to study the content for the experiments; Video section, where the learner is able to watch tutorial of how to use the package; and laboratory section where the learner is able to perform the experiments virtually. Figure 1 shows the screen shot of the package.

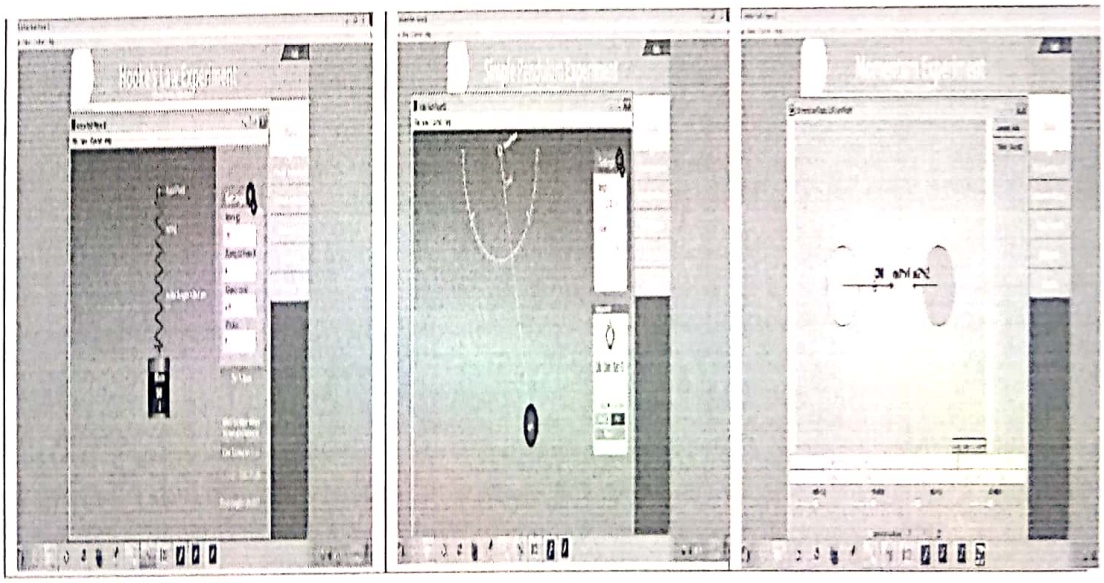

Figure 1: Screenshots of the Virtual laboratory package

The researchers personally visited the respondents, stated the purpose of the study and solicited for their cooperation. Thereafter, the virtual laboratory package was installed on their personal computer. They were given time to navigate and observe the package before they were given questionnaire to fill. The duly completed questionnaires were collated and analyzed to answer the three research questions.

Specifically, descriptive statistics of Mean and Standard deviation were used for the analyses which are presented in Table 1-3 with their interpretations and discussion of findings following.

Results

Research Question 1: How novel is the developedvirtual laboratory package meant for teaching and learning selected Nigerian secondary school physics concepts?

Table 1: Mean and standard deviation of computer experts' responses regarding the novelty of virtual laboratory package

S/N	Statement	N	Mean	Std.D.	Decision
1	The concept of learning physics through virtual laboratory is a new idea in my school.	35	2.68	0.18	Agreed
2	Virtual laboratory package is new to Physics students in my school.	35	2.88	0.38	Agreed
3	Virtual laboratory package is new to Physics teachers in my school.	35	2.74	0.24	Agreed
4	Virtual laboratory package is new to ICT staff in my school.	35	2.14	0.35	Disagreed
	Grand Mean		**2.61**		**Agreed**

Table 1 shows the mean and standard deviation of computer experts' responses on the novelty of virtual laboratory package. The table reveals that the mean response of respondents to each of the items is above 2.50 except item 4 with a mean response of 2.14. The grand mean of the four items is 2.61 which is above the decision mean of 2.50. This indicates that experts agreed and considered virtual laboratory package to be a novel way of learning physics in secondary schools in Nigeria.

Research Question 2: Is the developed virtual laboratory package for conducting selected Nigerian secondary school physics experiments interactive?

Table2: Mean and standard deviation of instructional design experts' responses regarding the interactive features of virtual laboratory package

S/N	Statement	N	Mean	Std. Dev.	Decision
1	Virtual laboratory package enables learner-to-learner interaction while conducting simple pendulum, Hooke's law and momentum experiments	22	2.13	0.37	Disagreed
2	Virtual laboratory package enables learner-to-content interaction while conducting simple pendulum, Hooke's law and momentum experiments	22	2.72	0.22	Agreed
3	Virtual laboratory package enables learner-to-tutor interaction while conducting simple pendulum, Hooke's law and momentum experiments	22	2.13	0.36	Disagreed
	Grand Mean		**2.32**		**Disagreed**

Table 2 shows the mean and standard deviation of instructional design experts' responses regarding the interactive features of virtual laboratory package. The mean response of experts to each of item 1 (learner-to-learner interactivity of the package) and item 3(learner-to-tutor interactivity of the package) is 2.13 while the mean response of experts to item 2 (learner-to-content interactivity of the package) is 2.72. The grand mean of the three items is 2.32 which is below the decision mean of 2.50. This indicates that experts disagreed and considered the virtual laboratory package not interactive.

Research Question 3: Does the developed virtual laboratory package on selected Nigerian secondary school physics concepts possess user-friendly attributes?

Table 3: Mean and standard deviation of instructional design experts' responses regarding user-friendly attributes of virtual laboratory package

S/N	Statement	N	Mean	Std. Dev.	Decision
1	Buttons and icons in the package make virtual laboratory package easy to use.	22	2.95	0.45	Agreed
2	Instructions in the virtual laboratory package are easy to comprehend.	22	3.00	0.50	Agreed
3	Content and procedure in the virtual laboratory package are arranged from simple to complex, known to unknown.	22	2.72	0.22	Agreed
4	Procedures and contents in the virtual laboratory package are suitable to students' need and level.	22	3.00	0.50	Agreed
5	Virtual laboratory package has detailed user and operational manual.	22	2.50	0.00	Agreed
6	Virtual tools and equipment in virtual laboratory package are well labeled.	22	2.68	0.18	Agreed
	Grand Mean		**2.80**		**Agreed**

Table 3 shows the mean and standard deviation of instructional design experts' responses regarding the user-friendly attributes of virtual laboratory package. The mean response of experts to each of the six items is above 2.50. Also, the grand mean of all the items is 2.80 which is greater than the decision mean of 2.50. This indicates that experts agreed and considered the package user-friendly.

Discussion of Findings

Findings of this study with regards to the novelty of virtual laboratory package revealed that the concept of learning physics through virtual environment is a new innovation in Nigerian secondary schools. This may be due to the fact that the use of lecture method to teach physics in classroom and also, the use of physical facilities in laboratory to conduct physics practical are the conventional practice in Nigerian secondary schools.

Also, another findings of this study revealed that experts rated in the interactive attributes of the developed virtual laboratory package low. This finding is also not in agreement with the view of Babateen (2011) who was of the opinion that virtual laboratory should be distinctively interactive and have unique sorts of interaction better than traditional multi-media. The fact that the package does not support synchronous online chatting among users may the reason why experts rated its interactivity low.

Furthermore, findings of this study concerning the friendly attributes of virtual laboratory package revealed that the package is user-friendly. This finding is in line with the recommendation of Dillon (2007) that virtual laboratory program should be developed in an interesting and attractive form in order to attract students' attention and urge them to complete the learning task. The package was considered friendly because of the excitement derived while navigating and clicking buttons and because of the fun derived while conducting complex experiments that look simplified on the computer.

Conclusion

It has been asserted that novel learning packages developed to facilitate teaching and learning of practical-based science subjects particularly physics are not being utilized in Nigerian secondary schools. Such packages can only be considered for selection and utilization in teaching and learning process if stakeholders are aware of their existence and if the package possess features that will enhance its adoption in teaching and learning process. This study has therefore revealed that virtual laboratory package is novel, not interactive but users-friendly.

Recommendations

Based on the findings that emanated from this study, it is recommended that physics teachers, students and school administrators should be made aware of newly developed virtual laboratory package, embrace

it and adopt it in teaching and learning of Nigerian secondary school physics. In addition, developers of learning packages such as virtual laboratory package should ensure they possess interactive features in order to enhance effective communication between learner and content, learner and peers as well as between learner and teacher while using the package.

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