

Chapter

Challenges of Usability of E-Solutions in Reimagining Education in Nigeria

Grace O. Aziken and Richard O. Oveh

Abstract

E-learning has been a main disruption in teaching and learning in the world, which has no doubt changed the narratives in the education sector. The advancements in the field of information and communication technologies have been a huge leap in the development of e-learning and presented a novel approach to education, with the switch from the conventional learning environment to transfer of knowledge online. During and after the COVID-19 pandemic it became imperative for more institutions of learning to adopt it. Despite the undeniable benefits of e-learning, usability has become the bane of its smooth implementation. This chapter highlights challenges associated with e-learning solutions and buttress the fact that usability will go a long way to give both teachers and learners a good user experience and give e-learning its pride of place in disruptive technologies. To successfully re-image education, more attention should be focused on ensuring usability of software solutions.

Keywords: education, COVID-19, e-learning, usability, user experience

1. Introduction

Education is key to improving productivity and overall development in any nation. This makes it mandatory that every nation invests in the education of its citizens. Also levels of education is a veritable tool to distinguish between developed and developing nations. The conventional environment for learning was a physical classroom, but with the introduction and advancements in Information and Communication Technology (ICT) electronic learning (e-learning) was developed [1]. E-learning is not a new concept, however it became popular during and after the COVID-19 pandemic when its implementation became a huge rescue to continue teaching and learning without physical contacts. Institutions at all levels were compelled to adopt e-learning or remote learning solutions in quick response to the lockdown during the COVID-19 pandemic. It is important to note that it has since become the trend even after the pandemic in most schools. Today, universities, other institutions of higher learning, secondary, primary, nursery and pre-Kindergarten schools and government agencies are investing in e-learning software solutions. Acceptance and adoption of ICT facilities among the populace has improved due to electronic methods of teaching and learning [2, 3] and this has enhanced the overall quality of teaching and learning.

This has also brought about a rapid increase in the number of available e-solutions for trainers and learners. E-solutions can be used outside conventional learning environments in distance learning, remote learning, personalized learning etc. and its many uses have led to a revolution of the education sector. Some of the tools that boost educational capabilities include the following modes of e-learning delivery; Distance Learning software systems, Learning Management System (LMS), Video conferencing apps (e.g. zoom and google meet) for teacher-student interaction and collaboration, real-time project co-editing, calendar scheduling, and auto-translation apps.

Studies continue to show a steady increase in demand for more suitable software solutions for learning despite the high number of available online learning tools in the market today, because the ones available have not adequately addressed the problem of usability in existing teaching or learning software solutions and in some cases both. This lack of user satisfaction with the e-learning solutions they have used or are currently using remains a recurring issue [4, 5]. The primary purpose of any e-learning solution is to aid learning, it is therefore expected that a software application developed for learning purposes must be enjoyable to use by both the trainers and learners for optimal utilization [6, 7]. Users should have a good experience with e-learning solutions for them to accept to and use it for its intended purpose. This is possible with customized e-learning solutions based on the peculiarities of trainers and learners so it is usable and give users satisfaction always. Developers of e-learning solutions should identify and understand the individuals (age, level of education, level of competency etc) to use the solution to achieve a successful customization. Some other factors that are necessary for consideration while developing the e-learning solution include the environment where the software is to be used and the ICT resources available for deployment of the developed solution.

1.1 Definitions of e-learning

The term e-learning can be described as synonymous to online learning, web-based training, internet based learning, distributed learning and net-based learning, and has been defined as a:

- Network or online learning that takes place in a formal context and uses a range of multimedia technologies. It is a learning system that is supported by electronic hardware and software either online (synchronous) or offline (asynchronous) [8].
- Multimedia based instruction, delivered using various instructional methods, which can be accessed by learners through their computers at their own will [9].

Electronic learning or e-learning is used by teachers, trainers or instructors to provide instructional programs for students at different locations. This form of learning is made possible by the availability of internet technology, tools like computers, laptops or smartphones, multimedia technologies and networks. It makes the following and more possible for both teachers and learners.

- Self-study by learners at any time and location
- Teachers are able to interact with and teach students outside conventional class environments

- Different skills can be acquired in various fields of study
- Customized and self-paced learning
- Communication with experts across the world virtually
- Accommodates more number of students for a lecture/class at the same time than is possible in physical classrooms
- Acquisition of world class education through access to lecture notes and tutorials on different topics from various international institutions
- Lectures can be recorded for future reference and replayed for recall.

1.2 Implementation of E-learning

1.2.1 E-learning pre-COVID-19 pandemic

E-learning was gradually gaining grounds before the pandemic as a necessity but there was no pressure to adopt this technology by institutions in the country. Most institutions adopting it were those of children and wards of elites. Institutions were encouraged to use it because of the associated gains but most schools could not due to the demands of technological advancements [10–12].

1.2.2 E-learning during e-COVID-19 pandemic

This period witnessed the implementation of several strategies to bridge the digital-divide in e-learning approach to teaching and learning [13]. Most institutions resorted to online classes for their academic programs while students used their devices to connect to online classes and listened to recorded teachings offline. Despite the economic hardship which became more severe during the pandemic, many parents/guardians of students who were willing to continue learning had no option but to procure computers, tablets, laptops and phones for their wards to join in the online classes and continue learning [14]. This crisis brought to the fore many areas of deficiencies and inequalities in education systems among which are lack of internet access and availability of devices for e-learning [15, 16].

1.2.3 E-learning post e-COVID-19 pandemic

After the pandemic, e-learning continued to gain ground and its implementation became more common at all levels of learning. However, due to poor maintenance culture and struggles involved in the acquisition of more recent facilities the use of e-learning systems has started dwindling and many institutions are adopting a mixed or blended learning system. There is a need to continue to emphasize the huge benefits that accrue from e-learning methods [10].

1.3 Why e-solutions in learning?

Many e-solutions exist for use in learning at different levels. The primary purpose of creating the various applications includes the following:

- to enhance learning
- customize learning
- make learning outside conventional environment possible
- give a wider coverage and provide alternatives sources of learning
- deliver learning solutions to learners doorstep

make teaching schedules more flexible and convenient for trainers

However, most software products still have limited usability as experienced in different scenarios when users have usability problem. When users encounter problems with software systems like e-learning systems, the following are likely to occur. They

- make mistakes at particular points or spots which is an indication that they do not understand that particular feature in the system
- take long time to complete a tasks and there seem to be no obvious improvements after a period of using the system
- need assistance to accomplish tasks with the system
- are reluctant to use the software

1.4 Challenges associated with using e-learning solutions

There are obvious challenges to the growth of e-learning technology in Nigeria [17]. Some of these include:

1.4.1 Lack of steady power supply

The epileptic nature of power supply in Nigeria is a hindrance to implementation of e-learning. Many parts of the country still struggle to have steady power supply and have to rely on secondary or alternative sources of power generation [18].

1.4.2 Poor economic status

The poor economic situation puts other sources of generating electricity out of the reach of many persons and institutions. A significant population of the nation live below poverty level which makes it difficult for them to the needs of their children and wards for optimal utilization of e-learning opportunities [19].

1.4.3 Lack of ICT infrastructure

The disparity in the availability of ICT facilities in some areas of the country especially rural areas continues to pose a great threat to the development of e-learning. Only a small percentage of the population in rural areas have access to computer and electronic devices for online learning [20–22].

1.4.4 Poor broadband penetration

Internet connectivity is required for e-learning activities among teachers and students [23, 24]. There is also limited bandwidth and challenges with internet connection making it difficult for learners to access online lectures real time and download materials like videos and lectures easily.

1.4.5 Training on how to use computer

Training teachers and learners on the use of different learning devices is not as well organized as it should due to limited access to devices. Many learners especially in primary and secondary schools use their parents' or older relatives, friends or neighbors phones for learning. It is evident that learners need more exposure to these devices to enhance their skills. Making it available and within reach will help train them more often and make them comfortable learning with them [25].

1.4.6 Lack of provision for learners with special needs

Students with special needs, disadvantaged backgrounds like states that have been victims of terrorists' attacks or those with Internally Displaced Persons (IDPs) have challenge utilizing e-learning technology. Some learners need special attention while learning and this lack of personal attention to these categories of persons make them unable to benefit much from the regular online learning [26, 27].

1.4.7 Lack of regular update training for teachers

Some teachers are not as knowledgeable in computer use as is required for online teaching, so they need further training. There is a need to conduct update courses for teachers to improve their skills and competency because students are adversely affected when the teachers lack the necessary skill for online teaching. Teachers who are involved in online teaching should not only have the know-how but enjoy using technology tools for students to be positively impacted by e-learning technology [28, 29].

1.4.8 Low computer literacy level among parents

Some children born in this computer age have parents that are not literate and some that are literate are not proficient enough in computer use to guide their children/wards on learning with computer. In most cases the students or learners are the ones who have to put these older ones through whenever they have difficulties working on their computers and devices. This makes it difficult for them to seek assistance when they encounter challenges using the device or the e-learning solution at home [30].

2. Usability of e-learning solutions

According to [31] usability often refers to how well users can use the functionality of the system. The ISO/IEC 25010 standard [32] defines usability as "the degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." It is a

software quality which includes the attributes of efficiency, effectiveness and user satisfaction. These three play a vital role in the evaluation of any software, including its usage, acceptance and sustainability.

Users' experiences with various e-learning solutions vary based on how these attributes have been built into the development of the software. Underestimating the importance of any of these attributes leads to a usability problem and an undesirable outcome like dumping the software solution, project failure, reduced productivity and crisis in organizations and poor learning experience [33]. User acceptance leads to a willingness to use a software solution to perform tasks for which it was developed and this helps improve productivity. Basically, usability depends on keeping users needs as a central focus in the design process (User Centered Design).

Gould et al. [34] highlighted four key principles of user-centered design. These include:

- Focusing early on users.

Identifying and understanding users' needs must be at the center of any successful software development project from the onset of the design process.

- Integrated design.

All phases of the design should be developed in parallel, instead of in sequence. The internal design of the product should be aligned with what is required for the user interface.

- Early and frequent testing.

The only currently possible method of software design is an empirical one. Integrating usability testing all through the development process gives users the opportunity to give feedback on designs before the release of the product.

- Iterative design.

It is necessary that designers and developers revise the design iteratively through rounds of testing. Iterative user-centered design (UCD) process can be applied to achieve good usability and User Experience (UX). The best-known UCD process is described in the ISO 9241-210 standard [35]. From the definition above, it is necessary to do the following in order to measure usability:

- identify a subset of the known group of users and involve them in the development project
- study the selected participants' situation and the problem they want to solve with the software product.

User Experience (UX) evaluations are vital for good usability, user studies and interaction design. The evaluations help to determine users need and the difficulties they encounter when using a system. Several evaluation methods exist for obtaining users' feedback to improve usability. Some of these methods are based on evaluation by UX experts and the commonest is usability testing with users, i.e. the actual end users perform typical tasks with the finished software product or a prototype.

Conventional methods can also be used in form of continual dialog between users and designers, where users are involved in the design process for example collaborative design workshops can be organized where users are allowed to formulate their own concepts/ideas or use scenarios.

It must be emphasized that developers are not typical users. They (developers) may be more knowledgeable in the technical aspect of the software development process but since they are not the actual users of the software product they must not assume that they know what the users want without robust interaction with them [36]. Software developers should empathize with the average user during the development of the software solution. Involving users early during software development improves interaction between developers and users and also fosters understanding among them while encouraging cooperation and ownership. It also gives the user a voice, thereby making them more willing to assist in the development process.

2.1 Attributes of usability

The definition of usability The ISO/IEC 25010 [32] listed three attributes of usability as effectiveness, efficiency and user satisfaction. The ISO 9241-11 standard [37] explains that this usability trio should be based on the context of use. These three and other identified components of usability are discussed below.

2.1.1 Effectiveness

The effectiveness of any software shows the usefulness of the software and the extent to which it solves users' problems. It can be measured as a percentage of the task completion with the software [33].

2.1.2 Efficiency

Efficiency addresses how a software solution solves identified problems and the ease of use of the application. In software engineering, it involves ensuring that the job gets done with less effort and not more than expected resources. Two metrics that can be used to measure efficiency are speed and interactiveness, which shows the time taken by a user to complete a task and the number of clicks required to perform an activity [38].

2.1.3 User satisfaction

A software solution that does not solve users problem to their satisfaction is considered a failure. If it solves the problem but it is difficult to use or the user experience is poor then the usability of that software is adversely affected and user satisfaction will not be achieved. Satisfaction with a system is a measure of how pleasing it is to use. The style of the design must meet the needs and expectations of the users. Subjective satisfaction can be evaluated through UX questionnaires [39].

2.1.4 Engaging

The interface of any online learning application should be engaging and exciting to use. The visual design and choice of colors are things that easily attract users attention and influence their preferences (especially on web sites) in a software solution [40].

2.1.5 Error tolerance

An error tolerant program is designed to prevent errors that occur from the user's interaction with the system [41] and to help the user recover from errors when they occur. An error tolerant system must be forgiving thereby allowing users to undo actions executed but not deemed necessary again or performed in error-back tracking.

Nielsen's usability definition however divides usability into five elements (attributes) which can be measured and used to specify usability objectives. They include efficiency, memorability, learnability, errors and satisfaction (**Figure 1**).

2.1.5.1 Learnability

Software systems should be easy to learn if users must have a good first impression of a system. Any experience contrary to this expectation will make users reluctant to return to the system. Not only experienced but novice users as well must be considered when designing to give users good experiences from a software system [42, 43].

2.1.5.2 Efficiency

Some users do not need to learn to use a system fully, they are satisfied by just learning its basic functionalities. Simplicity in interaction and visual design can make a user interface (UI) more efficient [44].

2.1.5.3 Memorability

Memorability measures how well users remember the different functions in a system after they have learned them. Sometimes even when the system has not been in use for some time, it is still possible to remember the functions when a system is designed with memorability in mind [43].

Simplicity and clarity reduces the number of possible errors users make while using a system. When a system is well understood, possibility of errors occurring is reduced. Errors are functions performed by a user which does not lead to the desired

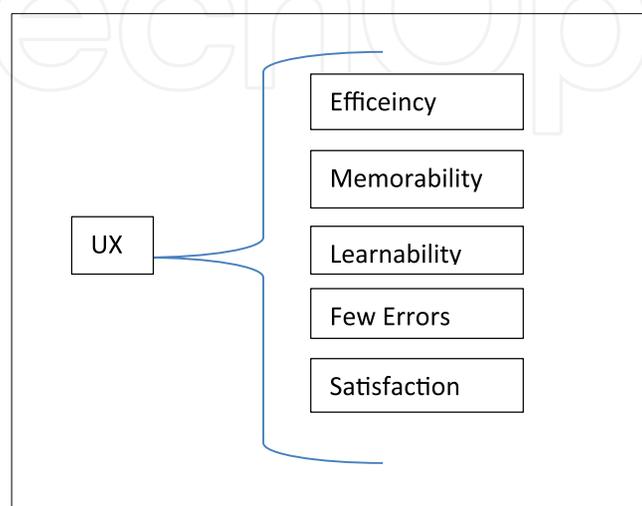


Figure 1.
Jacob Nielsen's usability attributes.

results. Error frequency of a system contributes significantly to the measurement of the effectiveness of that system [43].

2.2 User experience

Usability is a key aspect of the UX [45]. The concept of UX is currently gaining more ground in the software industry. It covers the totality of users impression about a software application, all aspects of user interaction, from their sensations, emotions and affects to the characteristics of the developed system and the environment where the interaction takes place [46] and opinions, trends, brand/image and social value [47]. Hence, the involvement of end users is imperative to achieve success in UX design process.

According to ISO standard (9241-210) [35], UX is “a person’s perceptions and responses that result from the use or anticipated use of a product, system or service”. There are various important tools which can be used to explain the concept of UX design to users. One of these resources is the user experience honeycomb by Peter Morville, a designer and information architect. He started with a diagram of three circles which he used to represent the link between (1) user needs and behavior (2) business goals and context and (3) content (**Figure 2**) [48].

Each application will be different based on the balance between context, content and users. Keeping all of these points in mind makes it easier to define priorities. This is also essential for helping companies break down tasks in order to formulate a strategy toward an end goal.

Consequently, it became necessary to come up with a better diagram that showed an in-depth explanation of user experience design, this led to the development of the user experience honeycomb. The user experience honeycomb is a tool which helps to explain the various facets of user experience design. A focus on the UX honeycomb will enable stakeholders identify the most important areas of user experience and begin the project by plugging away at the high level priorities, thus over time allowing the software solution to completely redefine the user experience remarkably.

Figure 3 shows seven items that comprise Peter Morville’s UX illustration of the facets of user experience design [48]. They include:

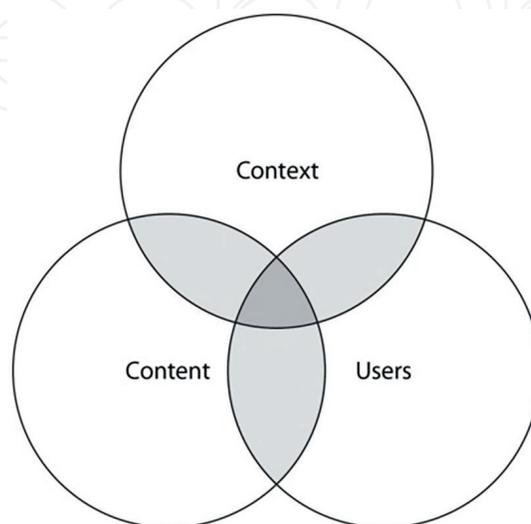


Figure 2.
Peter Morville concept of UX.

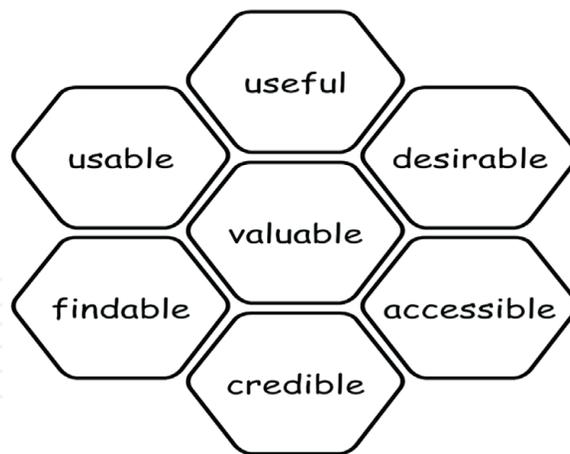


Figure 3.
Peter Morville's UX illustration of the facets of UX.

2.2.1 Usable

The system should be designed based on users peculiarities in order for them to understand it and not be alienated from the system. It should also be simple and convenient to use. Target users should be the central focus throughout the design process so the system will be suitable for use and address their needs.

2.2.2 Useful

The system should be designed to address users' problems instead of wasting their time, as this is the only way the software system will be useful to them.

2.2.3 Desirable

The visual esthetics of the system should be attractive to users and easy to translate. Design should be straight forward and appealing to the users for whom it was developed. This will make them to be willing to use the software application regularly.

2.2.4 Findable

Information should be easy to locate and there should be no difficulties navigating the interface. It should be possible to resolve users' problem easily and quickly. User Interface (UI) should not task software users to think beyond the problems they want to solve with the system to be bothered with technicalities of the design.

2.2.5 Accessible

The system should be designed for all categories of users to have the same user experience as others. A situation where experienced and novice users have different user experience with a system makes the system not accessible to all.

2.2.6 Credible

The system should work as the developer agreed with the users. This will make the users to have a good first impression and trust in the software product.

In refs. [11, 49] characterized the standards related to usability as follows:

1. The use of the product (effectiveness, efficiency and satisfaction)
2. The user interface and interaction.
3. The process of developing the product.
4. The ability of an organization to apply user-centered design.

3. Challenges of usability in e-learning solutions

Despite the numerous e-learning applications in use today, there is still demand for innovative software solutions for online teaching and learning. Some of the reasons for the dissatisfaction by users are:

3.1 Diverse learning needs

Different learners have varying learning styles and preferences hence different expectations from e-learning systems, which the existing systems have not adequately catered for in the available systems [50].

3.2 Technological advancements

Trainers and learners expect e-learning systems to incorporate functionalities and features of emerging technologies to e-learning systems to improve learning outcome. Some of these latest technologies are Virtual Reality, Artificial Intelligence and Gamification [51].

3.3 User experience and engagement

To provide an engaging and intuitive user experience should be the focus of any successful e-learning system development. Users should enjoy their learning experience and this is the way to fulfill this desire of users [52, 53]. Many e-learning systems are short-lived and lead to waste of money and effort because they do not meet usability standards.

3.4 Learning efficiency

A well designed e-learning solution should provide simple and straightforward pathways for efficient interaction. The UI should not be cluttered or busy as this will increase learners cognitive load [54].

3.5 Accessibility and inclusiveness

E-learning systems should be accessible to all categories of users including those with special needs. Involving them in the development or acquisition of the software solution will help ensure usability [55].

4. The way forward

Adopting innovative pedagogies is non-negotiable for online education delivery to have the desired reaching effect on both teachers and learners and boost productivity in any institution. Finding solutions by focusing on pedagogical issues and laying greater emphasis on case learning, collaborative learning and project-based online instructions can go a long way. However, Governments must put in the requisite effort necessary to reduce the gap in online education delivery by addressing the identified and obvious challenges in the face of economic inequalities.

Reimagining Education is a clarion call for stakeholders in education sector and Information Technology (IT) experts. E-learning has redefined teaching and learning and has proven to be more beneficial when usability is considered in the development of software solutions for online teaching and learning activities. To ensure usability of an e-learning solution, the following are suggested. It should

1. Personalize capabilities based on profiling of users of the system
2. Have an intuitive interface
3. Have a concise documentation of the system platform
4. Be easily accessible from any device.

E-learning solutions should be built to suit different users based on their preferences. User studies is therefore recommended to enable good teaching experience and learning journey.

5. Conclusion

Use of digital learning solutions in learning and teaching is commonplace in the Education sector today and there is a wide variety of digital learning solutions. Usability is a key element in successful software development project. When the actual users of a software product are not known, understood and involved in the development of the solution, the development project will result in failure. Ensuring the technical usability of a learning solution enables users to focus on their main task, learning. It is advisable to ensure a level of technical usability for devices and software used for educational purposes. There should be a basic level of technical usability so that learners can focus on learning rather than encountering problems from the technology.

The role of e-learning, creativity and technology cannot be over-emphasized in the development of successful and sustainable online solutions for teaching and learning in today's post pandemic era. Creativity is critical for the design of a software system that will be usable and useful to teachers and students. Interacting with and understanding target users of a software product during requirements gathering and subsequent phases help in idea generation for enjoyable products. Usability is achieved when necessary consideration is given to these issues and this will lead to the desired improvement in e-learning technology and increase in its uptake.

Abbreviations

ICT	Information and Communication Technology
LMS	Learning Management System
UCD	User Centered Design
UX	User Experience
IT	Information Technology

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