Development of an Interactive Web-Based Assessment Platform for Integration in the Smart Basic Education Schools in Enugu State Nigeria.

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Abstract

This study titled "Design and Development of an Interactive Web-Based Assessment Tool (IWBAT) for Integration into Smart Basic Education Schools in Enugu State, Nigeria" focused on the educational technology area of study, with the objective of developing a digital platform to enhance assessment efficiency, transparency, and security in basic schools. The study sought to answer questions on how an interactive web-based system could improve assessment delivery, feedback, and learner motivation. It adopted a research and development (R&D) design following the Instructional Design Framework, with a population comprising teachers and students from selected Smart Basic Education Schools in Enugu State. A purposive sampling technique was used to select the study sample. The instrument for data collection was a structured questionnaire validated by experts in educational technology and measurement and evaluation, while the reliability of the instrument was established using Cronbach Alpha, yielding a coefficient of 0.87. Data were collected through needs assessment and user testing and analyzed using mean and standard deviation to answer the research questions. Findings revealed that the developed IWBAT met the specified requirements, enhanced exam security, provided instant feedback, and improved assessment efficiency and fairness. Based on the findings, it was recommended that the IWBAT be adopted across Smart Basic Education Schools to promote digital transformation, secure assessment practices, and improved learner performance.

Keywords: Interactive Web-Based Assessment Tool (IWBAT); Smart Basic Education Schools; Digital Assessment; Educational Technology; Assessment Efficiency; Exam Security; Instructional Design Framework; Enugu State, Nigeria.

Introduction

The advent of the Fourth Industrial Revolution is introducing developments in Artificial Intelligence, Internet of Things, and other technologies in different sectors of our society, including education. This reality leads to a paradigm shift in which web-based cyber-physical environments will shape future learning environments making learning to become ubiquitous, and schools assuming new roles with systemic changes in communication, administration and management. The use of technologies aligned with pedagogical strategies and new methodologies leads to more-personalized smart learning systems (Eden, Onyebuchi & Adeniyi 2024). The landscape of smart learning systems

has witnessed this tremendous shift from the traditional system of learning to smart education. Smart education also known as digital education or e-learning is an emerging learning environment that advocates the necessity for learners to learn in real-life situation technologies (Gros, 2016, Spector, 2014). With the help of cutting-edge real-world technologies like artificial intelligence, virtual reality, and the internet of things, smart education can accomplish its objectives of teaching, learning, research, and learning assessment while becoming more individualized, interactive, and accessible (Ray 2016). As stated by Zhu et al. (2016), the idea of "smart education" is based on two categories of technology: intelligent technologies and smart devices.

Smart devices represent those electronic devices connected to other devices that can operate independently and interactively to a certain extent in classroom instructional and learning contexts (Cao & Liu 2020). They are emerging instructional and learning tools such as flipped classroom, mobile apps, clickers' devices, interactive multimedia, audio devices, internet, telephone and VoIP, mobile gadgets, instructional television, computer games, teaching machines, interactive whiteboards and programmed instruction, etc., Rodríguez, Olatz, Ana, José, & Néstor, (2020), with computing capacity and sensing function, which play a vital role in the classroom to create effective teaching and learning. There is a growing body of literature that recognizes the importance of smart devices use in the classroom settings (Cao & Liu 2020; Li, Wang & Ruan 2016; Bédard, Lison, Dalle, Côté, & Boutin, 2012). For example, Bédard, et al (2012) maintained that Smart devices are those latest technologies or devices and concepts used in classroom among students to students and students to teacher interaction. These tools have been making an increasing impact on the classroom and individualized instruction. Also, these tools have been used in science as an effective way of communicating ideas and concepts to students and have greatly improved students' performance especially those with special needs and slow learners (Pardo-Baldoví, San Martín-Alonso, & Peirats-Chacón, 2023). It has also been pointed out in (Stepanyuk, Mironets, Olendr, & Tsidylo, 2022) that the knowledge, skills and use of these smart instructional tools, can enable the teacher to perform some activities that most scientists employ to describe, predict and control the world around them. However, with the researchers' in-depth views of smart devices' working mechanisms in educational settings, the concept of "smart" in smart devices are not are not independent of intelligent technologies.

Intelligent technologies which have been categorized according to Ray (2016) on the basis of Internet of Things technology are used just like smart devices to create, analyze and personalize educational activities in an intelligent learning environment. According to Ikechukwu and Amos

(2023), an intelligent learning environment comprises both smart devices and intelligent technologies to give room to a more personalized form of educational activities in smart educational landscapes. Smart schools are few examples of smart educational landscapes.

Smart schools are learning institutions that have been systemically reinvented in terms of smart teaching-learning practices and school management using smart devices and intelligent technologies to prepare smart students for the Information Age (Recalde, Palau, Agustí & Cebrián 2021). According to the authors, smart schools are institutions that integrates technology to enhance education, leading to personalized and improved learning. Current research on smart schools explores the integration of technology to enhance education, focusing on areas like personalized learning, online learning, and the use of technology for administrative tasks, while also examining the challenges and ethical considerations of implementing and leveraging such systems (Khan, Abbas, Alruwaili, Nazir, Siddiqi, &Alanazi, (2024). Research investigates how implementing and leveraging technology and AI, can enhance personalized learning experiences, focusing on increased engagement, improved student outcomes, and providing teachers with data-driven insights to better tailor instruction (Ayeni, Al-Hamad, Chisom, Osawaru & Adewusi 2024). Findings from Caroline, Oroh and Pada (2023) on the effectiveness of online learning platforms and the impact of technology on student engagement and learning outcomes, also revealed that learning experiences, facilitated by smart school technologies, can lead to significant improvements in standardized test scores. On smart classroom, the authors explore the use of interactive whiteboards, educational apps, and other technologies to create engaging and dynamic learning environments and reported that teachers can use these smart technologies to provide targeted interventions and support to students who are struggling, leading to improved learning outcomes.

Apart from enhancing teaching and learning, Ayeni et al (2024) stated that these smart technologies can help in streamlining administrative tasks, such as attendance tracking, grade management, and resource allocation, freeing up educators' time for teaching and student support. Smart schools use technology to also facilitate communication and collaboration between teachers, students, and parents, creating a more connected and supportive learning community. Smart schools also explore the use of data analytics to monitor student progress, identify areas for improvement, and make data-driven decisions about teaching and learning.

In Enugu State Nigeria, Smart schools project has been inspired by all of these key areas of current research on smart schools as well as similar projects undertaken by other countries of the

world (Attarana, Aliasb & Sirajc 2012). For example, Enugu State proposed the idea of smart schools in 2023 and it became operational in 2024. This was to improve current activities of smart school and attempts to provide a standard framework for development of smart education in the state. In addition, one of the major concerns was also to balance education facilities in rural areas and urban areas in order to reach educational justice. Reaching educational justice in this regard involves integration of sustainable IT infrastructures in both the rural areas and urban areas schools. By sustainable IT infrastructure we refer to the integration of physical systems and technologies that has different roles in the school system from facilitating teaching, learning, assisting the school management to assess students' performances in a smart and effective way (Shahzad, Walke, Dahat &, Kurmi 2023).

Assessment of students' performance is an essential part of educational practice, as it allows the measurement of the achievement of learning objectives by students, and improves the quality of the instructional needs and curricula (Arnold 2022). Assessment is the systematic collection, review, and use of information about students' knowledge, skills and attitudes for the purpose of improving learning. (Palomba & Banta, 1999). It is one of the processes of measurement that leads to the appraisal of a good outcome from methods of teaching and learning in a school's curriculum. It is also part of the curriculum implementation process, the essence of which is to ascertain what has been learned by the students within a stipulated period and at a certain level of education (Ohamobi, Manafa, & Osegbue 2020). According to Phakiti and Steinhoff (2023) students' assessment is the process of administering tests, observation, or exams to the students to find out what they have learned from what they were taught. Similarly, assessment is an important stage of curriculum implementation, as it provides evidence of what students have learned and ensures that teaching and learning outcomes can be measured (Mbiriyakura & Kasowe, 2022). This concept has undergone significant evolution over the past few decades, moving from an isolated activity taking place at the end of the learning process with the only purpose of giving a mark to the student to a continuous and systematic process directed toward making decisions for the improvement of the educational practices (Joshi, 2019). Considering the aims and the way assessment is administered, Hassan, Tomalá, Coello, Silva (2024) maintained that assessment encompasses two broad spectrums of method - formative and summative.

Literature Review

Smart Basic Education Schools in Nigeria

The literature shows the terminology of 'smart school' has been used in limited countries but most others use these terms: 'ICT usage in schools' and 'ICT integration in schools'. This research has defined a new term as 'smart school system', which refers to all components of the smart schools including technology, people, process and education material.

Smart school is a learning institution that has been systemically reinvented in terms of teaching-learning practices and school management in order to prepare students for the Information Age. Information Technology or IT, as an important pillar of smart school system, has different roles in the system from facilitating teaching and learning activities to assisting the school management. The aim of the review is to investigate the smart school activities in Nigeria in order to propose an IT framework for improvement of the smart school system in Enugu State Nigeria. Although in recent years some efforts have been done for developing smart schools in Nigeria, there is still no comprehensive solution for development of smart school system to be referred.

The smart school project in Enugu State Nigeria has been inspired by a similar project undertaken by the Malaysian Ministry of Education (Attarana & Sirajc, 2012). For example, in Malaysia, the idea of smart schools was proposed in 1997 and became operational in 1999. According to Research objectives and significance of the study are discussed for a smart school to achieve its educational objectives, these teaching and learning concepts. The researcher hopes this study will help Ministry of Education of Nigeria to improve current activities of smart school and attempts to provide a standard framework for development of smart school. In addition, one of the concerns is to balance education facilities in rural areas and urban areas in order to reach educational justice in Nigeria. The status quo of smart schools in Nigeria was examined and lack of IT infrastructure standard for smart school systems was addressed. According to research by Ali, Zah, & Nor (2010), the biggest issues teachers encountered when integrating ICT in Malaysian smart schools were time, course content, and technical issues. Mahmoudi, Nalchigar, & Ebrahimi (2008), discovered that the traditional structure of Nigerian schools and the absence of relevant rules and regulations in the Ministry of Education were the main obstacles facing the country's smart schools.

Teachers and students in Nigerian smart schools do not have a positive attitude toward teaching and learning, according to Attarana and Sirajc (2012). Additionally, their study's findings showed that in order to improve the effectiveness of smart schools, more equipment should be given

to educational institutions, and teachers should take advantage of additional training opportunities and ICT courses in addition to receiving rewards for their involvement. However, the smart school project in Nigeria's Enugu State was started in 2023 and was based on the Malaysian model. In 2024, the state Ministry of Education carried out the project's pilot phase, converting 260 wards' worth of schools into smart schools. This project seeks a Master Plan which was chosen by education institution for development of ICT in Education. In fact, officials of Education gradually came to a deeper understanding of global developments and the role of ICT in development (Attarana, 2012). This led to the development of ICT in this phase as a general direction taken by the managers of education. In 2024, the road map of smart schools which was developed by the Enugu state Ministry of Education, have been mentioned as one of the key requirements of knowledge-based societies through the development of knowledge and entrepreneurial skills of students in these schools.

Objectives and activities of the schools are based on the Enugu State smart school but the sub structure are not different from what is obtained in other advanced countries. The project was expanded to other school districts after "The Road Map of the Smart Schools" was published in 2024. The project appears to be based on the implicit premise that, like in many other nations, ICT integration will become commonplace if schools are outfitted with computer hardware Ming, Hall, Azman, & Joyes (2010). "Financial investments for the educational use of ICT had not been in line with high expectations," according to the Second Information Technology in Education Study (SITES). According to previous sections, this research attempts to provide a framework for ICT infrastructure of smart school in relation to assessment of students' performance.

Assessment in Education

In order to evaluate curriculum, school quality, and system performance, as well as the quality of teacher instructional activities and student learning experiences, assessments are essential. Assessments serve as a tool for summative accountability evaluations of educators, educational institutions, and government agencies as well as for formative improvement of instruction and learning. Given its immense power, it would seem beneficial to have a more nuanced understanding of its past, present, and potential. The researcher start this overview with a quick historical tour that starts with assessments from the past three millennia and continues into the future, which is already happening in a variety of settings.

Between 2,500 and 3,000 years ago, the Chinese Imperial examination system was first documented (Gare, A. 2012). In the vast Chinese empire, that system was used to find and reward talent wherever it was found. It was intended to find students with high levels of literacy and memory

skills meritocratically so they could run the Emperor's bureaucracy of command and control over a sizable population, as opposed to depending only on recommendations, bribery, or nepotism. The system used standardized tasks to accomplish those objectives (e.g. G. finishing an essay in accordance with Confucian principles) under monitored conditions to guarantee performance comparability and integrity (Feng, Zhang, & Li 2022). The system consisted of a graduated sequence of tests that got harder and harder until nobody could receive the highest grade at the end since it was only given to the Emperor. In addition to receiving jobs with significant financial benefits, successful candidates were also publicly recognized on examination lists and granted the ability to wear particular colors or badges that indicated the level of examination they had passed. These factors were part of the justification for this extensive technology. It should come as no surprise that there was a thriving industry of creating cheat materials given the enormous prestige and potential for social advancement through scholarship. G. tiny books that imitated classic Confucian texts) and identifying dishonest people (e.g. G. groups of invigilators sitting in tall chairs with a view of the desks where candidates worked (Elman, Benjamin, 2013).

The literary and oratory remnants of the Roman Empire, such as schools of grammarians and rhetoricians, on the other hand, gave rise to European educational assessment, according to Britannica (2010). Schools were established simultaneously in a number of European cathedrals, monasteries (particularly Benedictine monasteries), and episcopal schools. Church priests were expected to learn Latin under Charlemagne in order to properly interpret the Bible, which resulted in more sophisticated academic and religious instruction. As early Renaissance European society evolved, schools were established under the direction of a Bishop, cathedral official, or even from non-religious guilds to individuals judged sufficiently qualified to instruct. To guarantee safe travel and freedom of thought, these schools granted their teachers and students certain rights and protections. Many of the clerical practices of reading significant texts and scholars assessing the quality of learning by comparing student performance in oral disputes, debates, and arguments to the opinions of higher ranked experts were adopted by European universities in the 1100s (de Ridder-Symoens 1991). In the centuries that followed, oral disputes were supplemented with written assignments and performances to assess the caliber of learning outcomes. However, as with the Chinese Imperial system, evaluation was predicated on the knowledge and discretion of more senior academics or officials.

These systems were established to satisfy the demands of either society or religion for numerate and literate scholars, bureaucrats, and thinkers. Further education, or even basic education, was typically a scarce and rationed resource. Standardized tests were used to choose applicants in a

largely meritocratic manner, even if they were just the procedure and not the task or scoring. Students and families participated in these processes because a successful education offered them hope of escaping hard labor and poverty. As a result, schooling served as preparation for the final exam, assessments during the schooling process were merely imitations of final assessments, and assessment was essentially a summative evaluation of the student's abilities.

More effective ways to reduce the workload associated with hearing memorized recitations were sought after as schooling and higher education expanded throughout the 1800s Britannica (2010). As a result, leaving exams were made a prerequisite for admission to learned professions (e.g. G. teaching), the public sector, and higher education. More effective methods of gathering information were developed as more students attended universities in the 1800s, particularly the essay exam and the practice of responding in writing without assistance. As students finish their written exam papers under time pressure and scrutiny using multiple-choice test methods, this tradition is still evident in the well-organized rows of desks in exam rooms. Due to this factor, standardized machine-scored tests have become more and more common throughout the century for graduate school admission, university admission, and even school evaluation. The process by which items are scored in two ways (i.e. e. whether correct or incorrect), statistical modeling in classical test theory produced simple and recognizable numbers (e.g. G. standard error of measurement, reliability, mean, and standard deviation; (Clauser 2022). In order to guarantee the validity of scores and their interpretation, validation techniques have become more intricate and multifaceted as the 20th century has gone on, and the concepts of validity have expanded (Zumbo, & Chan (2014). Among these were item response theory, factor analysis, scale reliability, equating, norming, and standard setting (Kline, Saggio & Sølvsten 2020). It is important to note that statistical techniques for analyzing test results originated in the early days of psychology. The field of educational testing started to resemble statistics more and more as psychometric techniques grew more sophisticated. In fact, according to Hallquist, Wright, & Molenaar (2021) psychometrics (i.e. e. statistical assessment of psychological phenomena) was becoming disconnected from psychology, which was the field most likely to use psychometric research and methods. It's interesting to note that although assessment is widely used in the educational field, few teachers are proficient in the statistical techniques required to evaluate their own exams, let alone those administered by central authorities. It is true that very few teachers receive training in statistical test analysis techniques, even fewer comprehend them, and nearly none apply them.

Assessment is, of course, more than just a series of questions or a scored task. It is a valid attempt to operationalize a sample of a curriculum domain, construct, or content. The difficulty with

assessment stems from the paradox that the content that is easiest to test and grade is typically the least demanding or valuable in any field. Learning objectives for Nigerian Junior and Senior Secondary Schools (JSS 1–3 and SSS 1–3) education and even more so for higher education, demand that students do more than simply memorize and repeat lists of terms, facts, or data points. Deep processing requires the recall of specific data pieces, but this is insufficient. Pupils must demonstrate critical thinking, creativity, problem-solving, analysis, and synthesis. Evaluating these abilities is very challenging and complex. However, it is simple to reduce society's valued goals to that when it is necessary to show that teachers are effective and that schools are accomplishing society's goals and purposes. As a result, the high-stakes exam is used as the curriculum in many societies. This would not be such a bad thing if we could be certain that the test's content reflected what society actually desired; this is known as measurement-driven reform, as defined by Resnick and Resnick (1992). However, studies conducted over long periods of time since the mid-1900s have demonstrated that a large portion of the material we test does not improve students' learning (Nichols and Harris, 2016). Scriven (1967) work on the philosophy and principles of evaluation was a significant development in the middle of the 20th century. The difference between formative evaluation, which occurs early enough in a process to influence its end points, and summative evaluation, which establishes the quantity, caliber, and merit of the output of the process, was one of the evaluation's most potent features, according to him. In education, the concept of formative evaluation was swiftly adopted to describe assessments that teachers used in the classroom to determine which students needed to learn what next (Bloom et al. (1971). High-stakes end-of-unit, end-of-course, or end-of-year formal exams that evaluated the caliber of student learning and achievement in a summative manner contrasted well with this. Scriven's formative evaluation led to the use of assessment procedures early in the educational course of events to inform students about what they needed to learn and teachers about what they needed to teach, whereas assessment as psychometrically validated tests and examinations historically focused on the summative experience.

However, the distinction between formative and summative has changed from one of timing to one of type since the late 1980s (thanks in large part to Sadler, 1989). Formative assessments were initially limited to classroom interactions that were informal rather than formal tests. Torrance (2012) expanded on this viewpoint by establishing the fundamentals of formative assessment globally.

This study utilized the R&D (Research and Development) design. According to Gustiani (2019), Research and Development (R&D) design by Gall, Gall and Borg is the investigational activities

conducted to improve existing products and procedures or to contribute to the development of new products or procedures. This study considered the R&D design as suitable because it intended to develop an interactive web-based assessment tool (IWBAT) for integration in the smart basic schools to assess students learning outcomes.

System Design and Implementation

The data collected for this research question is presented in Table 1 based on software requirements specifications for the development of the Interactive Web-Based Assessment Tool (IWBAT)?

Table 1: Mean responses on the Software Requirement Specifications for the development of the Interactive Web-Based Assessment Tool (IWBAT).

N=39

S/No	Items	X	SD	Remarks
1	Web-based Assessment Software	3.98	0.16	Required
2	64 Bit Operating System	3.75	0.44	Required
3	32 Bit operating System	3.58	0.47	Required
4	PHP Software	3.69	0.47	Required
5	Database for creating User account	3.83	0.39	Required
	Overall mean	3.77	0.46	Required

Table 1 showed the result of the software requirement specification analysis of the Interactive Web-Based Assessment Tool (IWBAT). All the items (1-5) had mean scores ranged from 3.58 which are above the cut-off point of 2.50 indicating that the items are required specifications for the development of the Interactive Web-Based Assessment Tool (IWBAT). The standard deviation score ranged from 0.16-0.72 indicating that the responses are not divergent.

Research question 2: To what extent is the architectural design appropriate for the development of the Interactive Web-Based Assessment Tool (IWBAT)?

Table 2 showed the result of the extent the architectural design is appropriate for the developed Interactive Web-Based Assessment Tool (IWBAT). all the items (1-5) had mean scores ranged from 3.65-3.80 indicating that the items are highly appropriate for the developed IWBAT

Table 2: Mean responses on rating how appropriate are the architectural design of the developed IWBAT.

N=39

S/No	Items	X	SD	Remarks
1	Architectural flow diagram of the IWBAT	3.80	0.46	Highly Appropriate
2	User Interface Design of the IWBAT	3.60	0.44	Highly Appropriate
3	USE Case View of the IWBAT	3.80	0.46	Highly Appropriate
4	Technical design of the IWBAT	3.65	0.46	Highly Appropriate
5	Quality verification and validation	3.70	.46	Highly Appropriate
	Overall Mean	3.71	0.46	Highly Appropriate

Table 2 showed the result of the extent the architectural design is appropriate for the developed Interactive Web-Based Assessment Tool (IWBAT). All the items (1-5) had mean scores ranged from 3.65 – 3.80 indicating that the items are highly appropriate, and the architectural design is highly appropriate for the development of the IWBAT. The standard deviation score ranged from 0.44-0.46 indicating that the responses are not divergent.

Research question 3: To what extent does the developed Interactive Web-Based Assessment Tool (IWBAT) conform to the architectural design that guided the development?

The data collected for research questions 3 was presented in Table 3 based on the extent of conformity of the IWBAT to architectural design.

Table 3: Mean responses on rating the extent of conformity of the developed IWBAT to architectural design

S/No	Items	X	SD	Remarks
1	Facial Recognition	3.95	0.22	Excellent
2	Student Identification	3.70	0.46	Excellent
3	Identification of impersonators	3.63	0.54	Excellent
4	Fast Processing of Data	3.78	0.42	Excellent
5	Highly secure system	3.80	0.41	Excellent
6	Accommodates large classes	3.78	0.42	Excellent
7	Stable over a long time.	3.70	0.52	Excellent
	Overall Mean	3.76	0.43	Excellent

Table 3 shows the result of the extent of conformity of the developed IWBAT to architectural design. The lecturers and software architects rated all items (1-7) as excellent with mean scores ranging from 3.63 – 3.95 which implies that the developed IWBAT conforms excellently to the architectural design that guided its development. The standard deviation score ranged from 0.4-0.52 indicating that the responses are not divergent.

Research question 4: To what extent does the functionality of the Interactive Web-Based Assessment Tool (IWBAT) conform to the requirements that guided its design (Alpha Testing)?

The data collected for answering research question 4 is as shown on Table 4.

Table 4: Mean responses on the functionality of the Interactive Web-Based Assessment Tool (IWBAT)

S/No	Items	X	SD	Remarks
1	Compatible with different operating systems	3.64	0.51	Excellent
2	Quick Processing Time	3.57	0.44	Excellent
3	Prompt student enrolment	3.51	0,57	Excellent
4	Prompt facial upload	3.50	0.53	Excellent
5	Prompt facial verification	3.50	0.60	Excellent
	Overall Mean	3.54	.56	Excellent

Table 4 showed the result of the functionality of the developed Interactive Web-based Assessment Tool (IWBAT). The lecturers and students rated all items (1-5) as excellent with mean scores ranged from 3.50 – 3.64 indicating that the functionality of the developed IWBAT conforms excellently to the requirements that guided its design (Alpha Testing). The standard deviation score ranged from 0.53-0.60 indicating that the responses are not divergent.

Research question 5: To what extent does user review of the Interactive Web-based Assessment Tool (IWBAT) developed conform to the requirements that guided its design (Beta Testing)?

The data collected for answering research question 5 is as shown on table 5.

Table 5: Mean responses on user review of the Interactive Web-Based Assessment Tool (IWBAT). N=2.35

S/No	Items	X	SD	Remarks
1	Ease of use.	3.62	0.52	Excellent
2	Effectively identifies impersonator	3.42	0.58	Excellent
3	Highly secured system	3.43	0.61	Excellent
4	Fast processing and verification of students	3.37	0.61	Excellent
5	Withstand stress testing	3.25	0.70	Excellent
	Overall Mean	3.42	0.62	Excellent

Table 5 showed the result of the user review by lecturers and students of the developed Interactive Web-Based Assessment Tool (IWBAT). The table revealed that all the items (1-5) considered for the user review with mean scores ranged from 3.25 to 3.62 re rated as excellent indicating that the user review of the IWBAT conforms excellently to the requirements that guided its design (Beta Testing).

Findings of the Study

The following findings emerged from the study based on the research questions.

Findings from research question 1 showed that the development for the Interactive Web-Based Assessment Tool (IWBAT) requires the following specifications:

a. Web-based Assessment software.
b. 64-bit system compatibility
c. 32-bit system compatibility.
d. PHP software compatibility
e. Database software for creating user accounts.

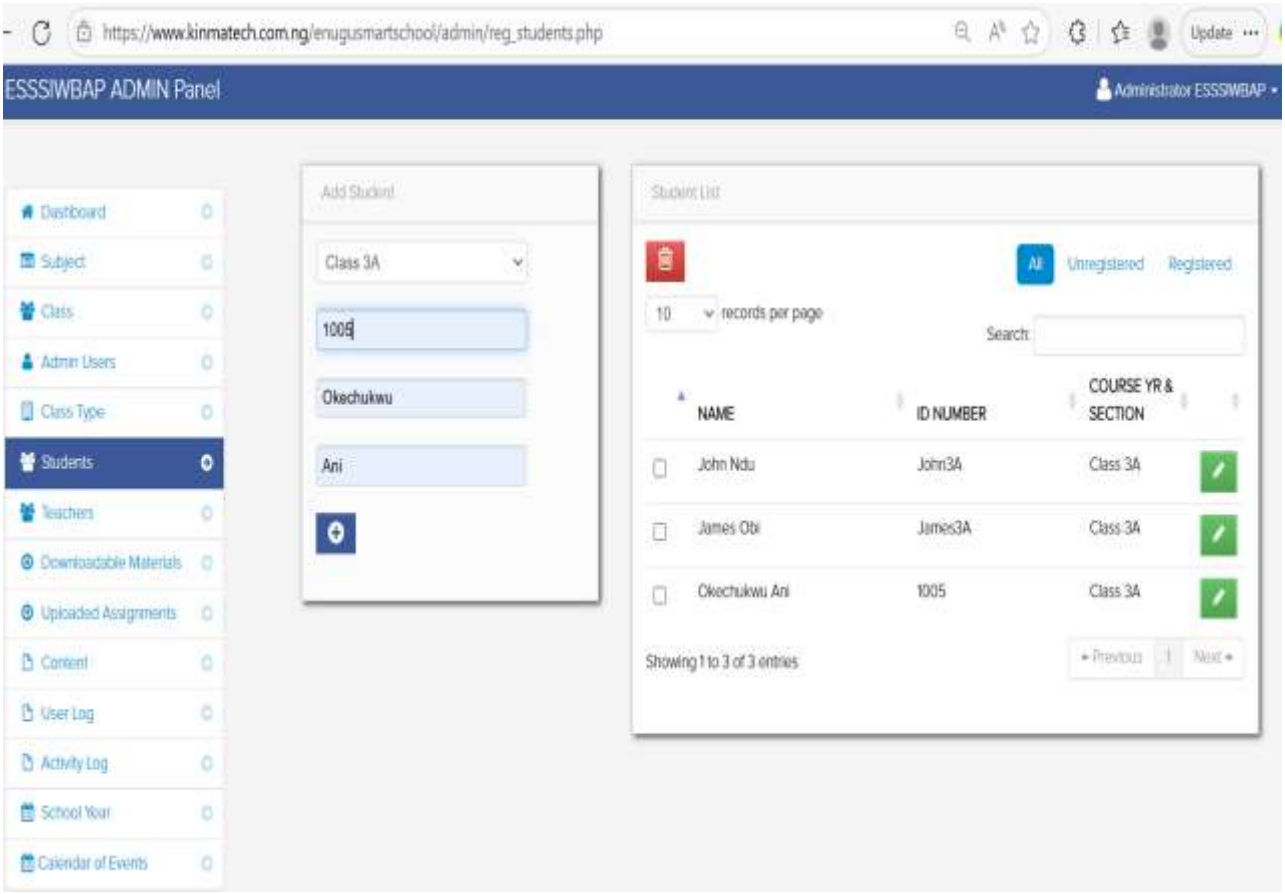
1. The architectural design was done after the software requirement specification phase and was appropriate for the study and fit for the development of the Interactive Web-Based Assessment Tool (IWBAT).
2. Finding from research question two showed that the following are highly appropriate for the architectural design of the developed Interactive Web-Based Assessment Tool (IWBAT) as following:

a. The Architectural flow diagram.
b. The User Interface Design.

c. The Use Case View.
d. The Technical design
e. The quality verification and validation.

3. Findings from the developed MFBS showed that the hardware components and the software components worked excellently, and the system was completed according to the architectural design, circuit diagram and the user interface design.
4. Findings from the developed IWBAT showed that the login page captured all the necessary information needed from the student for enrolment.
5. Finding form the developed IWBAT showed that the facial upload and saving was done seamlessly.

FIGURE 2: Enrolment Page of IWBAT



Discussion of the Findings

The findings on the specifications that guided the design of the Interactive Web-Based Assessment Tool (IWBAT) revealed that the web-based Assessment software and the PHP server-side scripting software are highly required for the development of the IWBAT, and this agrees with the

recommendation of Peng, Portugal, Alencar & Cowan (2021) on the assessment as a necessity for improved examination system. The assessment software must be compatible with different operating system for it to function maximally as the software drives the hardware device. Furthermore, the IWBAT can be installed on a 64-bit and 32-bit system without malfunctioning. This aligns with the assertion by Wressengger, Yamaguchi, Maiex & Rieck, (2016) for software solutions to be compatible with both 64-bit and 32-bit computer systems. The PHP software and the database software of the Interactive Web-Based Assessment Tool (IWBAT) are also required for the smooth running of the IWBAT.

The findings on the extent of appropriateness of the architectural design for the development of the IWBAT revealed that the user interface design is excellent and needs the required standard. The technical design and quality verification and validation also met the requirements set for the developed IWBAT. architectural flow diagram, User Interface Design, Use Case View, Technical design and Quality verification and validation are features that must be considered in a system when architectural design is been checked. This agrees with the assertion by (Bialy, Pantellic, Jaskolka, Schaap, Patcas, Lawford, & Wassyng, 2017) that the design phase is when the architectural design developed to meet the software requirement specification (SRS). Architectural design encompasses the depiction of constituent elements that form system, the interplay between these elements, the guidelines governing their arrangement and the regulations governing these guidelines. Di Martino & Exposito (2016) further said that the architectural design defines the plan for a solution which includes algorithm design, software architecture design, schema and logical diagram design and the Unified Modelling Language (UML).

The findings in the development of the IWBAT showed that the materials listed for the development of the IWBAT were sufficient for the development and the relevant software were compatible on Windows and Linux operating systems. The IWBAT was free of bugs. The web component was very responsive and compatible on various browser types. The system is ready for full deployment.

The findings on the conformity of the IWBAT to the architectural design revealed that the developed IWBAT could upload facial feature and use same in the easy detection of students and impersonators. This conforms to the architectural design as the developed IWBAT could capture multimodal features of students during enrolment and provide an interface for accessing the student details and information. This aligns with the assertion made by Sanders & Stappers (2014) that the main objective of the development phase is to transform the system design, which was prototyped in the Design Phase, into a functional system that fulfils the entire recorded system requirement.

The findings on the functionality test conducted on the Interactive Web-Based Assessment Tool (IWBAT) revealed that the IWBAT functional in line with defined requirements. The various features of the developed IWBAT, such as compatibility with different operating systems, fast student processing prompt student enrolment, efficient facial detail upload during enrolment, and quick face verification during examinations, were all rated as excellent. Hooda and Chihillar (2015) state that the alpha testing phase is the stage of software validation where new software is tested to guarantee that it will function as anticipated. Sallis (2014) further asserted that, assessing a developed program ensures that the work products and procedures meet predetermined provisions and plans. It also instils confidence that the software corresponds to specified technical specifications.

The findings on the user testing conducted on the Interactive Web-Based Assessment Tool (IWBAT) revealed that all items such as ease of use, effectively identifying impersonators, highly secured system, fast processing, and verification of students and the IWBAT ability to withstand stress feasting were excellent. This agrees with the assertion by Aguboshim & Miles (2018) that ease of use is a major consideration in the development of any new system. The system should be easy to use for the people it is designed for. The evaluation of Lecturers and students throughout the beta testing demonstrated that the IWBAT adheres to its intended design and can successfully accomplish its designated aim.

Conclusion

The creation of the Interactive Web-Based Assessment Tool (IWBAT) (MFBIS) was informed by the requirements acquired during the needs assessment. The system underwent development in accordance with an architectural blueprint. The developed IWBAT was put through a number of validation procedures, such as beta and alpha testing, and the results showed that the program complies with the requirements derived from the need analysis. During the beta testing phase, the developed IWBAT was subjected to additional testing to provide students a firsthand look at how to use it. According to the study's findings, students were motivated to see the IWBAT implemented because they believed it would improve exam security and offer deserving incentives to students who worked hard.

Recommendations

Based on the findings of the study, the researcher recommends the following:

1. The developed IWBAT should be adopted by Tertiary Institutions for the successful conduct of Computer Based Examinations and Improved security in the student's halls of residence.

2. The developed IWBAT should be adopted by teachers in various disciplines for the running of classes, taking of electronic attendance and the conduct of Computer based quizzes and semester examinations as it will ensure that only the appropriate students are allowed for classes and allowed to take their examinations.
3. The developed IWBAT should be adopted by examination bodies such as WAEC and JAMB for use in national examinations to avoid reoccurring cases of examination impersonation and restore utmost confidence in the examinations conducted by these examination bodies.
4. The developed IWBAT in this study should be adopted by various private and public organizations involved in mass recruitment of staff and personnel for the conduct of computer-based examination and promotional examination.
5. Private companies and organizations should adopt the developed IWBAT for access control into their buildings and facilities to avoid undue access and security breaches.

References

Abd-El-Aziz, A. E. L. A., Muhammed, K. J., & Dawodu, R. A. (2017). Effects of Web-Based Instruction on Students' Attitudes, Self-Efficacy, Anxiety and Academic Achievement in General Metalwork in Technical Colleges. Journal of Curriculum and Instruction, 10(2).

Achinewhu-Nworgu, E. (2019). An Overview of Nigerian Education Law and Policy: A Case Study of University Admission Policy (JAMB) and Impact on Youth Educational Development. Bulgarian Comparative Education Society.

Aguboshim, F.C. & Miles, G. (2018). Well-defined interface development process: an important interface design strategy to create essy-to-use banking ATM system interface in Nigeria. International Journal of Engineering Science, 19514.

Akinsanmi O, Agbaji OTR, Soroyewun MB, (2010). Development of an E- Assessment Platform for Nigerian Universities, Research Journal of Applied Sciences, Engineering and Technology 2(2)

Akinsola, J.E., Ogunbanwo, A.O., Okesola, O.J. Odun-Ayo, I.J., Ayegbusi, F.D., & Adebiyi, A.A. (2020). Comparative analysis of software development life cycle models (SDLC). Intelligent Algorithms in Osftware Enginnering, 1(9), 310 – 322.

Ali, W. Z. W., & Nor, H. M. (2010). The implementation of ICT integration in Malaysian smart schools. In New Achievements in Technology, Education and Development. IntechOpen.

Álvarez Jaramillo, J., Zartha Sossa, J. W., & Orozco Mendoza, G. L. (2019). Barriers to sustainability for small and medium enterprises in the framework of sustainable development—L iterature review. Business Strategy and the Environment, 28(4), 512-524.

Amirthalingam, G. & Radhamani, G. (2013). A multimodal appraoch for face and ear biometric system. International Journal of Computer Science Issues, 10(5), 234.

Ananda, F., Kuria, D.N., & Ngigi, M.M. (2016). Towards a new methodology for web GIS development. International Journal of Software Engineering & Applications, 7(4), 47-66.

Anwer, F., Aftab, S., Shah, S.S.M. & Waleed, U. (2017). Comparative analysis of two popular agile process models: Extreme programmeining and scrum. International Journal of Computer Science and Telecommunication, 8(2), 1-7.

Arnold J (2022). Prioritizing students in Assessment for Learning: A scoping review of research on students' classroom experience. Review of Education, DOI: 10.1002/rev3.3366

Attarana M, Aliasb N & Sirajc S (2012). Learning Culture in a Smart School: A Case Study. Social and Behavioral Sciences 64 International Educational Technology Conference Ietc2012 417 – 423

Au, W. (2022). Unequal by design: High-stakes testing and the standardization of inequality. Routledge.

Ayeni OO, Al-Hamad NM, Chisom ON, Osawaru B and Adewusi OE (2024). AI in education: A review of personalized learning and educational technology. GSC Advanced Research and Reviews, 18(02), 261–271. DOI: https://doi.org/10.30574/gscarr.2024.18.2.0062

Balaman, F., & Baş, M. (2023). Perception of using e-learning platforms in the scope of the technology acceptance model (TAM): a scale development study. Interactive Learning Environments, 31(8), 5395-5419.

Bao, X., Jiang, D., Yang, X., & Wang, H. (2021). An improved deep belief network for traffic prediction considering weather factors. Alexandria Engineering Journal, 60(1), 413-420.

Battina, D.S. (2021). The Challenges and Mitigation Strategies of Using DevOps during Software Development. International Journal of Creative Research Thoughts (ijcrt), 2320-2882.

Bayliss CR, Hardy BJ (2012). Supervisory Control and Data Acquisition, Editor(s): C.R. Bayliss, B.J. Hardy. In: Transmission and Distribution Electrical Engineering (Fourth Edition), Newnes, Pages 827-862, https://doi.org/10.1016/B978-0-08-096912-1.00021-6.

Bédard, D., Lison, C., Dalle, D., Côté, J.-A., & Boutin, N. (2012). Smart devices in classrooms: Enhancing student-student and student-teacher interaction. Journal of Educational Technology Innovations, 5(2), 123–138.

Bialy, M., Pantelic, V., Jaskolka, J., Schaap, A., Pateas, L., Lawford, M., & Wassyng, A. (2017). Software engineering for model-based development by domain experts. In Handbook of System Safety and Security (pp. 39-64). Syngress.

Biggs, J. (2001). The reflective institution: Assuring and enhancing the quality of teaching and learning. Higher education, 41(3), 221-238.

Birhanu M (2018).The Implementations and Challenges of Assessment Practices for Students' Learning in Public Selected Universities, Ethiopia. Universal Journal of Educational Research 6(12):2789-2806. DOI:10.13189/ujer.2018.061213

Bloom, B. S. (1971). Handbook on formative and summative evaluation of student learning.

Bolanta, O. R. (2024). Stakeholders' Perception of the Benefits, Challenges and Strategies for Implementing Continuous Assessment and Computer-Based Examinations in Business Education Programmes (Doctoral dissertation, Kwara State University (Nigeria)).

Boschert, S., & Rosen, R> (2016). Digital twin – the simulation aspect. Mechatronic futures: Challenges and solutions for mechatronic systems and their designers, 59-74.

Braude, E.J., & Bernstein, M.E. (2016). Software engineering: modern approaches. Waveland Press.

Britannica, E. (2010). Britannica Book of the Year 2010. Encyclopaedia Britannica, Inc..

Brookhart, S. M. (2017). The use of teacher judgement for summative assessment in the USA. In International teacher judgement practices (pp. 79-100). Routledge.

Brown, G. T. (2022, November). The past, present and future of educational assessment: A transdisciplinary perspective. In Frontiers in Education (Vol. 7, p. 1060633). Frontiers Media SA.

Bucki, R., & Suchanek, P. (2010). Modelling the Validation Process of Enterprise Software Systems. In Agents and Multi-Agent Systems: Technologies and Applications 2018: Proceedings of the 12th International Conference on Agents and Multi-Agent Systems: Technologies and Applications (KES-AMSTA-18) 12(PP. 187-196). Springer International Publishing.

Buede, D. M., & Miller, W. D. (2024). The engineering design of systems: models and methods. John Wiley & Sons.

Cao X and Liu L (2020). Use of Smart Devices: A Survey, Some Research Issues, and Challenges. In Conference: 2020 International Conference on Culture-oriented Science & Technology (ICCST). DOI: 10.1109/ICCST50977.2020.00079

Caroline, Oroh O, Pada D (2023). Enhancing Online Learning Experiences through Personalization Utilizing Recommendation Algorithms. International Journal Software Engineering and Computer Science (IJSECS) 3(3):398-407. DOI:10.35870/ijsecs.v3i3.1852

Chang, O., Zhinin-Vera, L., & Quinga-Socasi, F. (2020, October). Self-taught neural agents in clever game playing. In Proceedings of the Future Technologies Conference (pp. 512-524). Cham: Springer International Publishing.

Chua CY (2023).Full-stack web development for auto assessment platform. Final year project (FYP), Nanyang Technological University, Singapore. https://hdl.handle.net/10356/171971

Cohen, R. J., Swerdlik, M. E., & Phillips, S. M. (2021). Psychological testing and assessment. McGraw-Hill US Higher Ed USE.

Collins, A. (2017). Processes in acquiring knowledge. In Schooling and the acquisition of knowledge (pp. 339-363). Routledge.

Conforto, E.C., & Amaral, D.C. (2016). Agile project management and stage-gate model – A hybrid framework for technology – based companies. Journal of Engineering and Technology Management, 40, 1-14.

Cooper, J. D., Simmonds, M. J., Walker, N. M., Burren, O., Brand, O. J., Guo, H., ... & Gough, S. C. (2012). Seven newly identified loci for autoimmune thyroid disease. Human molecular genetics, 21(23), 5202-5208.

Cordle, J. (2015). The effects of utilizing high element ropes courses as a treatment intervention on self-efficacy. Clemson University.

Cresswell, T. (2012). Mobilities II: still. Progress in human geography, 36(5), 645-653.

Dahalan HM, Hussain RMR (2020). Development of Web-Based Assessment in Teaching and Learning Management System (e-ATLMS), Procedia – Social and Behaviorial Sciences, 9, pp 244-248. https://doi.org/10.1016/j.sbspro.2010.12.144

Dahlman, C., & Westphalm L. (2019). Techological effort in industrial development-en interpretative survey of recent research. The economics of new technology in developing countries, 105-137.

Daleel, E.M.E. 2016). Software engineering development and analysis of life cycle models. International Journal of Computer Applications, 975, 8887.

Davidson, C., & Ezeh, G. C. (2023). Challenges Facing The Use of ICT in Teaching Computer Studies In Public Secondary Schools In Awka South L.G.A. AfricArXiv. https://doi.org/10.21428/3b2160cd.03763750

de Ridder-Symoens, H. (Ed.). (1991). A history of the university in Europe: Volume 1, Universities in the Middle Ages (Vol. 1). Cambridge University Press.

Dey, N., Ghosh, M., & Chakrabarti, A. (2020). QDLC-The Quantun Development Life Cycle. Emerging Technologies 43(18) 1-18.

Di Martino, B., & Esposito, A. (2016). A rule based procedure for automatic recognition of design patterns in UML diagrans. Software: Practice and Experience, 46(7), 983.

Duckworth, E. (Ed.). (2001). Tell me more: Listening to learners explain. Teachers College Press.

Eden CA, Onyebuchi NC, Adeniyi IS (2024). Harnessing technology integration in education: Strategies for enhancing learning outcomes and equity, World Journal of Advanced Engineering Technology and Sciences 11(2):001-008. DOI:10.30574/wjaets.2024.11.2.0071

Elman, B. A. (2013). Civil examinations and meritocracy in late imperial China. Harvard University Press.

Federal Ministry of Education. (2021). Nigeria education sector analysis report. Abuja: FME.

Feng, S., Zhang, R., & Li, G. (2022). Environmental decentralization, digital finance and green technology innovation. Structural Change and Economic Dynamics, 61, 70-83.

Ferdowsi, S. Z., Sepahmansour, M., & Ghanbari Panah, A. (2021). Develop a causal model of academic performance based on intelligence beliefs and cognitive flexibility in ninth grade students. Theory and Practice in Teachers Education, 7(12), 1-24.

Gare, A. (2012). China and the struggle for ecological civilization. Capitalism Nature Socialism, 23(4), 10-26.

Garrison, D. R., & Anderson, T. (2007). E-learning in the 21st century: A framework for research and practice (Community of Inquiry scholarship & related essays). Routledge / author PDF.

Gathuri, J.W., Luvanda, A., Matende, S., & Kamundi, S. (2014). Impersonation challenges associated with e-assessment of university students. Journal of information Engineering and Applications, 4(7), 60-68.

Georgievskiy, A. F., & Bugina, V. M. (2021, March). Biogenic factor and phosphogenesis: legends and realities. In IOP Conference Series: Materials Science and Engineering (Vol. 1079, No. 7, p. 072030). IOP Publishing.

Gierl, M. J., & Lai, H. (2018). Using automatic item generation to create solutions and rationales for computerized formative testing. Applied psychological measurement, 42(1), 42-57.

Glasbey, J., Ademuyiwa, A., Adisa, A., AlAmeer, E., Arnaud, A. P., Ayasra, F., ... & Abbott, T. E. (2021). Effect of COVID-19 pandemic lockdowns on planned cancer surgery for 15 tumour types in 61 countries: an international, prospective, cohort study. The Lancet Oncology, 22(11), 1507-1517.

Goh, C., Kusnadi, Y., Pan, G., & Seow, P. S. (2022). Governance, risk and compliance (GRC) in digital transformation: Investor views. Accountancy Business and the Public Interest, 21, 200.

Gros, B. (2016) 'The design of smart educational environments', Smart Learning Environments, Vol. 3, pp.1–11.

Grudin, J. (2017). Obstacles to Participatory Design in Large Product Development Organisation Participatory Design in Large Product Development Organisations. Participatory Design (pp/ 99-119). Chemical Rubber Company (CRC) Press.

Gumpili, S. P., & Das, A. V. (2022). Sample size and its evolution in research. IHOPE Journal of Ophthalmology, 1(1), 9-13.

Gupta A, Kajal G, Joshi A, and Sharma D (2019). Tools for E-Assessment Techniques in Education: A Review. In Handbook of Research on E-Assessment in Higher Education, Pg 25. DOI: https://doi.org/10.4018/978-1-5225-5936-8.ch0082

Gustiani, S. (2019). Research and development (R&D) method as a model design in educational research and its alternatives. Holistics, 11(2).

Habib Ullah Khan, Muhammad Abbas, Omar Alruwaili, Shah Nazir, Muhammad Hameed Siddiqi, Saad Alanazi, (2024). Selection of a smart and secure education school system based on the internet of things using entropy and TOPSIS approaches, Computers in Human Behavior, Volume 159, 108346, https://doi.org/10.1016/j.chb.2024.108346.

Hallquist, M. N., Wright, A. G., & Molenaar, P. C. (2021). Problems with centrality measures in psychopathology symptom networks: Why network psychometrics cannot escape psychometric theory. Multivariate behavioral research, 56(2), 199-223.

Harris, L. R., & Brown, G. T. (2013). Opportunities and obstacles to consider when using peer-and self-assessment to improve student learning: Case studies into teachers' implementation. Teaching and Teacher Education, 36, 101-111.

Harry, B., & Klingner, J. (2014). Why are so many minority students in special education?: Understanding race and disability in schools. Teachers College Press.

Hassan M, Tomalá M, Coello C, Silva S (2024). Assessment methods and their impact on learning outcomes in education: Los métodos de evaluación y su impacto en los resultados del aprendizaje en la educación, LATAM Revista Latinoamericana de Ciencias Sociales y Humanidades 5(5), DOI:10.56712/latam.v5i5.2865

Honest N (2019). Role of Testing in Software Development Life Cycle. International Journal of Computer Sciences and Engineering 7(5):886-889. DOI:10.26438/ijcse/v7i5.886889

Hooda, I., & Chhillar, R.S. (2015). Software test process, testing types and techniques. International Journal of Computer Applications, 111(`3), 10-14.

Hoover, N. R., & Abrams, L. M. (2013). Teachers' instructional use of summative student assessment data. Applied Measurement in Education, 26(3), 219–231. https://doi.org/10.1080/08957347.2013.793187

Hunte, R., Mehrotra, G. R., & Klawetter, S. (2023). "We experience what they experience": Black nurses' and community health workers' reflections on providing culturally specific perinatal health care. Journal of Transcultural Nursing, 34(1), 83-90.

Ikechukwu, B.I. and Amos, U.S. (2023) 'Implementation of smart education in Nigeria's system of education', International Academy Journal of Educational Technology and Research, Vol. 8, No. 5, pp.1–13. Doi: 27214253871851.

Ismail, H. A. (2016). Intention to use smartphone through perceived compatibility, perceived usefulness, and perceived ease of use. JDM (Jurnal Dinamika Manajemen), 7(1), 1-10.

Ivan Š, Tamara R (2023). Optimization of MySQL database. Journal of Process Management New Technologies 11(1-2):141-151. DOI:10.5937/jouproman2301141Q

Jindal, R. P., Sarangee, K. R., Echambadi, R., & Lee, S. (2016). Designed to succeed: Dimensions of product design and their impact on market share. Journal of Marketing, 80(4), 72-89.

Kayode, A. E. (2019). Examining computer-based technology skill and academic performance of students in Nigerian universities (Doctoral dissertation, Doctoral Thesis, University of KwaZulu-Natal. University of KwaZulu-Natal ResearchSpace).

Kinyua, K., Okunya, L.O. (2014). Validity and Reliability of Teacher-mMade Tests: Case Study of Year 11 Physics in Nyahururu District of Kenya. African Educational Research Journal, 2(2), 61-71.

Kline, P., Saggio, R., & Sølvsten, M. (2020). Leave-out estimation of variance components. Econometrica, 88(5), 1859-1898.

Kute, S.S., & Thonat, S.D. (2014).. A review on various software development life cycle (SDLC) models. International Journal of Research in Computer and Communication Technology. 3(7), 778-779.

Laplante, P.A., & Kassab, M. (2022). Internnational engineering for software and systems. Auerbach Publications.

LARSON, m.b., & Lockers, B.B. (2019). Streamilined ID: A practical guide to instructional design. Routledge.

Layton, M.C., Ostermiller, S.J. & Kynaston, D.J. (2020). Agile Project Management for Dummies. John Willey & Sons.

Leiecht, N., Blohm, I., & Leimeister, J.M. (2017). Leaveraging the Power of the Crowd for Software Testing. IEEE Sofware, 34(2). 62-69.

Leonard, S., Alhaji, Y.A., & Linus, I. (2019). Curbing examination insecurity and its implications for the management of public secondary schools in Kofi East Education Zone of Kogi State.

Li H, Yang W, Wang J, Xu Y and Huang L, (2016). WiFinger", Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing, 2016. Available: 10.1145/2971648.2971738 [Accessed 21 July 2020].

Mahmoudi, J., Nalchigar, S., & Ebrahimi, S. B. (2008). Challenges of smart schools in Iran. Quarterly Journal of Educational Innovations, 7(27), 61–78.

Mamone, D., Bosio, A., Savino, A., Hamdioui, S., & Rebaudengo, M. (2020, October). On the analysis of real-time operating system reliability in embedded systems. In 2020 IEEE international symposium on defect and fault tolerance in VLSI and nanotechnology systems (DFT) (pp. 1-6). IEEE.

Manimaran, M., Shanmugam, A., Parimalam, P., Murali, N., & Murty, S.S. (2015). Software Development Methodology for Computer Based I&C Systems of Prototype fast Breeder Reactor. Nuclear Engineering and Design, 292, 46 – 56.

Mbiriyakura, R., & Kasowe, R. (2022). An assessment of the extent to which computers have been implemented on the curriculum in Harare. International Journal of Humanities Social Sciences and Education (IJHSSE), 9(10), 104–109. https://doi.org/10.20431/2349-0381.0910011

Ming, T., Hall, C., Azman, H., & Joyes, G. (2010). Supporting smart school teachers' continuing professional development in and through ICT: A model for change. International Journal of Education and Development using ICT, 6(2), 5-20.

Mohamed A, Dagmar A, Hofer D Kung J (2022). A systematic literature review for authorization and access control: definitions, strategies and models. International Journal of Web Information Systems 18(2). DOI:10.1108/IJWIS-04-2022-0077

Mokoginta D, Putri DE, Wattimena FY (2024). Developing Modern JavaScript Frameworks for Building Interactive Single-Page Applications. International Journal Software Engineering and Computer Science (IJSECS) 4 (2), pp, 484-496. DOI: https://doi.org/10.35870/ijsecs.v4i2.2831

Moorefield-Lang, H. M. (2015). When makerspaces go mobile: Case studies of transportable maker locations. Library Hi Tech, 33(4), 462–471. https://doi.org/10.1108/LHT-06-2015-0061.

Morgan, J.D. (2018). Applying 1970 Waterfall Lessons Learned within Today's Agile Development Processes. P, World Journal, 7, 1 -19.

Mukred, M., Yusof, Z. M., Alotaibi, F. M., Asma'Mokhtar, U., & Fauzi, F. (2019). The key factors in adopting an electronic records management system (ERMS) in the educational sector: a UTAUT-based framework. IEEE Access, 7, 35963-35980.

Narayan, K. G., Sinha, D. K., & Singh, D. K. (2023). Sampling techniques. In Veterinary public health & epidemiology: Veterinary public health-epidemiology-zoonosis-one health (pp. 111-123). Singapore: Springer Nature Singapore.

National Bureau of Statistics. (2022). Education statistics: Enrolment and schools by state. Abuja: NBS.

Newen, A. (2017). What are cognitive processes? An example-based approach. Synthese, 194(11), 4251-4268.

Nichols, S. L., & Harris, L. R. (2016). Accountability assessment's effects on teachers and schools. In Handbook of human and social conditions in assessment (pp. 40-56). Routledge.

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. Studies in higher education, 31(2), 199-218.

Nugroho, S., Waluyo, S.H., & Hakim, L. (2017). Comparative analysis of software development methods between Parallel V-Shaped and Iterative. International Journal of Computer Applications, 169(11), 7-11.

Nwogbo, V.N., & Ugwuoke, U.N. (2021). Teachers attitude to work as correlate to teachers job performance in Secondary Schools in Anambra State. African journal of educational management, teaching and entrepreneurship studies, 3(1), 129-135.

Nworgu, B. G. (2015). Educational research: Basic issues and methodology (3rd ed.). Nsukka, Nigeria: University Trust Publishers.

Palomba, C. A., & Banta, T. W. (1999). Assessment essentials: Planning, implementing, and improving assessment in higher education. Jossey-Bass

Pardo-Baldoví, M. I., San Martín-Alonso, Á., & Peirats-Chacón, J. (2023). The Smart Classroom: Learning Challenges in the Digital Ecosystem. Education Sciences, 13(7), 662. Offers insights into how smart classroom technologies aid interaction and learning processes.

Ray P (2016). A Survey on Internet of Things Architectures", EAIEndorsed Transactions on Internet

of Things, vol. 2, no. 5, p.151714, 2016. Available: 10.4108/eai.1-12-2016.151714.

Rodríguez, E., Olatz, A., Ana, J., José, N., & Néstor, M. (2020). Computing capacity and sensing functions in smart classrooms: Enhancing effective teaching and learning. Journal of Educational Technology and Smart Learning, 15(3), 45–62.

Shahzad I, Walke S, Dahat A, Kurmi P (2023). Smart School Application : Enhancing Administrative Efficiency, Communication, and Personalized Learning in Education. International Journal of Scientific Research in Computer Science Engineering and Information Technology. DOI:10.32628/CSEIT2390267

Zhu, Z.T., Yu, M.H. and Riezebos, P. (2016) 'A research framework of smart education', Smart Learn. Environ, Vol. 3, No. 4. Doi: 10.1186/s40561-016-0026-2.