*International Journal of Education and Development using Information and Communication Technology (IJEDICT),* 2020, Vol. 16, Issue 1, pp. 88-106

# Usable Educational Software: Teacher-educators' Opinion about *Ọpón-Ìmọ̀* Technology Enhanced Learning System, Nigeria

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## ABSTRACT

The study evaluated usability of the *Ọpón-Ìmọ̀* Technology Enhanced Learning System (*OTELS*), an educational software deployed for teaching and learning across state-owned senior secondary schools in Osun State, Nigeria. It employed a descriptive research design of the survey type. Eight teacher-educators in Educational Technology and Computer science were purposively selected from four public higher institutions in the state to critically evaluate how usable the software is. A researcher self-designed instrument, tagged the E-learning Usability Evaluation Questionnaire for Teacher-educators (EUEQT), was used for data collection. Reliability of the instrument was ascertained using Pearson Product Moment Correlation. The instrument yielded a reliability coefficient of 0.73 which indicated its suitability for the study. Findings from the study revealed that *OTELS* did not conform to most of the guidelines generated to evaluate the software (heuristics guidelines); only six out of fifteen did so. Respondents' area of specialisation was also found not to have an influence on the evaluation of the software. Based on its findings, the study therefore recommends a review of the educational software in order to increase its suitability for teaching and learning purposes.

***Keywords:*** *Heuristics, usability evaluation, educational software, Opón-Imọ̀, secondary school education, Nigeria.*

## INTRODUCTION

Education is argued to be the bedrock of national development. Consequently, many authors have advanced reasons why education should occupy a prime place in every society, including a developing one like Nigeria. Clear evidence of Nigeria's effort at prioritising education was contained in its National Policy on Education where it subscribed to leveraging on available modern techniques to deliver a world class education for the benefit of its citizens and the country at large (Sinha, 2008; Federal Republic of Nigeria, 2013). By inference, it means Nigeria, like every other country would embrace modern techniques including Information Communication Technology (ICT) for the benefit of its educational system. In this study, Information Communication Technology is defined as a collection of tools (hardware and software) that can be used to collect, collate, analyze, store and transmit learnable information from one end to the other without any loss to quality.

The introduction of Information Communication Technology (ICT) into the educational sector by earlier educators was deliberate; it was aimed at helping learners learn more facts in a short time whenever and wherever, without compromising quality or standards. According to Melhuish and

Fallon (2010), education is notable for leveraging materials not originally designed for its purposes, and using them to achieve educational gains. Specifically, Pathak and Manoj (2018) gave some reasons why ICT was introduced into education, to include, promotion of access to lifelong learning; effective management of learnable information; to accommodate all categories of learners and teachers; increase technological literacy, and reduction in cost of education. The authors went further to highlight immediacy of information; promotion of collaborative learning; multimedia approach to education; interactive learning presentation; access to open educational resources; multiple communication channels, and timely instructional delivery as some of the benefits of ICT in education.

As mentioned earlier, ICT comprises two major components: the hardware component which includes, but is not limited to radio, tape recorder, television, audio-visual projector, digital camera and computers such as the laptop, desktop and tablet. The software component, on the other hand, includes all resources that aid the hardware to perform effectively. The *Opon Imo* is a learning tablet distributed by the government of Osun State in Nigeria to aid effective teaching and learning across state-owned senior secondary schools. The tablet runs on a software tagged Osun Technology Enhanced Learning System (*OTELS*). The state commenced the distribution of the *OTELS* to all senior secondary school students in line with its ICT policy in 2013 (Osun State Government, 2013).

The *OTELS* is, arguably, the first stand-alone learning system in Nigeria. It is software housed in a computer tablet called the “Tablet of Knowledge”. The “Tablet of Knowledge” apart from housing the *OTELS,* also contains other educational materials which include games, the English language dictionary and the calculator. Additionally, the tablet has religious materials such as the Bible, Quran and Ifa theology as part of its content. Technically, the tablet runs on the android 4.0 Operation System and a Random-access Memory of 512-megabyte. The tablet which also has a combined memory of 32-gigabyte runs on a rechargeable but non-detachable battery which can work for six hours when fully charged (Akinremi, 2013; Osun.gov.ng, 2013; Jegede, Adeleke, Jegede & Ayanlade, 2015).

*The OTELS* has three distinctive learning environments - the electronic book (e-book) library, the audio-visual classroom and test platform. The e-book library houses electronic copies of recommended textbooks on subjects such as Mathematics, English language, Biology, Physics, Chemistry, and Economics among others for senior secondary school students. Similarly, the audio-visual section which is still being developed will house video recordings of live-teachers during instructional delivery for students who prefer the visual and aural learning styles. The test environment, on the other hand, houses the practice test and past examination questions of both the West African Examination Council (WAEC) and the Joint Admission and Matriculation Board (JAMB). The practice test is meant to test students’ performances after interacting with specific learning content contained in *the OTELS,* while the past examination questions help students prepare for the WAEC, JAMB and other external examinations.

Although, the *OTELS* is an innovation aimed at promoting effective teaching and learning among senior secondary school teachers and students in Osun state, it must be ensured that it is a learning system that could assist teachers and learners in achieving their academic goals rather than deterring them. The recent experience of information explosion has made learning more complex for many students, therefore, every educator must strive to make learning environments more conducive to learning in order to achieve improved learning outcomes. The foregoing is more valid, especially with newer technologies such as educational software that allow students to study independently of their teachers (Virvou, Katsionis & Manos, 2005). As more technologies continue to be infused into the teaching-learning environment, it will become necessary for such technologies to be tested to ascertain their usability.

According to Nielsen (2012), usability evaluation determines the survivability of any technological system. When a user finds a system, interface or software of interest difficult to use in any particular context, the easiest option would be to abandon such a system, interface or software. Usability is the ease with which a specific user can use a system, interface or software to achieve a given task without any form of discomfort. Four main usability attributes resonate with most usability evaluators:

1. How learnable is the system?
2. Can its efficiency be easily memorized?
3. Does it reduce error of commission?
4. Does it ensure user's satisfaction? (Nielsen, 2012; Carvalho, Évora & Zem-Mascarenhas, 2016).

Usability evaluation is the process of determining whether a system, software or interface is usable in a specific context by a certain user to achieve predetermined outcomes in less time satisfactorily. The key words in usability, therefore, are efficiency, effectiveness and user satisfaction.

There are many usability strategies that can be used to evaluate a system or an interface; these can be broadly categorized into two separate but inter-related areas - pedagogical and technical usability evaluation strategies (Jeffels, 2011). Some of these strategies include: heuristic evaluation, activity analysis, questionnaires/surveys, prototyping, cognitive walkthrough, thinking-aloud protocol and focus group (Buxton & Greenberg 2008; Wikipedia, 2013). However, the heuristics remain the most widely used by usability evaluators (Nielsen, 2012). The heuristics, also known as experts-based evaluation, is easy to use and less costly. It is a strategy that requires few independent evaluators in order to detect several usability problems against established rules (Papadopoulos & Xenos, 2008; Carvalho et al., 2016; Moumane, Idri & Abran, 2016). The evaluators, separated by location and time, evaluate a given system against established guidelines and submit their independent findings to a team leader who then collates their findings into a usability report, highlighting different guidelines violated and problems detected during evaluation (Buxton & Greengerg, 2008).

The Nielsen's and Alsumait and Al-Osaimi's heuristics adapted for this study have 15 guidelines including Visibility of System Status (timely visual feedback to a student about on-going activities); Match between System and Real World (how well can a student relate to the words and terminologies contained in the system); User Control and Freedom (this concerns how effortless the student can manipulate the system without going through extended dialogue);Consistency and Standards (this borders on the system's conformity with conventions; words, actions, concepts among others); Error Prevention (this speaks to how difficult it is for a student to commit errors while using the system);Recognition Rather Than Recall (borders on how easily the student can recognise different environments on the system); and Flexibility and Efficiency of Use (this asks questions about how supportive the system is to both expert and novice students, for example: Are there accelerators on the system? Can tasks be completed in record time?).

Others include Aesthetic and Minimalist Design (this asks questions such as: Does the system appeal to students? Are there irrelevant details on the system?); Help for Users to Recognize, Diagnose, and Recover From Errors (this borders on how the system supports error detection, how error messages are presented among others); Help and documentation (this concerns whether the system provides help to the students or not, how easy it is to access the help and how easy it is to apply the help provided.); Accessibility (how easily can a student locate the software content); Assessment (mode of assessing student's performance after learning with the software); Motivation to Learn (kinds of activities or reactions or interludes that can sustain student's interest in the software); Interactivity (the robustness of interaction between a student and the software such as prompt feedback); and Learning Content Design (which deals with how orderly the learning content are, for example: whether related items are grouped together or not) (Nielsen, 1995; Alsumait & Al-Osaimi, 2010).

**Statement of the Problem**

Information Communication Technology is a veritable tool that could assist teachers and students in conducting the business of teaching and learning better when appropriately used. One of the recent additions to the growing number of technologies in education, is software capable of powering hardware like the tablet computer for the benefit of teachers and students alike. However, good as educational software such as the *OTELS* might appear, it must pass the usability tests in order to ensure that it achieves targeted goals so as to sustain its usage among teachers and students. Being an innovation, empirical reports concerning its usability remain scanty. Previously, Tijani (2016) had documented usability evaluation of the *OTELS* from students' perspectives with the recommendations already implemented by the State Government for the benefit of students. However, there is need to document teacher-educators' opinions on the usability of the innovation in order to add to the growing literature on usability evaluation, and to present an empirical report on the phenomenon from the standpoint of the teacher-educators, to satisfy the concept of data triangulation with a view to improving the innovation for better performance.

**Research Objectives and Hypothesis**

The study specifically investigated the:

i. Degree of conformity of the *OTELS* to the heuristic guidelines
ii. Influence of teacher-educators' area of specialization on the evaluation of *OTELS*

While the respondents' evaluation of the degree to which the *OTELS* conformed to the heuristic guidelines are key to the study outcomes, and served as the main objective, for purposes of validation the study also addressed the influence of the teacher-educators' area of specialisation on their evaluation. In that regard the following hypothesis was formulated and tested at 0.05 level of significance in this study.

H1: There is no significant difference in the teacher-educators'' evaluation of the *OTELS* based on their area of specialisation.

**Clarification of Terms**

i. Teacher-educator: Educational technology and Computer science lecturers in the public Universities and Colleges of Education within Osun state.

ii. Heuristics: a set of guidelines used for software evaluation in usability engineering but adapted for the purpose of evaluating the usability of the *OTELS*.

**METHODS**

**Participants**

All Computer Science and Educational Technology lecturers in government-owned higher institutions of learning in Osun state constituted the research population for this study. These categories of respondents were selected due to their expertise in the fields of computer science and education respectively. Purposive sampling was used to select eight teacher-educators (four

Educational Technologists and four Computer Scientists) from four higher institutions in Osun State. The institutions were selected purposely because they run either a Degree or National Certificate of Education (NCE) in Computer Science and Education.

**Research Instrument**

The E-learning Usability Evaluation Questionnaire for Teacher-educators (EUEQT) was used for data collection. Nielsen's (1995) and Alsumait and Al-Osaimi (2010) heuristics form the basis on which the EUEQT was drawn after proper adaptation to reflect the focus of the study. The instrument contains items such as: (a) Visibility of system status (b) Match between system and the real world (c) User control and freedom (d) Consistency and standards (e) Error prevention (f) Recognition rather than recall (g) Flexibility and efficiency of use (h) Aesthetic and minimalist design (i) Help for users to recognize, diagnose, and recover from errors, (j) Help with documentation (k) Accessibility (l) Assessment (m) Motivation to learn (n) Interactivity and (o) Learning content design. The EUEQT was divided into three sections; A, B and C. Section A covered respondents' demographic information while sections B and C were designed using the 4-point Likert scale of Strongly Disagree =1, Disagree =2, Agree = 3 and Strongly Agree = 4. Questions on section B dealt with the technical usability while Section C contained questions on pedagogical usability of the *OTELS*.

**Validation**

The EUEQT was validated by four teacher-educators who were not part of the main study. Its reliability was determined using Pearson Product Moment Correlation. It yielded a reliability coefficient of 0.73 which indicated that the instrument was reliable.

**Data Collection and Analysis**

For data collection, the researchers visited the selected teacher-educators in their respective institutions to seek their participation in the study. After their commitments were obtained, the researchers released the e-learning devices and copies of the questionnaire to the respondents. The respondents were allowed to interact with the software for at least five days, and then responded to the research instrument after which the researchers returned to the teacher-educators to retrieve the completed questionnaire and the e-learning devices. All eight copies of the questionnaire were sorted and found usable. They were analyzed using frequency counts, simple percentages and t-test.

**FINDINGS**

Table 1 presents the distribution of teacher-educators based on their area of specialisations; four respondents (50%) were lecturers of Computer Science, while the remaining four teacher-educators (50%) were lecturers of Educational Technology.

***Table 1:*** *Demographic data of teacher-educators based on area of specialisation*

| Variables | A | Total | Percentage | B | Total | Percentage | Total |
|---|---|---|---|---|---|---|---|
| Area of Sp. | Com. Sci. | 04 | 50.0 | Edu. Tech. | 04 | 50.0 | 08 |

**Research Question 1:** To what degree did the *OTELS* conform to the heuristics guidelines?

Tables 2 to 16 and Figure 1 below were used to answer the research question.

**Note:** Agree and strongly agree were merged into strongly agree while disagree and strongly disagree were merged into strongly disagree

***Table 2:** Visibility of OTELS status when in operation*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 1 | Every display on the *OTELS* begins with a header which describes the screen contents | 3 | 37.5 | 5 | 62.5 |
| 2 | Every action on the *OTELS* provides feedback | 3 | 37.5 | 5 | 62.5 |
| 3 | When a task is completed on the *OTELS*, the system indicates that the next action can be started | 4 | 50.0 | 4 | 50.0 |
| 4 | On the *OTELS*, there is a visual cue about which icons are selectable | 3 | 37.5 | 5 | 62.5 |
| 5 | If multiple options can be selected in a menu, there is a visual feedback about which options are already selected | 6 | 75.0 | 2 | 25.0 |

As indicated in Table 2, most teacher-educators strongly agreed that the *OTELS* conformed to the heuristics guideline with respect to visibility of its status. This was represented by 62.5% of the respondents who strongly agreed that every display on the *OTELS* begins with a header which describes the screen contents while 37.5% strongly disagreed. More so, 62.5% of the respondents strongly agreed that every action on the *OTELS* provides feedback to learners while 37.5% strongly disagreed. A total of 50% of the respondents strongly agreed that when a task is completed on the *OTELS*, it indicates that next actions can be started while 50% strongly disagreed with this statement. Similarly, 62.5% of the respondents strongly agreed that on the *OTELS*, there was a visual cue about which icons are selectable while 37.5% strongly disagreed. Also, a total of 25% of the respondents strongly agreed that if multiple options can be selected in a menu, there was a visual feedback about which options are already selected while 75% of the respondents strongly disagreed.

The data in Table 3 below shows that most respondents strongly agreed that *OTELS* conformed to the heuristics guideline with respect to match between *OTELS* and the real world. 62.5% of the respondents strongly agreed that on the *OTELS*, only items that are related appeared on the same display while 37.5% strongly disagreed. Also, a total of 75% of the respondents strongly agreed that in the question and answer interface on the *OTELS*, instructions were stated in simple language while 25% strongly disagreed. In addition, 75% of the respondents strongly agreed that on the *OTELS*, questions and answers were clearly stated in the Q/A interface while 25% of the respondents strongly disagreed. A total of 87.5% of the respondents also strongly agreed that on the *OTELS*, there was consistency between prompts and actions while 12.5% of the respondents strongly disagreed. Furthermore, a total of 62.5% of the respondents strongly agreed that on the *OTELS*, the user interface offered activation such as “go” and “back” while 37.5% of the respondents strongly disagreed.

***Table 3:*** *Match between OTELS and the real world*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 6 | On the *OTELS*, only items that are related appear on the same display | 3 | 37.5 | 5 | 62.5 |
| 7 | In the question and answer interface on the *OTELS*, instructions are stated in simple language | 2 | 25.0 | 6 | 75.0 |
| 8 | On the *OTELS*, questions and answers are clearly stated in the Q/A interface | 2 | 25.0 | 6 | 75.0 |
| 9 | On the *OTELS*, there is consistency between prompts and actions | 1 | 12.5 | 7 | 87.5 |
| 10 | On the *OTELS*, the GUI menus offer activation; i.e. “go” ,” back” | 3 | 37.5 | 5 | 62.5 |

The data in Table 4 below shows that most respondents strongly disagreed with the position that the *OTELS* conformed to the heuristics guideline with respect to learner control and freedom. For instance, 87.5% of the respondents strongly disagreed with the statement that a learner is prompted to confirm commands that have negative consequences before operation, while 12.5% strongly agreed. 25% of the respondents strongly agreed that there was a “redo” and "undo" function on the *OTELS* while 75% strongly disagreed. Also, a total of 25% of the respondents strongly agreed that a learner could cancel out any operations in progress on the *OTELS* while 75% strongly disagreed. Similarly, 87.5% of the respondents strongly disagreed with the position that when a menu has more than four items on the *OTELS*, a learner could select an item by typing a mnemonic code while 12.5% strongly agreed. Furthermore, all respondents (100%) strongly disagreed with the statement that a learner could edit the learning contents on the *OTELS*.

***Table 4:*** *OTELS ensures learner’s control and freedom*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 11 | On the *OTELS*, a learner is prompted to confirm commands that have negative consequences before operation | 7 | 87.5 | 1 | 12.5 |
| 12 | There is a “redo” and “undo” function on the *OTELS* | 6 | 75.0 | 2 | 25.0 |
| 13 | On the *OTELS*, a learner can cancel out any operations in progress | 6 | 75.0 | | 25.0 |
| 14 | When a menu has more than four items on the *OTELS*, a learner can select an item by typing a mnemonic code | 7 | 87.5 | 1 | 12.5 |
| 15 | On the *OTELS*, a learner can edit the learning contents | 8 | 100.0 | 0 | 0 |

In Table 5 below we note that most respondents strongly agreed with the position that the *OTELS* conformed to the heuristics guideline with respect to consistency with industrial standards. To demonstrate this, a total of 100% of the respondents strongly agreed that on the *OTELS*, icons were labeled for proper interpretation. More so, 62.5% of the respondents strongly agreed that when EXIT (or its equivalent e.g. “quit” or “close”) is a menu choice on the software, it appeared at the bottom of the list while 37.5% of the respondents strongly disagreed. A total of 75% of the respondents strongly agreed that on the *OTELS*, abbreviations did not include punctuations while 25% strongly disagreed. Similarly, 87.5% of the respondents strongly agreed that high-chroma colours were used to attract learner’s attention on the *OTELS* while 12.5% strongly disagreed.

***Table 5:*** *Consistency of the OTELS with industrial standards*

| **S/N** | **Statement** | **SD** | | **SA** | |
|---|---|---|---|---|---|
| | | **F** | **%** | **F** | **%** |
| 16 | On the *OTELS*, all actions are labeled for proper interpretation | 0 | 0 | 8 | 100.0 |
| 17 | When EXIT (or its equivalent e.g. “quit” or “close”) is a menu choice on the *OTELS*, it always appears at the bottom of the list | 3 | 37.5 | 5 | 62.5 |
| 18 | Menu titles on the *OTELS* are either centered or left-justified | 1 | 12.5 | 7 | 87.5 |
| 19 | On the *OTELS*, abbreviations do not include punctuations | 2 | 25.0 | 6 | 75.0 |
| 20 | On the *OTELS*, high-chroma colours are used to attract the learner’s attention | 1 | 12.5 | 7 | 87.5 |

The data in Table 6 below shows that all respondents (100%) strongly disagreed with the statement that if an action will cause any damage to the content of the software, a learner is usually alerted. Also, all respondents (100%) strongly agreed that every display on the software had a title. A total of 62.5% of the respondents strongly agreed that changes to displays on the *OTELS* were easy to detect by a learner while 37.5% strongly disagreed. A total of 87.5% of the respondents strongly disagreed that in the test zone on *OTELS*, test records were accurately stored with dates and time while 12.5% strongly agreed. Similarly, a total of 87.5% of the respondents strongly disagreed that negative structures such as “do you want to quit?” were avoided while 12.5% strongly agreed. These results, as revealed by 62.5% of the respondents indicated that the *OTELS* did not conform to the heuristics guidelines with respect to error prevention.

***Table 6:*** *Capability of the OTELS to prevent error*

| **S/N** | **Statement** | **SD** | | **SA** | |
|---|---|---|---|---|---|
| | | **F** | **%** | **F** | **%** |
| 21 | If an action will cause any damage to the content of the *OTELS*, a learner is usually alerted | 8 | 100.0 | 0 | 0 |
| 22 | Every display on the *OTELS* has a title | 0 | 0 | 8 | 100.0 |
| 23 | Changes to displays on the *OTELS* are easy to detect by a learner | 3 | 37.5 | 5 | 62.5 |
| 24 | In the test zone on the *OTELS*, test records are accurately stored with dates and time | 7 | 87.5 | 1 | 12.5 |
| 25 | On the *OTELS*, negative structures are avoided (e.g. “Do you want to quit?”) | 7 | 87.5 | 1 | 12.5 |

In Table 7 below we note that the majority of the respondents strongly agreed with the position that the *OTELS* conformed to the heuristics guideline with respect to recognition of the software rather than recall. For instance, all the respondents (100%) strongly agreed with the fact that displays on the *OTELS*, always start in the upper-left corner of the screen and that different zones on the software were clearly separated. More so, 87.5% of the respondents strongly agreed that on the *OTELS*, colour coding was consistent throughout the system while 12.5% strongly disagreed. In the same vein, 87.5% of the respondents strongly agreed that meaningful groups on the software were clearly demarcated by borders while 12.5% strongly disagreed. On the other hand, a total of 37.5% of the respondents strongly agreed that inactive menus on the *OTELS* were either grayed or omitted while 62.5% strongly disagreed with this.

***Table 7:*** *Recognition of the OTELS rather than recall*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 26 | On the *OTELS*, the display always starts in the upper-left corner of the screen | 0 | 0 | 8 | 100.0 |
| 27 | Different zones on the *OTELS* have been clearly separated e.g. by space or colour. | 0 | 0 | 8 | 100.0 |
| 28 | On the *OTELS*, colour coding is consistent throughout the system | 1 | 12.5 | 7 | 87.5 |
| 29 | On the *OTELS*, meaningful groups are clearly demarcated by borders | 1 | 12.5 | 7 | 87.5 |
| 30 | On the *OTELS*, inactive menu items are either grayed or omitted | 5 | 62.5 | 3 | 37.5 |

The data in Table 8 below shows that 25% of the respondents strongly agreed that there were accelerators on the *OTELS* for an expert learner while 75% strongly disagreed. However, 100% of the respondents strongly agreed that learners who frequently use the software could actually tailor their actions while using the *OTELS* (i.e. use certain shortcuts), 75% of the respondents strongly agreed that the *OTELS* did not require much time to load while 25% strongly disagreed. A total of 62.5% strongly agreed that it was easy to switch from one zone to the other on the *OTELS* while 37.5% strongly disagreed. In an equal proportion, 50% of the respondents strongly agreed that movement to and from different zones on the *OTELS* were quick while 50% strongly disagreed. This is an indication that the *OTELS* did conform to the heuristics guidelines in terms of flexibility and efficiency of use of the *OTELS* as stated by 62.5% of the total respondents.

***Table 8:*** *Flexibility and efficiency of use of the OTELS*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 31 | There are accelerators on the *OTELS* for an expert learner | 6 | 75.0 | 2 | 25.0 |
| 32 | Frequent users can actually tailor their actions while using the *OTELS* (i.e. use certain shortcuts) | 0 | 0 | 8 | 100.0 |
| 33 | The *OTELS* does not require much time to load | 2 | 25.0 | 6 | 75.0 |
| 34 | It is easy to switch from one zone to the other on the *OTELS* | 3 | 37.5 | 5 | 62.5 |
| 35 | Movement to and from different zones on the *OTELS* are quick | 4 | 50.0 | 4 | 50.0 |

In Table 9 below, we note that all respondents (100%) strongly agreed that every icon on the *OTELS* was visually distinctive and that each icon on the *OTELS* stood out from its background. Also, a total of 75% strongly agreed that on the *OTELS*, all icons were represented with large objects while 25% strongly disagreed. Similarly, 62.5% of the respondents strongly agreed that bold lines were used to distinguish all icons on the *OTELS* while 37.5% strongly disagreed. A total of 75% strongly agreed that menu titles were brief yet long enough to communicate while 25% strongly disagreed. This result indicated that the *OTELS* conformed to the heuristics guidelines with respect to aesthetic design as demonstrated by 82.5% of the total respondents.

***Table 9:*** *Aesthetic design of the OTELS*

| **S/N** | **Statement** | **SD** | | **SA** | |
|---|---|---|---|---|---|
| | | **F** | **%** | **F** | **%** |
| 36 | All icons on the *OTELS* are visually distinctive | 0 | 0 | 8 | 100.0 |
| 37 | Each Icon on the *OTELS* stands out from its background | 0 | 0 | 8 | 100.0 |
| 38 | On the *OTELS*, all icons are represented with large objects | 2 | 25.0 | 6 | 75.0 |
| 39 | On the *OTELS*, bold lines have been used to distinguish all icons | 3 | 37.5 | 5 | 62.5 |
| 40 | Menu titles are brief yet long enough to communicate | 2 | 25.0 | 6 | 75.0 |

As shown in Table 10 below, most respondents strongly disagreed that the *OTELS* conformed to the heuristics guideline with respect to error recognition and recovery within the software. This was shown where 37.5% of the respondents strongly agreed that all error messages on the *OTELS* were grammatically correct while 62.5% strongly disagreed. 50% of the respondents strongly agreed that all error messages on the *OTELS* avoided the use of violent words while 50% also strongly disagreed. On the other hand, a total of 75% strongly agreed that prompts were stated in brief on the *OTELS* while 25% strongly disagreed. Also, 87.5% of the respondents strongly disagreed with the position that all error messages on the *OTELS* suggested causes of problems while 12.5% strongly agreed. A total of 62.5% of the respondents also strongly disagreed with the fact that all error messages indicated action(s) a learner needed to take to make necessary corrections while 37.5% strongly agreed.

***Table 10:*** *Error recognition and recovery within the OTELS*

| **S/N** | **Statement** | **SD** | | **SA** | |
|---|---|---|---|---|---|
| | | **F** | **%** | **F** | **%** |
| 41 | All error messages on the *OTELS* are grammatically correct | 5 | 62.5 | 3 | 37.5 |
| 42 | All error messages on the *OTELS* avoid the use of violent words (e.g. “Beware” “Danger”) | 4 | 50.0 | 4 | 50.0 |
| 43 | On the *OTELS*, prompts are stated in brief | 2 | 25.0 | 6 | 75.0 |
| 44 | All error messages on the *OTELS* suggest causes of the problem | 7 | 87.5 | 1 | 12.5 |
| 45 | All error messages indicate action(s) a learner needs to take to make necessary corrections | 5 | 62.5 | 3 | 37.5 |

The data in Table 11 below, shows that 25% of the respondents strongly agreed that there was a help menu for a learner on the *OTELS* while 75% strongly disagreed. Also, 25% strongly agreed that the help menu on the *OTELS* was visible to a learner while 75% also strongly disagreed. A total of 25% of the respondents strongly agreed that a learner could resume work where he/she left-off after accessing help on the *OTELS* while 75% strongly disagreed. Similarly, 75% of the respondents strongly disagreed that the help keys were consistent with the interfaces of the application it supports while 25% strongly agreed. Also, a total of 75% of the respondents strongly disagreed with the position that it was easy to access the help menu on the *OTELS* while 25% strongly agreed. This implies that the *OTELS* did not conform to the heuristics guidelines with regard to help and documentation with the *OTELS* as demonstrated by the responses of 75% of the total respondents.

***Table 11:*** *Help and documentation within the OTELS*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 46 | There is a HELP menu for a learner on the *OTELS* | 6 | 75.0 | 2 | 25.0 |
| 47 | The HELP menu on the *OTELS* is visible to the learner | 6 | 75.0 | 2 | 25.0 |
| 48 | A learner can resume work where he/she left-off after accessing HELP on the *OTELS* | 6 | 75.0 | 2 | 25.0 |
| 49 | The HELP keys are consistent with the interfaces of the application it supports | 6 | 75.0 | 2 | 25.0 |
| 50 | It is easy to access the HELP menu on the *OTELS* | 6 | 75.0 | 2 | 25.0 |

In Table 12 below we note that 87.5% of the respondents strongly agreed that the *OTELS* allowed a learner free access to the learning materials while 12.5% strongly disagreed. In the same vein, 87.5% strongly agreed that the different zones on the software were easily accessible to a learner while 12.5% also strongly disagreed. A total of 12.5% of the respondents strongly agreed that a learner could access past records of practiced tests on the *OTELS* while 87.5% strongly disagreed. Furthermore, 87.5% of the respondents strongly disagreed with the position that other applications (e.g. calculator) were accessible to a learner on the software while 12.5% strongly agreed. The decisions of the teacher-educators on the position that the *OTELS* conform to the heuristics guidelines with regard to content accessibility within the *OTELS* was inconclusive, while 50% of them strongly agreed that the system does, the other 50% strongly disagreed.

***Table 12:*** *Content accessibility within the OTELS*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 51 | The *OTELS* allows learner free access to the learning materials | 1 | 12.5 | 7 | 87.5 |
| 52 | The different zones on the *OTELS* are easily accessible to a learner | 1 | 12.5 | 7 | 87.5 |
| 53 | A learner has access to past records of practice tests on the *OTELS* | 7 | 87.5 | 1 | 12.5 |
| 54 | Other applications (e.g. calculator) are accessible to a learner on the *OTELS* | 7 | 87.5 | 1 | 12.5 |

As shown in Table 13 below, respondents were also divided on their opinions about whether the *OTELS* conform to the heuristics guideline with respect to content design within the software. While 50% of the respondents strongly agreed, the remaining 50% strongly disagreed.This was demonstrated by 62.5% of the respondents who strongly disagreed that the organisation of the learning contents on the *OTELS* could ensure achievement of its primary objectives while 37.5% strongly agreed. Also, 62.5% strongly agreed that the vocabulary and terminology used in the *OTELS* were appropriate for the learners while 37.5% strongly disagreed. A total of 75% strongly agreed that on the *OTELS*, similar learning contents were arranged together while 25% strongly disagreed. On the question about whether there were formulas and illustrations throughout the *OTELS*, 75% of the respondents strongly disagreed with this, while 25% strongly agreed.

***Table 13:*** *Content design within* the *OTELS*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 55 | The organisation of the learning content on the *OTELS* would ensure the achievement of its primary objectives | 5 | 62.5 | 3 | 37.5 |
| 56 | The vocabulary and terminology used in the *OTELS* are appropriate for the learners | 3 | 37.5 | 5 | 62.5 |
| 57 | On the *OTELS*, similar learning contents are arranged together | 2 | 25.0 | 6 | 75.0 |
| 58 | Abstract concepts e.g. formulas, are illustrated with concrete examples throughout the *OTELS* | 6 | 75.0 | 2 | 25.0 |

As shown in Table 14, 62.5% of the respondents strongly agreed with the view that the *OTELS* included self-assessments that could advance learner's achievement while 37.5% strongly disagreed. Also, 25% of the respondents strongly agreed that in the test zones, every correct response given by a learner was positively reinforced, while 75% strongly disagreed. On the position that the *OTELS* provides sufficient feedback (audio) to a learner for corrective directions, the respondents were divided equally on their opinions. 50% of them strongly agreed while 50% strongly disagreed. 87.5% of the respondents also strongly disagreed with the fact that the *OTELS* provided a platform for teachers to evaluate learner's progress while 12.5% strongly agreed. This implies that *OTELS* did not conform to the heuristics guidelines in terms of learner's assessment within the *OTELS* as demonstrated by 62.5% of the respondents.

***Table 14:*** *Learner's assessment within the OTELS*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 59 | The *OTELS* includes self-assessments that advance learner's achievement | 3 | 37.5 | 5 | 62.5 |
| 60 | In the test zones, every correct response given by a learner is positively reinforced | 6 | 75.0 | 2 | 25.0 |
| 61 | The *OTELS* provides sufficient feedback (audio, video) to a learner for corrective directions | 4 | 50.0 | 4 | 50.0 |
| 62 | The *OTELS* provides a platform for teachers to evaluate learner's progress | 7 | 87.5 | 1 | 12.5 |

The data in Table 15 below, demonstrates that the *OTELS* did not conform to the heuristics guideline with respect to capacity of the *OTELS* to motivate users to learn; this was stated by 53.1% of the respondents. 25% of the respondents strongly agreed that the *OTELS* rewarded learner's action meaningfully through audio, video or animation while 75% strongly disagreed. 87.5% of the respondents strongly agreed that the *OTELS* made learning interesting to a learner while 12.5% strongly disagreed. Meanwhile, a total of 37.5% of the respondents strongly agreed that educational games on the *OTELS* are sufficient for a learner while 62.5% thought otherwise. Similarly, 62.5% of the respondents strongly disagreed with the idea that the *OTELS* stimulates the learner for further inquiry in different ways while 37.5% strongly agreed.

***Table 15:*** *Capacity of the OTELS to motivate a learner*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 63 | The *OTELS* rewards learner's action meaningfully through audio, video or animation | 6 | 75.0 | 2 | 25.0 |
| 64 | The *OTELS* makes learning interesting to a learner through content presentations | 1 | 12.5 | 7 | 87.5 |
| 65 | Educational games on the *OTELS* are sufficient for a learner | 5 | 62.5 | 3 | 37.5 |
| 66 | The *OTELS* stimulates a learner for further inquiry in different ways | 5 | 62.5 | 3 | 37.5 |

In Table 16 below, we note that most respondents strongly disagreed with the fact that the *OTELS* conforms to the heuristics guideline with respect to interactivity of the software. Although 75.0% of the respondents strongly agreed that the terminologies used in the *OTELS* ensured easy interaction with the *system*, 25.0% of the respondents strongly disagreed. Their positions on the submission that the system engages a learner through challenging learning activities were divided equally; while 50% strongly agreed with the submission, the other 50% strongly disagreed. Also, a total of 62.5% of the respondents strongly agreed that through functionality, the *OTELS* increases learner's confidence while 37.5% strongly disagreed. 75.0% of the respondents strongly disagreed with the statement that the *OTELS* ensured higher interactivity with the learner through immediate response while 25% strongly agreed.

***Table 16:*** *Interactivity of the OTELS*

| S/N | Statement | SD | | SA | |
|---|---|---|---|---|---|
| | | F | % | F | % |
| 67 | The terminologies used in the *OTELS* ensure easy interaction with the system | 2 | 25.0 | 6 | 75.0 |
| 68 | The *OTELS* engages the learner through challenging learning activities | 4 | 50.0 | 4 | 50.0 |
| 69 | Through functionality, the *OTELS* increases learner's confidence | 5 | 62.5 | 3 | 37.5 |
| 70 | The *OTELS* ensures higher interactivity with a learner through immediate response | 6 | 75.0 | 2 | 25.0 |

The responses of the participants are further illustrated in Figure 1 below.

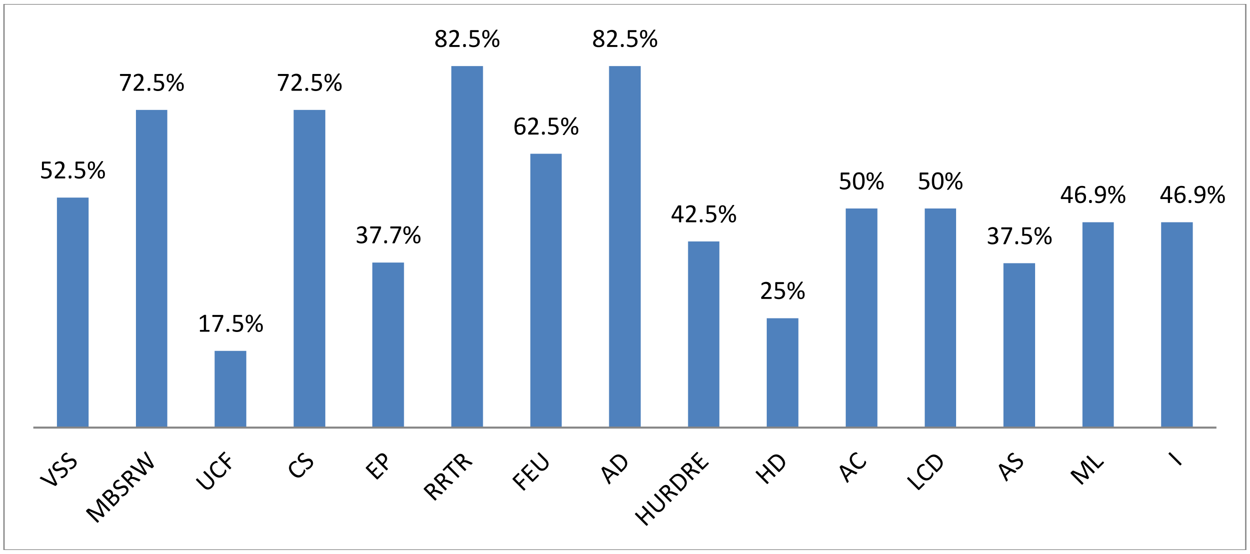


***Figure 1:*** Graphical illustration of experts' responses (strongly agreed) to the EUEQE

VSS =Visibility of *OTELS* status, MBSRW =Match Between *OTELS* and the Real World, UCF =*OTELS* Support for User Control and Freedom, CS =Consistency of the *OTELS* with Industry Standards, EP =Capability of the *OTELS* to Prevent Error, RRTR =Recognition of the *OTELS* Rather Than Recall , FEU =Flexibility and Efficiency of Use of the OTELS, AD =Aesthetic Design of the *OTELS*, HURDRE =Error Recognition and Recovery Within the *OTELS*, HD =Help and Documentation within the *OTELS*, AC =Content Accessibility within the *OTELS*, LCD =Content Design within the *OTELS*, AS =User Assessment within the *OTELS*, ML = Capacity of the *OTELS* to Motivate User, I =Interactivity of the *OTELS*.

Figures 2 and 3 below present screen shorts that illustrate different environments on the *Ọpón-Ìmọ̀* Technology Enhanced Learning System (*OTELS*).

*OTELS* home environment

Content environment with various subjects

***Figure 2:*** *OTELS* Home and Content Environment


Test environment    Test and report pages

***Figure 3:*** *OTELS* Test Environment

**Hypothesis Testing**

H1: No significant difference exists in the teacher-educators' evaluation of the *OTELS* based on area of specialisation.

***Table 17:*** *Teacher-educators' evaluation of the OTELS based on area of specialization*

| Teacher-educator | N | X | SD | Df | t | Sig | Remarks |
|---|---|---|---|---|---|---|---|
| Comp. Sci. | 04 | 180.75 | 25.02 | 6 | 0.48 | 0.65 | Accepted |
| Edu. Tech. | 04 | 171.75 | 28.19 | | | | |

From Table 17, it can be deduced that no significant difference exist between the teacher-educators' evaluation of the *OTELS* based on their area of specialisation. This was reflected in the result: t (6) = 0.48, p>.05. This implies that there was no significant difference between the evaluation of *OTELS* based on teacher-educators' (Computer science and Educational technology) area of specialization at 0.05 alpha level. The computer science teachers' evaluation was not significantly different from the educational technology teachers' evaluation. Thus, the hypothesis was accepted.

**Summary of findings**

1. The *OTELS* did not conform to most of the heuristics guidelines. Out of 15 heuristic guidelines, 7 of them viz. *OTELS* Support for learner's control and freedom, Capability of the *OTELS* to prevent error, Error recognition and recovery, Help and Documentation, Learner's assessment, Capacity of the *OTELS* to motivate learner and Interactivity of the *OTELS* were violated. Also, teacher-educators were equally divided on 2 of the guidelines viz. Content accessibility and Content design within the *OTELS*, while there was conformity with 6 of the guidelines - Visibility

of *OTELS* status, Match between *OTELS* and the real world, Consistency of the *OTELS* with industry standards, Recognition of the OTELS Rather Than Recall, and Flexibility and Efficiency of Use and Aesthetic design of the *OTELS*.

2. Area of specialisation did not have any significant influence on teacher-educators' evaluation of the *OTELS*.

**CONCLUSION**

Findings of this study have revealed that *OTELS* did not conform to most of the heuristics guidelines. Out of the fifteen (15) guidelines about which questions were raised, *OTELS* conformed to six (6). Seven (7) of the guidelines were completely violated while teacher-educators' opinions were equally divided on the remaining two (2) guidelines. It is instructive to note that the six guidelines to which *OTELS* conformed concerned its technical aspect. These are: the purity of icon colours, proper labelling of icons, consistency with industrial software standards, learners' ability to recognise the software icons and their functions, its flexibility, the use of popular terminologies and detect-ability of system status. They were all given priority. This is not surprising because these areas concern the outward appearance of the software which remains the unique selling points for most software developers of mobile applications.

However, the remaining four sections - the technical aspect, that is, *OTELS'* support for learner's control and freedom; Capability of the *OTELS* to prevent error; Error recognition and recovery; Help and documentation; and three sections dealing with the e-learning aspect of the *OTELS*, that is,Learner's assessment; Capacity of the *OTELS* to motivate learners; and Interactivity of the *OTELS* were neglected. This is a rather low point of the e-learning system in relation to its main objective. The system failed to ensure that probability of a learner committing errors was reduced. Even when errors were committed while using the *OTELS*, there was no help menu on the system for necessary corrections. Also neglected was the motivation aspect of the *OTELS*. Positive reinforcement has been found to have positive effects on students' performances at all levels (Adekeye, Aremu, &Ademuwagun, 2012); this was missing on the *OTELS*. In the test zone for example, no matter how brilliant a learner's performance in any of the subjects is; he/she receives no further reinforcement other than his/her test score. In terms of learner's assessment, although questions and answers on the *OTELS* were presented in clear language, there were no provisions to ensure proper records of the test so as to aid teachers, parents and even learners keep track of their academic progress. The results also revealed that *OTELS* does not support high interactivity with the learners; there were no accelerators for a frequent user on the software for them to tailor their use. The level of learner's control of the system is also low; for example, when a learner launches a programme and does not want to continue with it, he/she must wait for the programme to complete the process before exiting the environment. This does not ensure efficiency and has the potential to lead to user frustration.

In a different twist, on two sections of the usability guidelines, that is, content accessibility and content design, opinions of the evaluators were equally divided. In terms of content accessibility for instance, although some of the evaluators agreed that there were no hindrances to accessing the contents, others thought otherwise. This could be due to different levels of experience of the respondents with software applications. Some of them might have interacted with software in the past which allows quick access to content, while others might not have had the same experience. Also on content design, some of the evaluators agreed with the arrangement of the learning content while others felt the subject-groupings should be reviewed.

Also, as revealed by the findings of this study, teacher-educators' area of specialisation had no influence on the evaluation of the *OTELS.*Teachers across the two areas of specialisation (that is, Educational Technology and Computer Science) agreed on almost all items except for two categories where they were equally divided. Even on these, there was no influence of area of specialisation. The inference is that the involvement of teacher-educators from either of the two areas of specialisation would be valuable to future e-learning system designs and usability evaluation studies.

## IMPLICATION OF THE STUDY

The *OTELS* was introduced by the State Government of Osun for teaching and learning at the senior secondary school level in 2013, since then, its variants have been implemented by other governments and private organisations for different categories of learners. An empirical study such as this has implications for:

i. students and teachers who are primary users of the system at the senior secondary schools across Osun state;
ii. other entities who might be interested in implementing similar initiatives;
iii. researchers in the field of education; and
iv. State Government of Osun which is the initiator of the system.

## RECOMMENDATIONS

Based on the findings of this study, the following were recommended:

1. The government of the state of Osun should carry out a review of the *OTELS* in areas such as: *OTELS* support for learner's control and freedom, capability of *OTELS* to prevent error, error recognition and recovery within the software, help and documentation, learner's assessment, capacity of the *OTELS* to motivate learners and interactivity of the *OTELS* to ensure that the purpose for which the system was developed is realized.

2. Since it was discovered that teacher-educators' areas of specialisation did not have any significant influence on their evaluation of the *OTELS*, the Osun state government may endeavor to engage the services of either educational technologists or computer scientists in the development of subsequent versions of the educational software for usability testing before their eventual release for use by teachers and students.

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