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Journal of Centre for Distance and e-Learning (J-CDel) is a multidisciplinary peer-reviewed Journal in English published by CDel. It is devoted to academic research contributions and efforts of scholars from various disciplines. However, the focus is on all open and distance learning areas in every field. We welcome original research papers from all parts of the world. Papers for publication in J-CDel are selected through rigid peer review to ensure relevance, originality, timeliness, and readability. e-learner is published online only, following global trends. The Journal accepts papers by e-mail.

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Deployment of Learning Management System (LMS) for Sustainable Open and Distance Education in Nigeria

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Abstract

The evolution of technology has significantly impacted on the realm of education, especially in the promotion and sustainability of open and distance learning. While educational approaches are undergoing transformative and innovative shifts that are embracing and adaptative, Learning Management Systems (LMS) was seen as, a cutting-edge technology poised to meet diverse needs of educators, students, and educational institutions. The paper therefore provides a concise historical antecedent of LMS in distance education, stating some salient features on its relevance to effective deployment in open and distance education in Nigeria.

Keywords: learning management system (LMS), distance education and sustainable innovation

1.0 Introduction

The evolution of distance education in recent times has witnessed remarkable progress in technology utilisation. Tracing its roots, Chukwunonso, Ibrahim, Selamat, Idama and Gadzama (2013) observe that distance education started from the humble beginnings in 1728 with the introduction of new shorthand method by Caleb Philip through weekly mailed lessons. The action continued with the use of correspondence by Isaac Pitman to teach shorthand in Great Britain, thus, leading to the integration of technology and the introduction of online learning programs at the K-12 level in 2008. In line with meeting the objectives of the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 1985), in prioritizing education for all and sustainable development, open and distance education emerges as the most effective strategy to ensure the achievement of the goals.

The prevalence of distance education systems today is so widespread that any discussion on the integration of technology in learning is incomplete without acknowledging its application in distance education. Chukwunonso et al, (2013), observe that the present era has witnessed a complete transformation in the way they learn, play, and work, which is facilitated by the adoption of the Internet and web-based technologies. For instance, the Open University United Kingdom (OUUK), which served as a model for numerous other nations formulated comprehensive strategies and action plans to promote ICT education (Anene et al, 2014). In Malaysia, the Open University Malaysia (OUM) stands out as a pioneering academic institution that harnessed e-learning to deliver its academic programs (Anene et al, 2014). Notably, these technologies have served as "lifesavers" during and after the outbreak of the COVID- 19 pandemic by facilitating the swift transition to online learning, and at the time preventing a collapse of the educational sector.

2.0 The Need for Innovation in Open and Distance Education

Innovation in open and distance education stems from the evolving response to changing needs and demands of the diverse learners. These emerging areas involve the periodic policy revisions for sustainable development, the establishment of a quality culture, enhanced student support services, course content design, the development of ICT-based modules, evaluation methodologies and practices, interactive delivery modes, and collaboration with various enterprises. Hence, the application of new technologies in open and distance education provides an appropriate starting point for delineating the knowledge required in today's global society.

The impact of ICT in education is evident in the use of devices and tools such as multiple media in the teaching-learning process. Although, the integration of ICT into education is multifaceted, Rahman (2014) stipulates that it involves not only technology, but also curriculum and pedagogy, institutional readiness and teachers' competencies among others. Hence, one of the benefits OF ICT is the use of various strategies by the facilitators to actively arouse learners' interest. Consequently, the presence of innovative practices such as ICT-enabled online student registration, program delivery, assignment and project report evaluation, online examinations, availability of results online, accessibility of self-learning materials in a digital repository, is capable of meeting diverse needs of learners in open and distance education.

Information and Communication Technologies (ICTs) encompass tools, equipment, machines, gadgets, and application support systems used for gathering, storing, retrieving, using, transmitting, manipulating, and distributing information with precision and efficiency. These technologies foster communication, enhance decision-making and problem-solving skills. In serving various functions in education, ICT is routinely incorporated into daily classroom teaching, open and distance learning, and online education, establishing virtual classrooms and proven to be an effective tool and medium for formal, non-formal, and informal education.

While advocating a paradigm shift in the learning environment, ICT has the potential of transforming the traditional views and methods of teaching and instruction from content-based testing to problem-solving and competency-based assessment, shorter duration examinations, flexibility of time limits, open-book examinations, self-assessment, peer assessment and feedback, maintaining a daily diary, and emphasis on continuous evaluation. The use of ICT tools for evaluating student progress serves as an innovative and user-friendly assessment and evaluation systems in ODL, providing an evidential base and establishing linkages between course structure, instructional delivery, and student expectations. Agreeably, management and evaluation are crucial components of managing the ODL system. Hence, scholars maintain that encouraging learners to maintain e-portfolios, utilizing them as assessment and evaluation tools, particularly in online academic programs have begun in some open and distance universities (Chaudhary & Dey, 2013).

3.0 Learning Management System (LMS)

The efficient delivery of educational contents requires the establishment of a distance education model. One of such models is learning management system (LMS). LMS serves as a virtual platform for e-learning, facilitating the management, monitoring of students, content delivery, learning tracking, testing, communication, registration processes, and scheduling. West, Waddoups, and Graham (2007) report that the system offers various time-saving features that are

beneficial to instructors. In serving as pivotal for a virtual learning environment, LMS exhibits several common features namely:

- guiding students in the educational direction
- delivering knowledge in diverse formats, such as text, presentations, flash, video, audio, etc.
- facilitating interactive applications for students
- assessing students through assignments and examinations
- delivering results to students
- enabling communication between students (discussion boards, chat, email, etc.) and between students and teachers
- facilitating interaction between students and lesson content
- managing the registration process
- handling scheduling and class management
- maintaining records for students, teachers, and the system (logs)
- recording examination entries and results
- collecting homework
- managing grades
- generating reports
- tracking student attendance records
- distributing e-learning content online and fostering knowledge and idea sharing.

These attributes of LMS suggest there are several systems that are employed in achieving these features. Some of which are free. For example, Moodle, Claroline, ATutor), while others require payment (e.g., Blackboard, WebCT, among others) (Cavus, 2010). Among the open-source free LMS systems, Moodle is distinguished as one of the most effectively and popularly acclaimed system use.

3.1 Moodle LMS

Moodle is an acronym for Modular Object-Oriented Dynamic Learning Environment. It is among the open-source LMS systems and rivals commercially available alternatives. According to a recent survey and investigation, moodle is recognised as the most effective and widely utilised open-source LMS system currently accessible.

3.2 Compelling Attributes of Moodle

The following compelling attributes are attributable to Moodle:

- it operates as an open-source learning management system.
- installation is straight forward, whether on a local machine or across a network.
- educators can effortlessly create online lessons using the platform.
- it has a broad user group, frequent announcements and regularly introduction of new versions.
- it supports 75 different languages as of today, allowing users to choose the language for a given LMS session.
- used in over 215 countries globally, Moodle boasts more than 1,176,162 registered members on its website (Moodle, 2012).

- required no licensing fees, as it is freely distributed as open source under the General Public License (GPL). Institutions using Moodle invest time and resources only in creating lessons.
- developed with a Social Constructionist Pedagogy approach, thus, distinguishing itself from other LMS systems.
- effortlessly upload lesson notes prepared by facilitators in various formats (e.g., SCORM, flash, MP3, RSS, PowerPoint, PDF, Word).
- competes with commercial packages such as Blackboard and WebCT, holding a significant share in the education sector.
- it is utilised by renowned establishments.
- it is easily operated with an account from a web service provider.
- no programming skills are obligatory in its use.
- constant additions of new features, such as blogs or modules, are distributed free of charge.
- being an open-source package, security issues are addressed promptly compared to commercial LMS packages.
- the large user base, drawn by its free-of-charge nature, aids in testing and enhancing the system.
- is user-centric, making it easily accessible for any educational institution engaged in distance education without incurring fees.

3.3 Properties of Moodle learning Management System and Educators

Some of the properties of Moodle that promote its use by educators are briefly highlighted

- Moodle is grounded in and aligns with the principles of social constructivist pedagogy.
- It accommodates both face-to-face (synchronous education) and fully online education formats.
- As an interface, it functions seamlessly with simple, efficient, compatible, and low-tech internet browsers (e.g., Internet Explorer, Firefox).
- Lesson lists are transmitted to the internet through the service provider, and courses can be indexed using search engines like Google for guest users. Moodle allows the categorisation of lessons, enabling easy and targeted searches, even with several thousand lessons loaded and controlled within the LMS.
- WYSIWYG HTML editor facilitates the editing of various items such as resources and forums.
- It supports the incorporation of multimedia products like video, Flash, PowerPoint, Excel, etc.

Given its open-source nature and support from universities and user groups, new modules are continuously developed, added, and distributed to users without cost. These modules can be accessed and shared freely on the Moodle website (http://www.moodle.org), allowing interested parties to download and use the required modules effortlessly on their server computers.

3.4 Learning Activities and Modules in Moodle

Lesson: lessons can be saved and reused in subsequent years. All activities related to lessons are presented in a weekly format, allowing students to easily view and follow all semester activities through the internet,

Examination: The striking feature about the system is the advanced examination module. This module simplifies the setup of multiple-choice examinations and facilitates swift assessment. Consequently, any deficiencies in subjects taught through theory can be promptly identified, enabling a focused review of challenging questions and a re-delivery of related content. The examination module supports various question types, including single-answer multiple choice, multiple-answer multiple choice, fill-in-the-gaps, pairing answers, true-false questions, and even mathematical questions with region-based acceptance criteria. Examinations can be conducted not only during regular lecture hours, but also outside normal hours. The system introduces randomisation of question-and-answer order to eliminate reliance on memorisation in repeated examination conditions. Hence, students receive immediate feedback on their scores, access correct answers, and learn from their mistakes instantly. This transforms examinations into learning activities, granting students the opportunity to revise and improve their answers. Additionally, a percentage factor can be configured, reducing a student's mark for each incorrect answer if desired.

Assignment: The assignment module prompts students with questions based on classroom theory. Upon completing the assignments, students can upload result files (.doc, .xls, .cpp, .java, etc.) to Moodle. The system can automatically mark assignments, or educators can manually assess them with feedback provided to students, while results are sent automatically via email. Assignment hand-in dates are also restricted based on various criteria. Detailed records of a student's semester activities, including completed assignments and grades, are easily accessed.

Survey: Utilising Moodle's survey module, educators are able to efficiently gather student opinions on various topics. Feedback on lecture delivery, assignment difficulty, quizzes, and emerging ideas can be converted into a survey format. The Moodle survey module enables all students to participate and share their opinions, providing valuable insights to educators about the overall class level and opinions.

3.5 Communication Modules found within Moodle

Forum Module: Through Moodle's forum module, students are able to post their questions on a pre-established forum. The flexibility of using these forums both within and outside regular lesson hours for asking and answering questions empowers students to extend their learning activities beyond traditional class times. Furthermore, the forum facilitates the grading of messages. If desired, these grades can be translated into student marks, fostering a more efficient and higher-quality teaching environment. Monitoring all messages sent by students throughout the semester is easily manageable. For students hesitant to ask questions in a classroom setting, forums provide a comfortable alternative. Questions and answers from these forums can be compiled into a frequently asked questions section, serving as a valuable knowledge resource.

Wiki Module: A wiki is a repository of knowledge pages accessible to everyone and open for modification. In preparing course notes by educator using the module, students have the opportunity to contribute to or modify the notes as desired. Hence, Wiki allows for quick, easy

preparation and review of lecture notes, and promptly rectifying any errors. In addition, student modifications are trackable, and if desired, these changes could be reverted. Pages dedicated to each topic are categorised under different keywords, establishing links to Wiki pages whenever the corresponding keyword appears on the course website. Moreso, students can be encouraged to form groups and collaborate on Wiki pages for specific topics, fostering teamwork. The pages created by student groups can be modified, if necessary, by other students, ensuring quick error correction and the development of a knowledge environment for future use.

3.6 Distribution of Authorities within the Moodle

Moodle encompasses distinct roles with varying authorities and responsibilities:

(a) **System Administrator**: This role involves server preparation, including the installation of PHP, Apache, and MySQL. The System Administrator downloads Moodle and installs it on the server. They add teacher(s), open lesson(s), assign teacher(s) to lesson(s), and add students to the system. Additionally, they can perform system backups, restore the system if necessary, and address issues related to system operation.

(b) **Teachers:** contribute lesson syllabuses to the system, load assignments, prepare examinations, add offline sources, and set up communication tools like chat, forums, and blogs. They also integrate dictionaries into the system, create backups of their own lessons, and monitor students' progress and activities through logs.

(c) **Students:** enter the system using their usernames and passwords. They have access to lesson contents, prepare assignments, upload them to the system, take examinations, check results, establish communication with friends or instructors, download documents offline to their computers, and print them. They can also view their own performance levels in the class.

(d) **Guests:** are limited to searching within the system in specified areas.

4.0 Deployment of LMS in Distance Education

In recent years, there has been a substantial surge in the acceptance and utilisation of Learning Management Systems (LMS) across tertiary institutions all over the world. Colleges and universities in developed nations have successfully implemented online education platforms, allowing students to attend lectures, collaborate, and access learning materials from any device, anywhere, and at any time through the internet (Bahari, 2020). These systems often integrate multimedia tools such as video, text, and audio, along with communication tools such as email, chat, discussion forums, and assessment tools (Skulmowski &Rey, 2020). Despite the advantages of LMS, a significant number of colleges and universities in many developing countries, particularly in Africa experienced disruption of academic activities owing to poor knowledge of the system and the outbreak of COVID-19 pandemic. Statistics show that as of May 25, 2020, 990,324,537 learners across 130 countries, constituting 56.6% of the world's total enrolled learners, were affected by school closures resulting from the pandemic (UNESCO as cited in Husky. et al., 2020).

In contrast to the figure, tertiary institutions in countries like the US, UK, Germany, France, Cyprus, and Malaysia successfully integrated all teaching and learning activities to an online environment using various LMS following the disruption of traditional face-to-face method by COVID-19.The disruption caused by the pandemic, particularly in terms of the suspension of conventional face-to-face teaching methods, has had a detrimental impact on the sustainable

development of the global educational sector, especially in developing countries. Consequently, adopting e-Learning technologies such as LMS becomes imperative for the continuity of educational activities especially during pandemics. However, the uptake of LMS in Nigeria has been slow, with only a few institutions incorporating it for academic purposes (Yakubu & Muhammadou, 2019). These challenges are said to have some negative impacts on the sustainability of educational activities in Nigeria.

5.0 Challenges in the use of Learning Management System in Nigeria

The application of Learning Management Systems (LMS) in open and distance education in Nigeria is faced with several challenges. These challenges are briefly discussed:

1. **Limited Infrastructure:** many open and distance education study centres in Nigeria are characterised by inadequate technological infrastructure, such as reliable internet connectivity and electricity. Thus, hampering the seamless use of LMS, as both students and educators may struggle with access to online resources.
2. **Financial Constraints:** Many educational institutions in Nigeria, especially those in rural areas are not adequately funded. Implementing and maintaining an LMS requires adequate financial resources for its smooth and seamless operation.
3. **Inadequate Training:** poor training of both educators and students on how to use LMS pose a great challenge in educational system, as such restrains the overall effectiveness of an online learning experience.
4. **Content Relevance and Localization:** Some LMS platforms may not adequately cater for the content needs of Nigerian educational institutions. Thus, adapting the content to align with local educational standards and requirements is crucial for the success of LMS in the country.
5. **Resistance to Change:** resistance to the adoption of new technologies and a preference for traditional teaching methods is still on the increase in the educational system of the country. A pragmatic shift to online learning is needed for the successful integration of LMS into the educational system.
6. **Inadequate Technical Support:** Limited technical support for users serves as a contributing factor to the use of LMS. Technical issues may arise, and without prompt and reliable support, users may face disruptions in their online learning activities.
7. **Security Concerns:** Concerns about data breaches, unauthorised access, and other security issues may deter educational institutions from fully embracing LMS. Ensuring the security and privacy of sensitive educational data is therefore paramount.
8. **Electricity Challenges:** Inconsistent power supply constitutes a barrier to the use of LMS in Nigeria. Without a reliable power source, students and educators are restricted from optimally accessing online learning materials consistently.
9. **High Cost of Purchasing Electronic Devices:** Many students may not have personal devices, such as laptops or tablets, for accessing online learning materials owing to the high cost of the devices. Hence, are retrained from benefiting from the enormous advantages of LMS.
10. **Cultural and Linguistic Diversity:** Nigeria is culturally and linguistically diverse. Adapting LMS content to cater to this diversity and ensuring that educational materials are presented in multiple languages can be a complex challenge.

6.0 Way forward

The following are suggested as way forward in the use of Learning Management Systems (LMS) in Nigeria

1. **Infrastructure Development**
    - **Investment in Technology:** The government and educational institutions should prioritise investment in technology infrastructure, including improving internet connectivity and ensuring reliable power supply.
    - **Public-Private Partnerships:** Collaboration between the public and private sectors can facilitate the development of technology infrastructure.
2. **Financial Support**
    - **Government Funding:** The government should allocate funds specifically for the implementation and maintenance of LMS in educational institutions, especially in economically disadvantaged areas.
    - **Grants and Sponsorships:** Explore opportunities for grants and sponsorships from private organisations to support the adoption of LMS.
3. **Training Programs**
    - **Comprehensive Training:** Develop and implement comprehensive training programs for both educators and students on the effective use of LMS. Part of the content in the training should cover navigation, content creation, and troubleshooting.
    - **Continuous Professional Development:** Establish ongoing professional development programs to keep educators abreast of new features and best practices in using LMS.
4. **Content Localisation**
    - **Curriculum Integration:** Collaborate with LMS providers to ensure that platforms align with the local curriculum and educational standards.
    - **Development of Local Content:** Encourage the creation of educational content that reflects the cultural diversity and linguistic variations within Nigeria.
5. **Change Management**
    - **Awareness Campaigns:** Conduct awareness campaigns to highlight the benefits of online learning and address misconceptions. Emphasise how LMS can enhance the quality of education.
    - **Stakeholder Involvement:** Involve educators, students, parents, and community leaders in decision-making processes related to the adoption of LMS.
6. **Technical Support**
    - **24/7 Helpdesk:** Establish a dedicated helpdesk or support system to address technical issues promptly and assist users.
    - **Training for Local Support Teams:** Train local support teams within educational institutions to handle common technical challenges independently.
7. **Security Measures**
    - **Data Protection Policies:** Implement and enforce robust data protection policies to ensure the security and privacy of educational data.
    - **Regular Audits:** Conduct regular security audits of LMS platforms to identify and address potential vulnerabilities.

8. **Device Accessibility**
    - **Government Initiatives:** Implement government initiatives to provide affordable devices to students or establish technology hubs where students can access devices.
    - **Collaboration with NGOs:** Collaborate with non-governmental organisations (NGOs) to facilitate the distribution of electronic devices to students in need.
9. **Cultural and Linguistic Considerations**
    - **Multilingual Platforms:** Develop LMS platforms that support multiple languages to accommodate Nigeria's cultural and linguistic diversity.
    - **Cultural Sensitivity Training:** Provide training to content creators and educators on cultural sensitivity to ensure inclusivity in online learning materials.
10. **Research and Development**
    - **Research Initiatives:** Encourage research initiatives focused on understanding the impact of LMS in the Nigerian context and identifying innovative solutions to address challenges.
    - **Pilot Programs:** Conduct pilot programs in collaboration with educational institutions to test and refine LMS implementations before full-scale adoption.

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Artificial Intelligence in Test Item Generation, Assessment, Grading and Reporting Tools in Education

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Abstract

The education sector is experiencing a rapid transformation with the emergence of Artificial intelligence (AI). The revolution of AI in test item generation, assessment, grading, and reporting is overwhelming. This article is a brief overview of some AI tools for automated item generation, AI-powered adaptive assessments, and automated scoring, grading/reporting. In the review it was found that there, numerous AI tools that can be used to grade assignments, quizzes, and exams, providing immediate feedback to students as well as analyze graded data, identifying trends, and patterns. It was also found that AI could be used in generating reports on student performance, and providing insights into knowledge gaps. With AI, the education sector is working towards improved productivity, precision, and student understanding, among others.

Introduction

Scholars view the field of artificial intelligence (AI) differently. AI can broadly be seen as computerized systems that work and react in ways commonly expected of human intelligence, like ability to learn, solve problems and achieve goals under uncertain and varying conditions (Dwivedi, Hughes & Ismagilova, 2021). This mean that AI systems can learn from data, solve complex problems, interpret data and make decision. Pearl (2018) defined Artificial Intelligence as the science of making machines do things that would require intelligence if done by humans. Based on these views, Artificial Intelligence (AI) can therefore be defined as the development of intelligent machines that can perform tasks that typically require human intelligence. These intelligent machines play significant roles in different fields, especially in the field of education.

Traditional teaching, learning and assessment relied heavily on teachers-learners' instruction and printed materials before the advent of artificial intelligence (AI) technologies. Teachers were the primary source of knowledge dissemination, delivering lectures and content preparation through textbooks. As such, students' access to information was limited to what the teachers taught in the classroom and what was available in physical libraries which made research and reference time-consuming. Also, the tests used for assessing the extent teachers and learners have accomplished their goals take great effort to prepare and sometimes have an effect on grading and reporting.

Assessment is the process of determining students' learning progress and it could be formal or informal. Assessment was typically paper-based, for both standardized tests and exams. Personalized learning was challenging due to large class sizes, making it difficult to cater for individual needs. Feedback was also often delayed and as such hindering students' academic growth. The lack of interactive tools and multimedia resources also constrained student's engagement and interactivity. In essence, traditional assessment was constrained by its physical limitations, resulting in less adaptable and varying learning opportunities. The emergence of artificial intelligence was a big relief to the limitations associated with

in-person instruction and assessment. Artificial Intelligence on the other hand can augment human capabilities which enables scientists, engineers and mathematicians to solve complex problems more effectively and drive innovation (Brynjolfsson & McAfee, 2017). Due to this importance, there is a need to therefore become more knowledgeable about AI technologies and more proactive in considering public policies around their use and application across educational fields.

Almost all schools have embraced the use of computer and computational technologies. This has created great opportunities in schools for automatic, adaptive and efficient AI technologies to be applied in various academic activities. Artificial Intelligence in Education (AIEd), as an interdisciplinary field, emphasizes applying AI to assist instructors' assessment processes, empower students' learning process and promote the transformation of the educational system (Chen & Lin 2020). Artificial intelligence in education has the potential to enhance assessment practices and pedagogical development in the teaching processes by accessing students' performance automatically, monitoring and tracking students' learning (Berland, Davis & Smith, 2015) and predicting at-risk students (Hellings & Haelermans,2020).

Furthermore, Artificial intelligence in Education is also beneficial for using assessment feedback to improve student-centred learning, such as providing adaptive tutoring (Kose & Arslan, 2017), recommending individualized learning resources (Ledesma & García, 2017) and diagnosing students' learning gaps (Liu et al., 2017). Artificial intelligence in Education also brings about opportunities to transform the educational system by highlighting the essential role of technology (Hwang, Xie & Wah, 2020), enriching the mediums of knowledge delivery (Holstein, McLaren & Aleven, 2019) and changing the instructor-student relationships (Xu & Ouyang, 2022). Kose and Arslan (2017), also highlighted that AI Technologies are transforming educational practices. This can be observed in item generation**,** assessment**,** grading**,** and reporting. These advancements help teachers save time, enhance precision and provide immediate feedback.

AI tools in Item Generation

Test item generation is concern with the process of creating questions (items). Test items can be developed by humans or generated through AI tools. The goal of test item development/generation is to produce valid and reliable test items that accurately measures examinees' skills, knowledge or abilities in a given subject or discipline. The focus of this review is to list those AI tools that could be used for test items generation. AI tools can analyze curricular materials and generate questions at varying difficulty levels, ensuring that learners of all proficiencies are appropriately challenged. For example, Gierl and Lai (2018) noted that AIG systems allow for the efficient creation of diverse test items and this reduces the time and resources required for manual question development. Similarly, the study by Chan and Fan (2019), showed that pre-trained language models can be efficiently used to generate questions. Also, Several lines of evidence from the studies of Lelkes et al. (2021) and Khan et al. (2021) suggest that AI-powered tools like GPT-3 are the crucial creators of reading comprehension quizzes (including questions, correct answers and distractors) which significantly reduce the teachers' time and effort. In addition, Dijkstra et al. (2022) revealed that while early quiz-generating models were rule-based, developments in neural and transformer-based techniques have substantially increased the correctness and complexity of questions. This is particularly beneficial in education settings, where quizzes provide essential practice for knowledge acquisition. Also, the research of Khan et al. (2021) claims that the EduQuiz model fine-tunes GPT-3 which can automatically generate high-quality

comprehension quizzes so that teachers can focus more on in-class instruction. AI-driven tools offer a practical solution for teachers to save time while ensuring the value of quizzes.

Test item generation tools are numerous and not restricted to Automated Test Item Generation Tools (TestGen, QuestionMark, Assessment Generator, Quizlet and Kaplan), AI-Powered Test Item Generation Tools (Edmentum, DreamBox, Curriculum Associates, Houghton Mifflin Harcourt and McGraw-Hill AI tools), Open-Source Test Item Generation Tools (Moodle, OpenEdX, OLAT, TCExam and GIFT). Other Test Item Generation Tools are QuizCreator, TestCreator, ExamBuilder, AssessmentMaster and QuestionWriter among others. These AI tools need the attention of researchers to determine their efficiencies, benefit, limitations and so on.

AI tools in Educational Assessment

AI is significantly improving educational assessment through innovations, timely and effective ways of determining learning outcomes in schools. Educational assessment platforms utilize artificial intelligence to streamline grading and assessment creation. For instance, the study by Mirchi et al. (2020) used AI for simulation-based training in medicine, and they created a Virtual Operative Assistant to give automatic feedback to students based on metrics of performance. From a formative educational paradigm, they integrate virtual reality and AI to classify students in relation to proficiency performance benchmarks and the system gives feedback to help them improve.

In the field of medicine, Janpla and Piriyasurawong (2020) used of AI to produce tests in e-learning environments and they develop intelligent software to select questions for online exams. In a different work, Saplacan et al. (2018) repoted that feedback provided by digital systems in learning situations has some problems such as eliciting negative emotions (these are neglect, frustration, uncertainty, need for confirmation and discomfort) experienced by students in higher education. Samarakou et al (2016) used Student Diagnosis, Assistance, Evaluation System based on Artificial Intelligence, (StuDiAsE) for continuous monitoring and assessment of engineering students. Samarakou et al found that AI proves its usefulness to provide personalized feedback and evaluate performance with quantitative and qualitative information. Rodríguez-Ascaso et al. (2017) used adaptive learning systems and self-assessment for people with disabilities and found that the procedure allows students, both disabled and non-disabled, to self-assess and report adequately their preferences to access electronic learning materials. Although there were interaction problems in a number of students with visual impairment, AI-base adaptive learning systems and self-assessment is beneficial. Based on the review, it can be deduced that various authors used different AI tools that aligns with the nature of research they are executing.

There are very many assessment tools which include Online Assessment Tools (like Quizlet, Kahoot, Quizizz, Assessment Generator, and TestGen), Learning Management System (LMS) Assessment Tools (example Moodle, Blackboard, Canvas, Schoology and Edmodo), Game-Based Assessment Tools (like Classcraft, ClassDojo, Duolingo, Khan Academy, and CodeCombat), Mobile Assessment Tools (Socrative, Poll Everywhere, Nearpod, Top Hat, and Plickers). Other Assessment Tools are Google Forms, Microsoft Forms, SurveyMonkey, Typeform and JotForm. Further researches and evaluation of each these assessment tools should be carried out to determine which one best suit ones specific needs.

AI tools in Grading

In school, students' responses are systematically assigned quantities (scores) during class activities, or examination and this process is called grading. The grading of test-takers could be done manually or electronically (automated). Studies have shown the benefits of automated grading platforms in evaluating student work effectively. Oduntan et.al. (2018) examined a comparative analysis of Euclidean Distance and Cosine Similarity measure in an Automated Essay-Type Grading System where result showed that cosine similarity measure has a higher positive correlation than the Euclidean distance. Vijaya et al (2022) described and compared different methods based on machine learning, artificial intelligence and natural language processing that can be adopted to evaluate and score essays written by students. Suresh et al (2023), also developed an AI-powered system for automated essay grading. The system utilized natural language processing and Graph based techniques to analyze, and grade written essays. The system was able to provide a more efficient and accurate essay grading process, so the teachers can provide valuable feedback to students.

Some AI tools for grading are Rubric and Grading Tools (Rubric-O-Matic, Gradio, Gradecam, Rubric Studio, and Grading rubric), Automated Grading and Feedback Tools (for instance Turnitin, Grademark, PeerMark, Kritik, and Hypothesis), AI-Powered data analytics and reporting tools (Brightbytes, Illuminate Education, and SchoolCity). Other AI tools for reporting students' performance are Gradekeeper, TeacherKit and ClassDojo which is also consider assessment tool. Some of the tools can used to generate test items, assess students, score, grade and report performance simultaneously.

AI tools in Reporting

Reporting in education is the process of communicating students' academic progress and achievement to parents, guardians, students and those who have genuine needs for it. Grading and reporting are intertwined and very important in every educational setting. Teachers use report card, narrative report or letter, open/visiting day among other to tell parents about the academic achievement and challenges of their children. More recently, this process is also being automated. In the study by Cruz-Jesus et al. (2020), artificial intelligence techniques was used to identify features and patterns that would describe critical aspects of the academic achievements of students in high schools within the Portuguese public-school system would attain. The researchers employed various AI methods, including Artificial Neural Networks (ANNs), to analyze a dataset of 110,627 students from Portuguese public high schools in the academic year 2014/2015. The study concludes that AI methods, particularly Random Forest, can provide a valuable tool for predicting academic achievement and could be used to identify students at risk of failing early in the academic year. This could potentially lead to interventions that improve student outcomes and reduce the rate of school dropouts.

Ling (2023) investigated the impact of AI-mediated language instruction compared to traditional instruction on English learning achievement among learners in China. In this experimental research, the experimental group to receive instructions using the Duolingo AI platform while the control group did not. Both of the groups took a pre- and post-test to measure their English language proficiency in separate areas of listening, reading, writing, and speaking. Quantitatively, the results presented evidence that the experimental group's scores were significantly higher than those of the control group.

AI tools in reporting are numerous but studies in their usage are lacking. For instance the following AI tools are useful for grading and there include Rubric and Grading Tools (Rubric-O-Matic, Gradio, Gradecam, Rubric Studio, and Grading rubric), Automated Grading and Feedback Tools (for instance Turnitin, Grademark, PeerMark, Kritik, and Hypothesis), AI-Powered data analytics and reporting tools (Brightbytes, Illuminate Education, and SchoolCity). Other AI tools for reporting students' performance are Gradekeeper, TeacherKit and ClassDojo which is also consider assessment tool. Some of the tools can be used to generate test items, assess students, score, grade and report performance simultaneously, which means that they are multipurpose tools. Sánchez-Ruiz, et,al (2023) cautioned that the ethical implications of these systems and measures that guides appropriate implementation of these tools should be put in place to ensure their responsible use in academic environments.

It is a laborious task for teachers to manually craft their questions and answer options, especially in multiple choice questions (MCQs), mark, grade and reports data concerning the students. However, the use of AI tools would significantly simplify the process and make it easier to accomplish, and lead to a substantial reduction in teachers' workload. These will in turn afford teachers more time to provide additional support to students who need it. Unfortunately, many educators are hesitant to migrate from analogue ways of doing things to the use of digital tools that proves to be more productive, efficient, and more accurate. This paper aims to expose to researchers AI tools for in item generation, assessment, grading and reporting in education that could be explore in their studies.

Conclusion

The paper provides insights into the transformation of the education sector through AI and its tools in assessments. Educational institutions are increasingly adopting AI technologies for assessment purposes. As such it becomes crucial to understand the artificial intelligence tools that are essential in item generation, assessment, grading and reporting. The integration of artificial intelligence (AI) in educational assessment is aimed at improved productivity, precision, and student understanding among others. This has led to AI gaining significant acceptability in the education sector, thus, AI tools should be explored and utilized by teachers and researchers to achieve greater efficiency and improved educational outcomes.

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Utilization of ICT Tools to Improve English Language Acquisition among Open and Distance Learners in Opi Community Study Centre, Enugu State, Nigeria

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Abstract

The study examined the use of ICT tools in Improving English Language among Open and Distance learners in Opi community Study Center in Enugu State. The design adopted for this study was descriptive survey design. Two research purposes and two research questions guided the study. The population of the study comprised 251. 16 facilitators and 235 learners in NOUN Opi. The instrument for the study was a structured questionnaire, titled, Utilization of ICT Tools to Improve English Language Acquisition among Learners in ODL Questionnaire (UICTTELA). The questionnaire was face validated by three experts. Cronbach alpha reliability co-efficient of 0.76 was adopted. The data collected were analyzed using mean and standard deviation. Some findings revealed that ICT tools has great potential to improve the English learning skills of ODL if properly integrated in teaching and learning ,Also, Open Library app enable learners to explore diverse genres and authors, thereby expanding their reading skill. Recommendations are made.

Introduction

English language, which is the Nigeria's lingua franca is a subject taught in Nigerian schools from pre-primary school to the university level. English is compulsory in Nigerian schools especially in secondary schools because it is the language of communication, teaching and learning. Thus, without a credit pass in English language, in both Basic Education Certificate Examination (BECE) and West African Senior Secondary School Examination (WASSSCE) is declared incomplete. According to William (2013), English is the language of worldwide communication. The author emphasized that with 415 million speakers across 12 nations, English is the second most widely spoken language in the world after Mandarin Chinese, which has an estimated 800 million native speakers. Since English is required for interviews on international media, several hundred million people speak English, including most of the world's leaders. The importance of English language, which includes effective communication and its usage in business, makes its acquisition by learners in open eand distance-learning programme important.

Open and Distance Learning (ODL) refers to educational programs that are designed to provide learning opportunities to individuals who are not physically present in a traditional classroom setting. ODL leverages various technologies to deliver educational content, facilitate communication between instructors and students, and provide access to resources and support services. Open and distance learning programme is charactertised by flexibility, use of technology, and students centered learning. ODL programmes offer flexibility in terms of time and location. Learners can access course materials and complete assignments at their own pace and from any location, making education more accessible for those with personal or professional commitments (Perraton, 2016). Also, ODL relies heavily on digital technologies, including online learning platforms, video conferencing, and digital libraries. These technologies facilitate the delivery of content, interaction between students and instructors, and access to a wide range of resources (Moore & Kearsley, 2015).

Again, ODL promotes a learner-centered approach, where students have greater control over their learning process. This approach accommodates diverse learning styles and paces, enhancing the overall learning experience (Anderson & Dron, 2015).

Learners in Open and Distance Learning (ODL) programmes come from diverse backgrounds and have varied motivations, characteristics, and learning needs. A significant portion of ODL learners are adult learners who seek to enhance their skills, achieve professional development, or change careers. These learners often balance education with work, family, and other responsibilities (Bozkurt, 2019). ODL learners are typically self-motivated and capable of independent study. The absence of a physical classroom requires them to manage their time effectively and take responsibility for their learning (Garrison, 2017). Also, the learners in ODL may have a feeling of isolation since the absence of face-to-face interaction can lead to feelings of isolation among ODL learners. They may miss the social aspects of traditional learning environments, which can impact their motivation and engagement (Keegan, 2016). Therefore, learners in ODL are characterized by life experience, dedication, goal oriented and flexible learning. Since many of them are already engaged in work life and need promotion and improvement in their communications there is need to improve their learning of English language through Information communication technology.

Information and communication technology (ICT) alludes to technologies that allow for telecommunication-based information access, it covers the internet, wireless networks, mobile devices, and other contact channels. Kreijnsa, van Acker, Vermeulend, and van Buuren (2014) defined Information and Communication Technology as a set of tools enabling, supporting, and reinforcing educational reform. In the words of Ratheeswari (2018), Information and communication technology is the computer and internet connections used to handle and communicate information for learning purpose. Furthermore, Ratheeswari emphasised that ICTs are making dynamic changes in society. They are influencing all aspects of life. The influences are felt more and more at schools. Information communication technology can play a key role in the teaching and learning of oral English language. Information and communication technology can cover all the four skills of English language (Listening, Writing, Reading, and speaking). The modern way of teaching-learning process depends on information and communication technology (Mohammed, 2018). Mohammed stressed that ICT has a beneficial influence on students' attitudes towards oral English language learning. Students have a great chance to choose the components that will allow them to fulfill their learning strategies, which the conventional methods were unable to do. The availability of materials such as images, animations, audio, and video clips is very illustrative because it helps learners practice and show a language in novel ways. Hence, the need for the utilization of ICT in learning English language among learners in ODL programme.

Utilization is the effective application of materials or resources for accomplishing a task. Utilization is defined as the effective application of information communication technology (ICT) tools in teaching the language skills of reading, writing, speaking and listening in English language among learners in ODL programme. Information and Communication Technology tools offer a variety of ways to improve English language speaking skills among learners in ODL programme. Platforms like Duolingo, Rosetta Stone, and Babbel offer interactive lessons in English speaking. These platforms provide structured exercises, pronunciation practice, and real-life scenarios to engage learners actively. A study by Lian (2018) found that learners who used Duolingo significantly improved their English speaking proficiency compared to a control group. Again, Websites like

iTalki, Tandem, and HelloTalk connect learners with native English speakers for language exchange. Learners can engage in real-time conversations, receive feedback, and practice speaking in a natural environment. Research by Ren and Li (2017) demonstrated that language exchange activities facilitated through iTalki led to significant improvements in learners' speaking skills. More so, Virtual Reality and Augmented Reality technologies offer immersive environments for language practice. Apps like VRChat and MondlyVR allow learners to interact with virtual avatars or environments, practicing real-life scenarios such as ordering food in a restaurant or giving directions. A study by Lee and Wong (2019) found that learners who used VR-based language learning applications showed significant improvements in speaking fluency and confidence.

Additionally, mobile apps provide convenient and accessible ways for learners in ODL to practice speaking English anytime, anywhere. Apps like Speak English Fluently, ELSA Speak, and Speechling offer personalized feedback on pronunciation and speaking exercises. Research by Hsu and Chiu (2016) demonstrated that consistent use of mobile language learning apps led to improvements in learners' speaking accuracy and fluency. Also, platforms like Reddit, Stack Exchange, and language-specific forums provide spaces for learners to ask questions, share resources, and engage in discussions with other English speakers. Participating in these communities encourages active communication and helps learners gain confidence in speaking English. A study by Liu and Hsu (2015) highlighted the positive impact of online communities on learners' speaking proficiency through peer interaction and feedback. Therefore, ICT tools offer diverse opportunities for learners in ODL programme to enhance their English speaking skills through interactive platforms, virtual environments, mobile apps, and online communities.

Concomitantly, Information and Communication Technology (ICT) tools improves English language reading skills among learners in ODL. For instance, Interactive e-books and digital libraries provide multimedia-rich content, such as audio narration, animations, and interactive exercises, which cater to different learning styles and preferences (Sung, Chang, & Liu, 2017). These resources allow learners in ODL programme to engage with authentic English texts at their own pace and reinforce comprehension through interactive activities. Also, web-based platforms designed specifically for improving reading comprehension offer a range of texts tailored to different proficiency levels. These platforms often include features like vocabulary support, comprehension questions, and progress tracking (Jeon & Yamashita, 2016). Such platforms enable learners to practice reading in English within a supportive environment, receiving immediate feedback to enhance understanding. Continuing, mobile applications provide convenient access to reading materials anytime, anywhere. Apps like language learning platforms or news aggregators offer a plethora of English articles, stories, and news updates, allowing learners to immerse themselves in authentic English content (Liu & Zhang, 2018).

Additionally, some apps incorporate gamification elements to increase motivation and engagement among learners in ODL. Participating in online discussion forums and social media groups dedicated to English language learning enables learners in ODL programme to practice reading while interacting with peers and native speakers (Hoven & Palalas, 2017). Engaging in discussions on various topics exposes learners to diverse vocabulary, expressions, and cultural nuances, thereby enhancing their reading comprehension skills. Also, Adaptive learning systems utilize algorithms to tailor learning materials and activities based on learners' proficiency levels, learning preferences, and progress (Chen et al., 2019). These systems provide personalized reading experiences by

presenting texts matched to each learner's reading level and offering targeted feedback to address individual learning needs. Therefore, ICT tools offer a diverse range of resources and platforms that can significantly improve English language reading skills among learners in ODL programme through leveraging interactive e-books, online platforms, mobile applications, social media, and adaptive learning systems.

Therefore, since English language is the official language in Nigeria used for communication, trade and commerce, learning it becomes imperative for all and sundry. However, some learners in open and distance learning programme experience difficulty in learning the Englsh language skills reading, and writing. This may be as a result of poor teaching methods or lack of necessary material. Therefore, the need to introduce information communication technology as a means of improving English language acquisition among learners in open and distance learning programme.

Statement of the Problem

English language is the official language in Nigeria used for communication, trade and commerce, learning it becomes imperative for all and sundry. However, many learners in open and distance learning programme experience difficulty in learning the language skills in English language of reading, writing, speaking and listening and this create a barrier between learners and understanding what the teacher taught them.. The utilization of Information and Communication Technology (ICT) tools seems to be an alternative to bridge the gap. These tools would provide a dynamic and interactive learning environment, facilitating improvements in speaking, reading, writing, and listening skills.

However, the prevailing situation suggests that there might be limited access to ICT tools, inadequate training on their effective utilization, or insufficient integration of these tools into English language learning programmes for learners in ODL programme. As a result, learners in ODL may not be benefiting optimally from the potential advantages that ICT tools offer in language acquisition. Hence, the need to integrate information communication technology in teaching English language acquisition among learners in ODL programme is necessary.

Therefore, the problem of the study is to determine the extent to which ICT tools can be used to improve English language acquisition among learners in National Open University of Nigeria, Opi community study center, Nsukka Enugu State.

Purpose of the Study

The general purpose of the study is to determine the extent to which ICT tools can be use to improve English language acquisition among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State. Specifically, the study seeks to:

1. Determine the extent to which ICT tools has been used to improve speaking skills among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State.
2. Find out the extent to which ICT tools has been utilised to improve reading skills among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State.

Research Questions

The study were guided by the following research questions

1. To what extent has ICT tools been utilized to improve speaking skills among learners in National Open University of Nigeria, Opi community study center in Nsukka, LGA Enugu State?
2. To what extent has ICT tools been utilized to improve reading skills among learners in National Open University of Nigeria, Opi community study center in Nsukka, LGA Enugu State?

Methodology

The design adopted for this study was descriptive survey design. This is because it is fact finding in nature. Descriptive survey aims at collecting data on, and describing in a systematic manner the characteristics, features or facts about a given population. These studies are only interested in describing certain variables in relation to the population. (Nworgu, 2015). It is appropriate for this research because its sets to find out the utilization of ICT tools to improve English language acquisition among learners in NOUN Opi community study center, Nsukka, Enugu State. The study was conducted in Nsukka Local Government Area of Enugu State. Nsukka L.G.A has its headquarters located at Nsukka town, in the hilly and green sites which Nsukka is known for, close to colonial quarters of the pre-Independence years. .

The researcher chose Nsukka LGA for the study because, despite the presence of NOUN Opi study center in the area, the level to which the learners communicate in English and also understnd what is being taught is still low, hence the need to ascertain the utilization of ICT tools to improve the language skills in English language among the learners in NOUN Opi study center. The population of the study comprised 251. 16 facilitators and 235 learners in NOUN Opi community study centre. (NOUN, Opi study center, 2024). The entire population was not sampled because it is manageable and Questionnaire titled Utilization of ICT Tools to Improve English Language Acquisition among Learners in ODL Questionnaire (UICTTELA) was used to collect data relevant for the study. The questionnaire was designed for this study by the researcher in line with the two research questions guiding the study. The questionnaire includes two research questions. The respondents were required to tick (√) at the appropriate options that represented their opinion. Cluster A elicited data on the extent has ICT tools has been utilized to improve speaking skills among learners in NOUN Opi study center with 8-items. Cluster B elicited data on the extent ICT tools has been utilized to improve reading skills among learners in NOUN Opi study center with 6-items. The response mode adopted for the study was: Very High Extent (VHE) = 4points; High Extent (HE) = 3points; Low Extent (LE) = 2points; Very Low Extent (VLE) = 1point. The instrument for data collection was validated by 3 experts. 2 from the Departments of Adult Education and Extra-Mural Studies and one from Science Education, all from University of Nigeria, Nsukka, to ascertain the relevance of the instrument and its appropriateness to the study. After thorough assessment and corrections, they recommended that it is valid in terms of producing authentic results that will suit the study. The corrections made was used to draft the final copy of the instrument.

To ensure the reliability of the instrument, a trial test was carried out by giving out copies of the questionnaire to respondents. 10 facilitators and 15 learners from NOUN Enugu Study centre which is different from Opi community study centre but shares the same experience in terms of job orientation. The reliability co-efficient of 0.76, 0.72, was obtained for clusters A B respectively using Cronbach Alpha Statistical Tool. The researcher with the help of two (2) research assistants who were briefed collected the data for this study on the modalities and techniques to be used in administering the questionnaire to the respondents. The questionnaire was collected immediately to ensure high return. The researcher and her assistants distributed 251 copies of the questionnaire, and all of them were duly filled and returned. This idea is to help ensure high return rate of the instrument. In analysing the data generated from the field, the research question formed the basis for the analysis. The data generated were analysed with mean and standard deviation. After the data analysis, 2.5 above were used as the criterion mean for acceptance. If the calculated mean is 2.5 and above it means that the response item has been accepted otherwise reject.

Presentation of data

Research Question One: To what extent has ICT tools been utilized to improve speaking skills among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State?

Table 1: Mean Responses on the Extent ICT Tools have been Utilized to Improve Speaking Skills among Learners in National Open University of Nigeria Opi Community Study Centre.

n=251

S/N	Item Statement	Mean	SD	Decision
1	Zoom provide opportunities for learners to engage in real-time speaking practice	2.76	.59	HE
2	Skype provides simulations for face-to-face communication	2.88	.51	HE
3	Google Meet provides a supportive environment for learners to practice conversational English	2.63	.62	HE
4	Video chat connects language learners with native speakers for language exchange sessions	2.68	.58	HE
5	Virtual reality offer opportunities for learner to practice speaking English in virtual environments	3.74	.43	HE
6	Google Speech-to-Text provides instant feedback on pronunciation and intonation for learners.	3.89	.30	HE
7	Smart phones offer daily speaking exercises for learners	3.55	.65	HE
8	Virtual language lab software allows learners to record and playback the language of interest.	3.45	.65	HE
	Grand Mean	**3.19**	**0.54**	**HE**

Table 1 showed the mean responses on the extent ICT tools has been utilized to improve speaking skills among learners in National Open University of Nigeria Opi community study center. From the table, the mean ranges from M = 2.63 – 3.89. This showed that all the items in this cluster were accepted as the extent ICT tools has been utilized to improve speaking skills among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State.

Research Question Two: To what extent has ICT tools been utilized to improve reading skills among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State?

Table 2: Mean Responses on the Extent ICT Tools have been utilized to Improve Reading Skills among Learners in National Open University of Nigeria Opi Community Study Center.

n=251

S/N	Item Statement	Mean	SD	Decision
9	Read theory app provides personalized reading materials tailored to the proficiency level and interests of learners	3.16	.55	HE
10	Google Play Books allow learners to read at their own pace and customize their reading experience	3.62	.48	HE
11	Internet Archive provides materials with features like highlighting, note-taking, and built-in dictionaries	3.24	.44	HE
12	Open Library app enables learners to explore diverse genres and authors, thereby expanding their reading skill.	3.41	.85	HE
13	Voice Dream Reader app allows learners to listen to digital texts while following along with the written words	3.10	.51	HE
14	Goodreads and Library app facilitate virtual book clubs and reading groups where learners can learn more from their peers	3.65	.47	HE
	Grand Mean	**3.36**	**0.55**	**HE**

Table 2 revealed the mean responses on the extent ICT tools been utilized to improve reading skills among learners in National Open University of Nigeria Opi community study center. The table showed that the means responses range between M = 3.10 – 3.65. This showed that all the items in this cluster were accepted as the extent ICT tools has been utilized to improve reading skills among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State.

Discussion of Findings

This study showed that ICT tools highly improve the speaking skill of ODL in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State. This is because Zoom provide opportunities for learners to engage in real-time speaking practice. Skype provides simulatations for face-to-face communication. Google Meet provides a supportive environment for learners to practice conversational English. This finding is in agreement with Chun (2016) who noted that various online platforms, such as Zoom, Skype, and Google Meet, offer opportunities for adult learners to engage in real-time speaking practice with instructors or peers. These platforms simulate face-to-face communication and provide a supportive environment for learners to practice conversational English. Further the study showed that video chat connects language learners with native speakers for language exchange sessions. Virtual reality offers opportunities for learner to practice speaking English in virtual environment. Google Speech-to-Text provides instant feedback on pronunciation and intonation for learners. Smart phones offer daily speaking exercises for learners; and virtual language lab software allows learners to record and playback the language of interest. This finding supported by Bakla (2016) who stated that tools like Speech Recognition and Google Speech-to-Text convert spoken language into text, providing instant feedback on pronunciation and intonation for adult learners. These tools allow learners to identify and correct

pronunciation errors, thereby improving their speaking skills Apps like ELSA Speak, Speak English Fluently, and Speak English Daily offer speaking exercises, pronunciation drills, and dialogues for adult learners to practice speaking English anytime, anywhere using their smartphones (Li & Vasilakos, 2017).

In addition, the study showed that ICT tools highly improves reading skills among learners in National Open University of Nigeria Opi community study center in Nsukka, LGA Enugu State . This is because read theory app provides personalized reading materials tailored to the proficiency level and interests of learners. Google Play Books allow learners to read at their own pace and customize their reading experience. Internet Archive provides materials with features like highlighting, note-taking, and built-in dictionaries. This is in agreement with Tao and Sheu (2018) that Read Theory, and Read Works, offer a wide range of leveled reading passages accompanied by comprehension questions and interactive activities. These platforms provide personalized reading materials tailored to the proficiency level and interests of adult learners. E-book readers like Kindle and e-reader apps such as Apple Books and Google Play Books offer access to a vast library of digital books, allowing adult learners to read at their own pace and customize their reading experience with features like highlighting, note-taking, and built-in dictionaries (Kukulska-Hulme & Viberg, 2018).

Further, the study showed that Open Library app enables learners to explore diverse genres and authors, thereby expanding their reading skill. Voice Dream Reader app allows learners to listen to digital texts while following along with the written words; and Goodreads and Library app facilitate virtual book clubs and reading groups where learners can learn more from their peers. Text-to-speech software, such as Natural Reader and Voice Dream Reader, convert written text into audio, allowing adult learners to listen to digital texts while following along with the written words. Similarly, audiobook services like Audible provide access to professionally narrated books, enhancing accessibility and comprehension for readers with diverse learning preferences (Wylie & Coyne, 2016).

Conclusion

From the findings of this study,its crystal clear that ICT APPS has great potential to improve the English learning skills of ODL if properly integrated in teaching and learning It will also make it easy for the learners to understand other courses being taught in class and also make communication easy for both facilitators and learners..

Recommendations

Based on the findings of the study, the following recommendations are made:

1. There is need to facilitate ongoing professional development programmes to train facilitators on the effective use of ICT tools for teaching writing and listening skills. This can include workshops, seminars, and online courses focusing on integrating ICT into language instruction.
2. Also, there is need to encourage the sharing of best practices among facilitators through collaborative platforms and regular meetings. Facilitators who have successfully integrated ICT tools for speaking and reading can share their strategies and experiences.

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Effectiveness of Technology-Based Classroom Testing on Students' Academic Engagement in Geometry

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Abstract

Purpose: The study aimed to determine the effectiveness of technology-based classroom testing on students' academic engagement in geometry.

Design/Approach/Methods: Four research questions and hypotheses guided the study which adopted the within-subject experimental research design. The Kahoot mobile testing platform was used for the experiment. The study sample consisted of 44 SS II students drawn using a multistage sampling procedure. The instrument for data collection was a Geometry Student Academic Engagement Scale (GSAES) developed by the researcher and face validated by experts. The Cronbach Alpha reliability index of the GSAES was determined to be 0.91. The data for the study was collected on three occasions, before, during and after the experiment. The data was analyzed using Repeated Measures Analysis of Variance.

Findings: The data analysis showed that technology-based classroom testing effectively enhanced students' behavioural, social, cognitive and overall academic engagement in geometry. The difference in students' behavioural, social, cognitive and overall academic engagement in geometry was also significant.

Originality/Value: The study concluded that technology-based classroom testing effectively enhances students' academic engagement in geometry. The researcher recommended, among others, based on the study's findings that teachers should leverage technology-based classroom testing to enhance students' academic engagement.

Keywords: Technology, Testing, Academic, Behavioural, Social, Cognitive, Engagement

Introduction

Students' academic engagement in geometry has been blamed by educational stakeholders for the unsatisfactory performance of students in geometry, a subsection of Mathematics. The West African Examination Council (WAEC) chief examiner's report decry the unsatisfactory situation in mathematics (WAEC, 2023). In the realm of mathematics education, geometry plays a crucial role in developing students' spatial reasoning and problem-solving skills (Eren, et al., 2020). As such, understanding the effectiveness of technology-based testing (TBT) on students' academic engagement in geometry is important. Nwoke (2017) opine that geometry is an important aspect of mathematics, which helps students think logically to understand how

to deal with measurements and relationships of lines, space, angles, surfaces, positions, sizes, shapes and solids; to develop spatial abilities in the use of concrete materials and activities, and ideas of construction for fields of architecture and engineering fields. Agbo and Uzor (2021) described geometry as the branch of Mathematics that deals with shapes and space. Geometry in this study is viewed as a branch of mathematics that deals with space, lines, angles and shapes. Perhaps, it can be deduced that the knowledge of algebra offers useful initiatives by which students understand and appreciate the world and space around us. Also, the report suggested that a low level of students' academic engagement is a probable accomplice to the poor achievement of students in geometry-mathematics.

Students' academic engagement has been described as a key factor in raising the level of interest, motivation, and active participation in learning geometric concepts. Engaged students are more likely to persevere through challenging tasks, seek out additional resources for learning, and develop a deeper understanding of the subject matter (Tessmer & Richey, 2017). Abla and Fraumeni (2019) defined academic engagement as the level of intellectual, social and emotional readiness, curiosity and motivation to participate in learning endeavors. To Trowler et al (2022) students' academic engagement is a measure of students' participation in instructionally beneficial activities towards a measurable outcome. According to Agah et al. (2023), students' engagement in learning spaces is a crucial index for academic success. Evans and Zhu (2023) defined students' academic engagement as a measure of students' pursuit of learning objectives with efforts to overcome learning tasks. In this study, students' academic engagement connotes all efforts of student that gravitate towards active involvement with the content of the geometry learning materials to infuse mastery.

Theoretically, the framework of this study rests on the engagement theory, which clones experiences teaching with technology (Kearsley & Shneiderman, 1998). The engagement theory postulates that students connect with learning activities through interaction with others and through meaningful activity tasks. Drawing from the engagement theory, learning is noted to occur when students are sufficiently engaged with peers, significant others, technological devices and the environment. The engagement theory is sufficiently tenable to learning in technology-based environments, which involves collaborative efforts and can facilitate creative, meaningful, and authentic learning to facilitate student participation, interaction, and information access. Technology, including mobile devices, can also facilitate creativity and communication needed to sustain engagement (Bernacki et al., 2020). Students' academic engagement in this study is defined as a function of three component dimensions as accounted in Tomović (2021); and Agah et al. (2023) viz; behavioural engagement, associated with deportments; social or emotional engagement, associated with feelings; and intellectual or cognitive engagement, associated with the intellects.

Existing literature has delineated the dimensions of students' academic engagement. Trowler et al. (2022) defined behavior engagement as the level of students' involvement in learning to comply with behavioral norms, such as regular attendance and participation and eschewing negative or disruptive conducts. Behavioral engagement in this study refers to students' determination to conduct self to achieve the desired personal goals such as developing skills and passing the subject. Such goals can help diminish undesirable behavior by boosting intrinsic motivation and encouraging immersion in the learning process. Sobremisana and Aragon (2016); Delfino (2019); Hollister et al. (2022); He et al. (2022); and Pathak and Mishra

(2023) examined students' behavioural engagement and suggested it as a veritable indictor of academic success, especially when technology is integrated in the learning process. Tomović (2021) defined social engagement as the interaction between students, peers, and instructors that positively contributes to students' overall learning experiences. Social engagement allows students feel emotional, connected and concerned about the content of instruction and others in the learning environment, according to Agah et al. (2023). In this study, social engagement refers to the extent to which mathematics students communicate, feel connected and network with peers, teachers and other significant individuals and resources to surmount geometric problems. Alalwan (2022); Zhao et al. (2022); Pandita and Kiran (2023); and Kumar (2024) examined students' social engagement and highlighted its important contribution to academic success, especially when technology is integrated in the learning process. The intellectual engagement refers to students' cognitive investment and absorption in their academic work, which can stimulate students to go beyond boundaries and enjoy learning challenges (Hsieh & Chen, 2016). In this study, intellectual engagement refers to mathematics students' cognitive investment in the learning content to surmount the technology-based classroom testing (TBCT). Wallace-Spurgin, (2019); Azizan (2023); Godsk and Møller (2024); Ma et al. (2024); and Ma, Mutua and Kigen (2024) examined students' cognitive engagement and highlighted the important role it plays in the academic success of students, especially when technology is integrated in the learning process.

Academic engagements have been found in other fields to be effective in connecting students to real world experiences, thus, making instructional contents meaningful for students. Such a meaningful instruction prepares students for problem solving and enhances students' ability to transfer learning to solve real life problems. Students' academic engagement in geometry will likely position students in the realms of mastery with the learning contents for high achievement and may be indicated by interest, attention, optimism, curiosity and passion to persevere and execute learning tasks. Delfino (2019) highlighted that students' academic engagement is one of the essential ways of understanding the character and attitude of students during instruction. According to Lei et al. (2018), students' engagement is a strong determinant of academic achievement, which is the main focus of all academic interventions, especially in mathematics and specifically in geometry.

Although the importance of geometry in understanding the world around us, a plethora of scholars have been alarmed with the unsatisfactory achievement of students in mathematics over the years that has been tied to such an important part of mathematics. Khansila et al. (2022) believes that a number of reasons suffice why students perform poorly in geometry. Perhaps, among those is the orthodox testing approach used in classrooms, especially in developing countries like Nigeria, which exacerbates the current trend of adopting technology in examinations, according to Oguguo et al. (2024). According to Yilmazer and Keklikci (2015), the use of technology matters tremendously in geometry especially in converting abstract concepts into concrete terms for students. The National Council of Teachers of Mathematics (2000); Agwagah et al. (2019) believe that the use technology to support students' learning in mathematics can be of immense benefits, especially in geometry. Also, this suggests that the abysmal achievement of students in geometry can be alleviated by a technology based classroom testing (TBCT) approach.

The growing concerns of research in recent years, has beamed on exploring the effectiveness of technology-based classroom testing on students' academic engagement and achievement in various academic subjects, including Mathematics. The current wave of technology in education is fast metamorphosing learning spaces (Emaikwu et al., 2015), and is continuously finding enormous usefulness in the practices of assessments (Uduak et al., 2023). Mishra (2024) defined technology based testing (TBT) as a transition from the orthodox pen-and-paper testing to digital testing solutions often referred to as computer-based testing (CBT). In this study, the technology-based tests are assessment approaches that teachers employ to collect evidence of students' learning on geometric content using a test assessable on smart devices. The CBT slightly differs from the TBT in that the former is limited to the use of computer technology while the later expands to the use of other smart devices and internet of things (IoT) to administer, evaluate and report the outcome of test either online or offline unlike the orthodox paper-pencil-based format. Technology-based classroom testing (TBCT) is a formative assessment practice, involving the use of digital tools and platforms to administer tests for assessment purposes in classroom settings (Gikandi et al., 2011), and could be extended to summative as well as authentic assessments if the need arose. Such tests allow for immediate feedback, personalized learning experiences, and opportunities for students to engage with the material in a more interactive manner. Another major advantage of incorporating technology into classroom testing is that educators can better track student progress, identify areas of weakness, and tailor instruction to meet the diverse needs of learners. The emergence defines the modern era of testing which is marked with a sprinting efficiency and flexible.

A growing number of studies have investigated the integration of technology in assessment practices like class tests. Elmahdi et al. (2018) found that technology based formative assessment enhanced students' learning engagement, saved time, guaranteed equal participation opportunities, and made the learning environment fun and exciting. Simpson et al. (2020) demonstrated that technology enhanced formative assessment was effective for enhancing students' engagement and learning motivation. Hagos and Andargie (2022) fount that the integration of technology in formative assessment practices like tests improved students' engagements and learning outcome. Huang et al. (2024) showed that technology-enhanced formative assessment improved students' achievement and engagement in learning. Evidence from these studies suggest technology based classroom tests can influence student engagement by providing immediate feedbacks that facilitate critical thinking, problem-solving abilities, self-esteem, confidence and motivation. However, there is no clear empirical evidence to explain the effectiveness of technology-based classroom testing (TBCT) on students' academic engagement and achievement in geometry. The significance of this study is to provide educators with insights on the effectiveness of technology based classroom testing (TBCT) towards enhancing learning outcomes in geometry. Also, to bridge the gap between technology integration and formative assessment practices in geometry, this study ultimately contributes to the advancement of teaching and learning in mathematics. Hence, the present study investigated the effectiveness of technology-based classroom testing (TBCT) on students' academic engagement for improved achievement in geometry using the Kahoot testing platform. The study was steered by the following questions:

1. What are the mean behavioural academic engagement score of students in geometry before, during and after exposure to TBCT?
2. What are the mean social academic engagement score of students in geometry before, during and after exposure to TBCT?
3. What are the mean cognitive academic engagement score of students in geometry before, during and after exposure to TBCT?
4. What are the mean joint academic engagement (behavioural, social and cognitive) score of students in geometry before, during and after exposure to TBCT?

Hypotheses

HO_1: The mean scores of students' behavioural academic engagement in geometry before, during and after TBCT do not significantly differ.

HO_2: The mean scores of students' social academic engagement in geometry before, during and after TBCT do not significantly differ.

HO_3: The mean scores of students' cognitive academic engagement in geometry before, during and after TBCT do not significantly differ.

HO_4: The mean joint academic engagement (behavioural, social and cognitive) scores of students' cognitive academic engagement in geometry before, during and after TBCT do not significantly differ.

Materials and Methods

The within subjects (repeated measure) research design was adopted in the experimental study. According to McLeod (2023) the within subjects research design collects measurements at different times or occasions on the dependent variable condition from the same subjects. The measurement occasions serving as control, one to another (Ugwuany, 2022). The researcher applied the repeated measures research design in the study due to the small sample size accessible due to the availability of mobile smart devices required for the experiment. Three occasions of data were collected in the study, three weeks before the treatment, immediately at the end of the first treatment session (considered as during treatment) and three weeks' time after the treatment (Technology-based classroom testing, TBCT, using Kahoot testing platform). This is represented as:

$$O_a \quad X \quad O_b \quad O_c$$

Where,

O_a = before treatment

O_c = after treatment

X = Treatment (TEFA)

O_b = during treatment

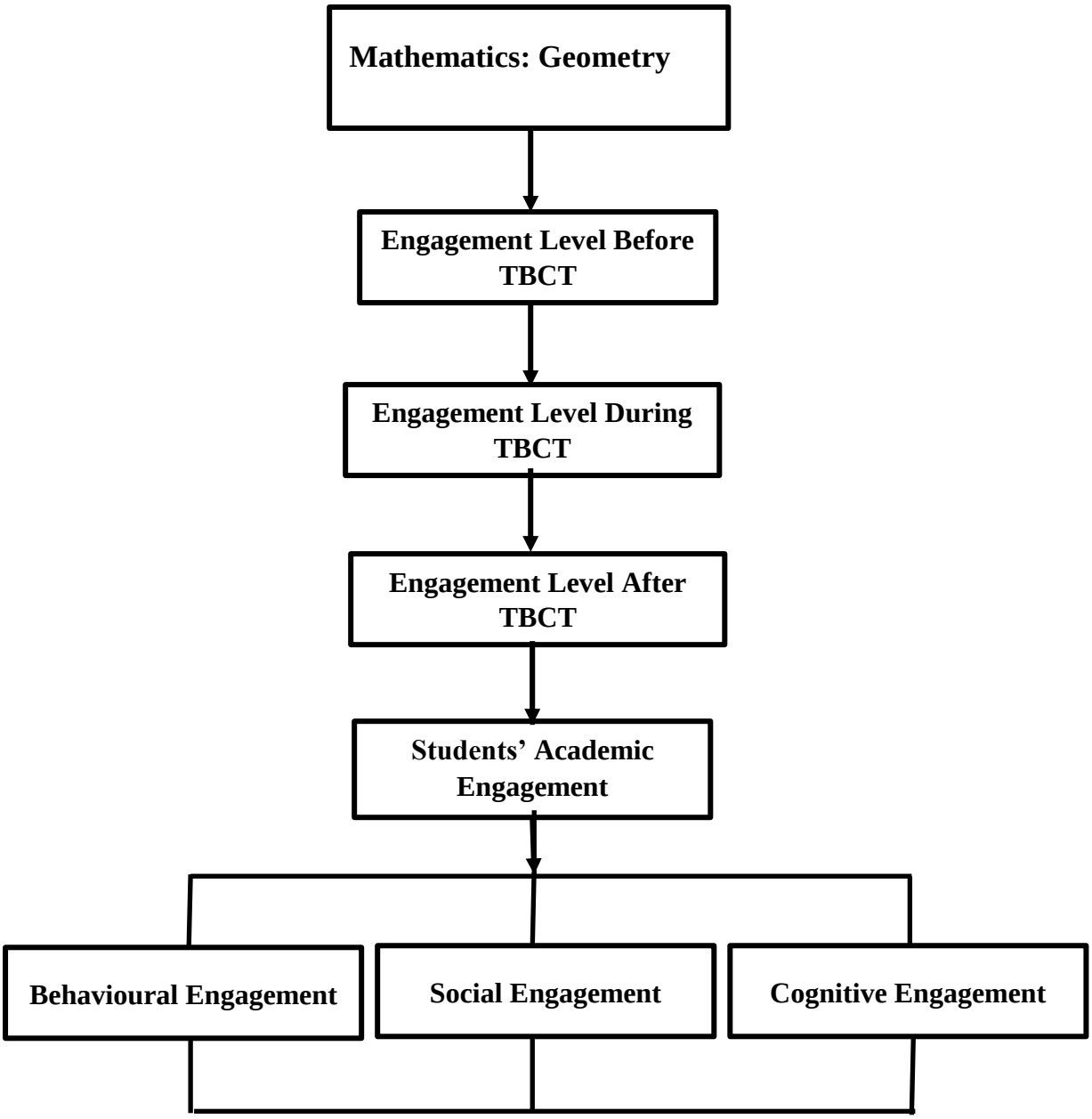

Figure 1. Schematic representation of the study

In Figure 1, geometry is conceptualized as the basis for the problem in mathematics among secondary school students, perhaps due to insufficient engagement with the content of instruction. To investigate the problem, technology based classroom testing (TBCT) was integrated into instruction and data on students' academic engagement level composed of behavioural, social and cognitive engagements were collected from the same set of students before, during and after the TBCT to determine the effectiveness of the instructional intervention at those times separately and collectively as dimensions of students' academic engagement in geometry.

The same subjects participated in all sessions of the experiment. The study was conducted in Nkanu-East Local Government Area (LGA) one of the 17 LGAs and part of the Agbani Education zone, in Enugu State, Nigeria. The sample for the study was 44 SS II (23 male and

21 female) students drawn from a population of 7736 SS II students in the LGA. A multistage sampling procedure was used to draw the sample for the study. In the first stage, two public senior secondary schools in the LGA were drawn by simple random sampling technique via balloting with replacement. In the second stage, a disproportionate random sampling technique was used to draw 22 students from each of the sampled schools. Finally, a simple random sampling technique by a dip-of-luck was used to select the students who participated in the study.

The instrument for data collection was a researcher-developed 27-item "Geometry Student Academic Engagement Scale" (GSAES). The GSEAS was prepared based on the 4-point Likert scale response type and was used to elicit responses on students' academic engagement in geometry. GSEAS contain 9 item statements in each of the three clusters to elicit responses on each domain: behavioural, social and cognitive academic engagement of students in geometry. The GSEAS was face-validated by three experts in the Psychology unit, Department of Educational Foundations, Measurement and Evaluation unit and Mathematics Education Unit, Department of Science Education, all in the Faculty of Education, University of Nigeria, Nsukka. The internal consistency of the GSEAS emerged as 0.91 for the overall scale and 0.93, 0.79 and 0.88 for the respective clusters using the Cronbach Alpha method after pilot testing the instrument on SS II students in Enugu North LGA.

The experiment was conducted directly by two trained regular SS 2 mathematics teachers of the students in the sampled schools as research assistants. The research assistants were trained for three days before the experiment on the purpose of the experiment, the use of the experimental lesson plan, the methods of the experiment and the administration of the instrument. The treatment was a technology-based classroom testing instructional procedure facilitated by the Kahoot platform on mobile phones and the teachers' laptop computer. The data for the study was collected three weeks before the treatment, during the one school week treatment period and three weeks after the treatment. The experiment lasted for seven weeks. Extraneous variables were controlled in the experiment. The single experimental group eschewed any chance of subject interaction. Regular class mathematics teachers were trained and used to conduct the experiment in the sampled schools as research assistants to control for Hawthorne effect. The school administration ensured that the subjects sampled were available and partook in all sessions of the experiment to avoid subject mortality in the experiment. The time lag between the collection of data ensured that the subjects did not simply recall their initial responses on the items and given that they were not informed about the resurgence of the data collection, these minimized the effect of test-wiseness.

The data collected in this study was analyzed by Repeated Measures Analysis of Variance in Statistical Package for Social Sciences (SPSS) version 25 software. Mean and standard deviation were used to address the research questions while the hypotheses were tested at 0.05 level of significance using within subjects Analysis of Variance (ANOVA). The analysis was based on within-subjects effect and the assumptions of data normality and sphericity. The obtained exact probability (p) value was the basis for decision on the null hypothesis, it was rejected if it was less than 0.05. The Mauchly's W test of Sphericity showed a significance of (W=0.97, 2) p = 0.55, (W=0.98, 2) p = 0.62, (W=0.96, 2) p = 0.43 and (W=0.94, 2) p = 0.30 for the variables, behavioural engagement, social engagement, cognitive engagement and the joint engagement respectively indicating that the variances of the differences are not

significantly different for each, hence implying sphericity in the normally distributed data for the dependent variables in the study.

Ethical Clearance

The management of the sampled school ethics provided ethical permission for the conduct of this study.

Results

Table 1: Mean and standard deviation of students' engagement in geometry n = 44

Test Occasion	Before		During		After	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Behavioural Engagement	16.14	4.91	21.27	4.95	27.95	3.66
Social Engagement	15.98	3.77	16.52	5.28	19.32	4.22
Cognitive Engagement	19.89	4.83	23.20	4.47	27.05	3.87
Joint Engagement	52.00	9.60	61.00	9.42	74.32	7.49

n = Sample size, $\bar{X}$ = Mean, SD = Standard Deviation

Table 1 presents the mean and standard deviation on the behavioural, social, cognitive and joint dimensions of students' engagement in geometry. Before the treatment, the mean score of 16.14 and a standard deviation of 4.91 was recorded for students' behavioural engagement, during the treatment, a mean score of 21.27 and a standard deviation of 4.95 was recorded for students' behavioural engagement and after the treatment, a mean score of 27.95 and a standard deviation of 3.66 was recorded for students' behavioural engagement in geometry. This indicated that students' behavioural engagement was lowest before the treatment commenced, increased as the treatment progressed and peaked after the treatment was completed with the lowest standard deviation after the administration of the treatment.

From Table 1, prior the treatment, the mean score of 15.98 and a standard deviation of 3.77 was recorded for students' social engagement, during the treatment, a mean score of 16.52 and a standard deviation of 5.28 was recorded for students' social engagement and after the treatment, a mean score of 19.32 and a standard deviation of 4.22 was recorded for students' social engagement in geometry. This also indicated that students' social engagement was lowest before the treatment commenced, increased as the treatment progressed and peaked after the treatment was completed with the lowest standard deviation before the administration of the treatment.

Also, Table 1 shows that prior the treatment, the mean score of 19.89 and a standard deviation of 4.83 was recorded for students' cognitive engagement, during the treatment, a mean score of 23.20 and a standard deviation of 4.47 was recorded for students' cognitive engagement and after the treatment, a mean score of 27.05 and a standard deviation of 3.87 was recorded for students' cognitive engagement in geometry. This also indicated that students' cognitive engagement was lowest before the treatment commenced, increased as the treatment progressed and peaked after the treatment was completed with the lowest standard deviation

before the administration of the treatment. While cognitive engagement means increased steadily, the standard deviation reduced steadily indicating a nexus of technology based testing on students' cognitive engagement in geometry.

Furthermore, Table 1 shows that prior the treatment, the mean score of 52.00 and a standard deviation of 9.60 was recorded for students' joint (behavioural, social and cognitive) academic engagement, during the treatment, a mean score of 61.00 and a standard deviation of 9.42 was recorded for students' joint academic engagement and after the treatment, a mean score of 74.32 and a standard deviation of 7.49 was recorded for students' joint academic engagement in geometry. This also indicated that students' joint academic engagement was lowest before the treatment commenced, increased as the treatment progressed and peaked after the treatment was completed with the lowest standard deviation before the administration of the treatment. While joint academic engagement means increased steadily, the standard deviation reduced steadily indicating a nexus between technology based classroom testing on students' joint academic engagement in geometry.

Table 2: Significance in the mean engagement scores of students in geometry due to TBCT

Tests of Within-Subjects Effects

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Occasion	Behavioural_ Engagement	Sphericity Assumed	3090.24	2	1545.12	88.80	.00	.67
		Greenhouse-Geisser	3090.24	1.95	1588.21	88.80	.00	.67
		Huynh-Feldt	3090.24	2.00	1545.12	88.80	.00	.67
		Lower-bound	3090.24	1.00	3090.24	88.80	.00	.67
	Social_ Engagement	Sphericity Assumed	282.68	2	141.34	7.39	.00	.15
		Greenhouse-Geisser	282.68	1.96	144.55	7.39	.00	.15
		Huynh-Feldt	282.68	2.00	141.34	7.39	.00	.15
		Lower-bound	282.68	1.00	282.68	7.39	.01	.15
	Cognitive_ Engagement	Sphericity Assumed	1129.56	2	564.78	83.11	.00	.66
		Greenhouse-Geisser	1129.56	1.93	586.90	83.11	.00	.66
		Huynh-Feldt	1129.56	2.00	564.78	83.11	.00	.66
		Lower-bound	1129.56	1.00	1129.56	83.11	.00	.66
	Joint_ Engagement	Sphericity Assumed	11094.97	2	5547.49	107.57	.00	.71
		Greenhouse-Geisser	11094.97	1.90	5856.13	107.57	.00	.71
		Huynh-Feldt	11094.97	1.98	5605.36	107.57	.00	.71
		Lower-bound	11094.97	1.00	11094.97	107.57	.00	.71
Error (Occasion)	Behavioural_ Engagement	Sphericity Assumed	1496.42	86	17.40			
		Greenhouse-Geisser	1496.42	83.67	17.89			
		Huynh-Feldt	1496.42	86.00	17.40			
		Lower-bound	1496.42	43.00	34.80			
	Social_ Engagement	Sphericity Assumed	1643.99	86	19.12			
		Greenhouse-Geisser	1643.99	84.09	19.55			
		Huynh-Feldt	1643.99	86.00	19.12			
		Lower-bound	1643.99	43.00	38.23			
	Cognitive_ Engagement	Sphericity Assumed	584.44	86	6.80			
		Greenhouse-Geisser	584.44	82.76	7.06			
		Huynh-Feldt	584.44	86.00	6.80			
		Lower-bound	584.44	43.00	13.59			
	Joint_ Engagement	Sphericity Assumed	4435.03	86	51.57			
		Greenhouse-Geisser	4435.03	81.47	54.44			
		Huynh-Feldt	4435.03	85.11	52.11			
		Lower-bound	4435.03	43.00	103.14			

Table 2 presents the significance of the means of students' academic engagement on different testing occasions before, during and after exposure to Technology based classroom testing (TBCT). An F value of 88.80 and associated probability value of 0.00 was obtained for the significance of the mean behavioural engagement before, during and after the TBCT treatment. Since 0.00 < 0.05, the null hypothesis one (HO_1**)** which states that the mean scores of students' behavioural academic engagement in geometry before, during and after TBCT do not significantly differ was rejected. Therefore, the mean scores of students' behavioural academic engagement in geometry differs significantly before, during and after TBCT. The effect size of 0.67 indicated that 67% increase in students' behavioural academic engagement scores in geometry was due to the TBCT intervention. This indicates a reasonable difference in the mean behavioural academic engagement scores of students in geometry before, during and after exposure to TBCT.

The obtained F value of 7.39 has an associated probability value of 0.00 for the significance of the mean social engagement before, during and after the TBCT treatment. Since 0.00 < 0.05, the null hypothesis two (HO_2**)** which states that the mean scores of students' social academic engagement in geometry before, during and after TBCT do not significantly differ was rejected. Therefore, the mean scores of students' social academic engagement in geometry differs significantly before, during and after TBCT. The effect size of 0.15 indicated that 15% increase in students' social academic engagement scores in geometry was due to the TBCT intervention. This indicates a reasonable difference in the mean social academic engagement scores of students in geometry before, during and after exposure to TBCT.

Also, the obtained F value of 83.11 has an associated probability value of 0.00 for the significance of the mean cognitive engagement before, during and after the TBCT treatment. Since 0.00 < 0.05, the null hypothesis three (HO_3**)** which states that the mean scores of students' cognitive academic engagement in geometry before, during and after TBCT do not significantly differ was rejected. Therefore, the mean scores of students' cognitive academic engagement in geometry differs significantly before, during and after TBCT. The effect size of 0.66 indicated that 66% increase in students' cognitive academic engagement scores in geometry was due to the TBCT intervention. This indicates a reasonable difference in the mean cognitive academic engagement scores of students in geometry before, during and after exposure to TBCT.

Furthermore, an F value of 107.57 and an associated probability value of 0.00 was obtained for the significance of students' mean joint (behavioural, social and cognitive) academic engagement before, during and after the TBCT treatment. Since 0.00 < 0.05, the null hypothesis three (HO_4**)** which states that the mean scores of students' joint academic engagement in geometry before, during and after TBCT do not significantly differ was rejected. Therefore, the mean scores of students' joint academic engagement in geometry differs significantly before, during and after TBCT. The effect size of 0.71 indicated that 71% increase in students' joint academic engagement scores in geometry was due to the TBCT intervention. This indicates a reasonable difference in the mean joint academic engagement scores of students in geometry before, during and after exposure to TBCT.

Discussion

Findings from the study suggest that technology based classroom testing (TBCT) is effective for improving students' academic engagement in geometry. The finding of the study showed that technology based classroom testing (TBCT) was effective in improving the dimensions of students' academic engagement in geometry. The outcome of the study showed that TBCT improved students' behavioural academic engagement. This may be a result of the ethical conduct often emphasized in computer education lessons encouraging students to comport themselves and behave responsibly instead of conducts that may warrant unsuccessful computer reactions. Also, students in this tech-driven era are often more motivated in when technological devices are applied for instructional purposes. The finding of this study agrees with those of Sobremisana and Aragon (2016); Delfino (2019), Hollister et al. (2022); He et al. (2022); and Pathak and Mishra (2023) to the extent that the integration of technology enhanced students' behavioural engagement. The finding of this study calls to mind the effectiveness of technology based classroom testing in enhancing students' behavioural academic engagement in geometry.

The finding of this study also showed that technology based classroom testing (TBCT) was effective in improving students' social academic engagement. This may be as a result of the need to navigate the computer program environment in the quest for success on the testing which may not be a requirement on the geometry trait being tested. Also, the current adoption of technology encourages a certain degree of collaboration with peers to advance and make the best use of the technology device and platform. The finding of this study agrees with those of Alalwan (2022); Zhao et al. (2022); Pandita and Kiran (2023); and Kumar (2024) to the extent that the integration of technology enhanced students' social engagement. The finding of this study calls to mind the effectiveness of technology based classroom testing in enhancing students' social academic engagement in geometry.

Also, the finding of this study showed that technology based classroom testing (TBCT) was effective in improving students' cognitive academic engagement. This may be because the testing program environment motivates students to perform at their intellectual peak. Also, it may have some potentials to ignite a connection to the real world senecios and support meaningful learning thus enhancing geometry problem solving skills and engaging the cognitive ability of students. In fact, technology based testing in classrooms may have strong capabilities following the immediate feedback to stimulate students mental functioning and the curiosity to sustain their engagement in learning geometry. The finding of this study agrees with those of Wallace-Spurgin, (2019); Azizan (2023); Godsk and Møller (2024); Ma et al. (2024); and Ma et al. (2024) to the extent that the integration of technology enhanced students' cognitive engagement. The finding of this study calls to mind the effectiveness of technology based classroom testing in enhancing students' cognitive academic engagement in geometry.

Furthermore, the finding of this study portrayed the effectiveness of technology based classroom testing (TBCT) in improving students' joint or overall academic engagement based on the behavioural, social and cognitive dimensions. It is possible that the integration of technology in the classroom testing scenarios may have warranted the unprecedented improvement in students' academic engagement mean scores. The current day students, as digital natives are very comfortable with technological tools and when such devices are

integrated in the instructional environment, one can only expect a heightened response of students expressed by their engagement in the academic matters for as long as such intervention is sustained. The finding of this study agrees with those of Lei et al. (2018); Delfino (2019); Alalwan (2022); Zhao (2022); Pandita and Kiran (2023); Pathak and Mishra (2023); and Kumar (2024) to the extent that the integration of technology enhanced students' academic engagement. The finding of this study emphasizes the effectiveness of technology based classroom testing in enhancing students' academic engagement in geometry.

Conclusion

The continuous intrusion of technology in classrooms and the attendant interest of students to explore beyond boundaries has raised curiosity concerning the effectiveness of technological interventions in classrooms. The purpose of the study was to determine the effectiveness of technology based classroom testing (TBCT) on students' academic engagements both separately as dimensions of academic engagements (behavioural, social and cognitive) and jointly in geometry. The within subjects, repeated measures research design was adopted for the study. The study found that TBCT was effective for improving students' academic engagement in geometry. Therefore, the study concluded that TBCT effectively enhances students' academic engagement in geometry.

Recommendations

Relying on the outcome of this study, the researchers recommended among others, that:

1. Teachers should leverage technology-based classroom testing to enhance students' academic engagement.
2. School management should support technology-based classroom testing in their schools for enhanced students' achievement.
3. Government should collaborate with experts in providing support, training and facilities for effective implementation of technology-based classroom testing in schools to ensure students engage with geometry lesson contents to foster improved academic achievement in mathematics.

Availability of Data and Material

The dataset generated and analysed during the current study are available in SPSS ".sav" format in google drive repository at https://drive.google.com/file/d/1B1hkcy3yzoTL2Y1vJrnCzMxcXlQZFbjn/view?usp=sharing

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Development of Interactive Multimedia-Based Courseware for Early Childhood Education using Authoring Systems

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Abstract

The study developed an interactive multimedia-based courseware (IMBC) for preschools using authoring systems. Five specific purposes, five research questions and three null hypotheses guided the study. The Research and Development (R&D) design based on the theoretical foundation of Incremental Software Development Model (ISDM), was adopted for the study. The study involved four phases: Phase I (Needs assessment); Phase II (Development of the IMBC); Phase III (Validation of the IMBC); and Phase IV (Trial-testing the IMBC). The participants for the study comprised five (5) ICT experts, nine (9) lecturers in the Department of Computer & Robotics Education, 69 parents, and 35 preschool teachers. Structured questionnaire were developed and used for data collection. The reliability of the questionnaire was determined using the Cronbach Alpha method, and an overall reliability coefficient of 0.83, was obtained. Mean and standard deviations were used to answer the research questions while t-test statistic was used to test the null hypotheses at 0.05 level of significance. The findings of the study revealed that IMBC proved to be effective in teaching basic literacy and numeracy to preschoolers. Preschool teachers and parents were satisfied with the contents of the IMBC. The study also revealed that preschoolers were excited with the IMBC, because, it actively engaged them in the learning process, and helps them in identification and classification of objects shown on the screen as well as in spelling and pronunciation of words. Based on the findings of the study, the researchers recommended that preschools should be equipped with modern ICT gadgets to encourage the integration of innovative products into the curricular of early childhood education. The preschool teachers should be trained regularly on the effective ways of implementing ICTs in the classroom.

Keywords: Multimedia, Interactive Multimedia, Preschool, Authoring Systems, Courseware

Introduction

Early childhood education is the type of education given to children in their formative early years in order to prepare them for further education. Section 2 of the National Policy on Education (NPE) refers to early childhood/pre-primary education as education given in an educational institution to children prior to their entering the primary school (Federal Republic of Nigeria (FRN), 2004). It includes the creche, the nursery and the kindergarten (FRN, 2004). The objectives of early childhood education, according to the NPE document, include inculcating in the child the spirit of enquiry and creativity through the exploration of nature, the environment, art, music and playing with toys, etc.; developing a sense of co-operation and team-spirit; learning good health habits; and teaching the rudiments of numbers, letters, colours, shapes, forms, etc.

Children are seen as the future hope for tomorrow and it is the desire of parents to provide their children with the basic knowledge and skills that will improve their wellbeing and guarantee their future education and career. It would therefore be disappointing if the expectations of parents, communities and the society were not actualized because of poor training of children at the early

stages of life especially in this era of digital technology. According to Preradovic, Unic, and Boars (2014), introducing innovative teaching and learning approaches in early education are vital in educating the digital citizens who grow up in the world of modern technologies.

Today's young learners grow up in the world of internet technologies unlike the previous generations (Nwangwu et al., 2024). Several studies have revealed that digital technologies such as interactive multimedia-based courseware gives young learners the opportunity to be actively involved in their learning experience, enhances their social, language and cognitive skills as well as enables them to discover the world around them (Overton, 2015; Kneas & Perry, 2015; Munoz 2018; Scott 2021). Interactive multimedia-based courseware (IMBC) refers to digital content that allows user interaction with dynamic and immersive experiences by integrating multiple forms of media, such as text, audio, video, images, and animation that simplify the learning process. According to Encyclopedia Britannica (2017), interactive multimedia-based courseware is any computer-delivered electronic system that allows the user to control, combine, and manipulate different kinds of media, such as text, sound, video, computer graphics, and animation. It is one of the innovative strategies that can be employed in teaching and learning process in early childhood education. Children of nowadays are born into the world of digital technologies and would prefer being taught with interactive multimedia courseware to enable them compete favourably with their counterparts globally. The benefits of age-appropriate interactive multimedia-based courseware include its ability to make learning fun, motivate pupils to learn and to create an opportunity for them to become active participants in the learning process (Nwangwu, 2024; Rvachew 2021; Open Colleges 2020).

Children learn fast by what they see and hear which makes them audio-visual learners. However, Baird (2022) pointed out that children of nowadays do not only visualize and listen to contents but also manipulate devices at their disposal for interactive learning, which could improve their mastery of learned contents, knowledge retention, motivation to learn, control over what they learn, and improvement in their academic achievements. In order to achieve this aim, there is need to digitalize the curricular of the early childhood education especially the basic literacy and numeracy curricular to augment the face-to-face mode of teaching and learning. Education stakeholders should encourage the development and use of indigenous-based interactive multimedia courseware in early childhood education since most of the available courseware are foreign-based. This will help in promoting the African culture, language, teaching and learning patterns, among others. According to Nwangwu (2021), most foreign-based multimedia tutorials are often linear, somehow blurred with inaudible narrations, and often play so fast that learning with them can be challenging. These limitations motivated the researchers to develop an indigenous-based interactive multimedia courseware for teaching literacy and numeracy in early childhood education in Nigeria.

The implementation of interactive multimedia courseware in early childhood education requires the dedication of the teacher in ensuring that the pupils are well guided in using digital technologies for their learning. The teacher input makes facilitation of the learning process easy, provides support to the children, and guides them in using digital technologies responsibly. A study by

Ganyaupfu, (2013) revealed that teacher-student interactive method was the most effective teaching method, followed by student-centered method while the teacher-centered approach was the least effective teaching method.

Interactive multimedia-based courseware (IMBC) are developed using authoring tools such as Adobe Animate, iSpring Suite, Adobe Captivate, Camtasia Studio, etc. Nichols (2024) defined an authoring tool as a program that enables developers to create a digital course and publish it in select formats. Instead of using code to manually create a course, an authoring tool lets developers use drag-and-drop and other user-friendly interfaces to make a course – no coding required (Nichols, 2024). According to Stanojevic (2024), authoring tools are those used to create, collaborate, integrate, and publish engaging and interactive content meant mostly for training and educational purposes. Similarly, Andreev (2024) refers to authoring tool as software application or platform that enable users to create multimedia content, including text, graphics, audio, and video, in a cohesive and interactive format. The use of the authoring systems for the development of the courseware is because such systems allow the use of scripting language and pre-programmed elements for the development of interactive multimedia software titles, and they are easy to use by non-programmers to create enriching contents. According to Avelino (2023), authoring software applications are designed to improve and simplify the entire process of digital learning content creation; are easy to use and have many useful features, like course customization, gamification, and quiz creation; and are primarily used by experts, managers, and trainers looking to train, educate, and upskill their workforce.

The present study developed an IMBC for teaching literacy and numeracy using Adobe Animate and other authoring/multimedia tools. Adobe Animate was developed by Adobe for use in designing vector graphics and animation for television series, online animation, websites, rich web applications, game development, commercials, and other interactive projects (Wikipedia, 2024). The program also offers support for raster graphics, rich text, audio video embedding, and ActionScript 3.0 scripting. With Adobe Animate, developers can quickly publish to multiple platforms in just about any format and reach viewers on any screen (Adobe, 2024).

Despite the benefits of interactive multimedia-based courseware in early learning, it is surprising that in this era of ICT proliferations, most public and private preschools in Nigeria still subject the young learners to learning basic literacy skills (numeracy, writing, reading and life skills), in a hard way, using marker and whiteboard (and in some cases, blackboard and chalk). The children, who are supposed to learn through animated audio-visual contents projected on the digital screen or installed in the school tablets, are made to read abstract contents that are difficult to understand. Children are forced to resort to rote memorization, which do not promote mastery and long-term retention of learned concepts. This negatively affects children's interest in learning leading to possible drop out of school, refusal to go to school, or loss of interest in education. Therefore, teaching children with digital technologies such as interactive multimedia-based courseware will expose children to real-life practical-oriented concepts in areas of literacy and numeracy. Studies (Wong & Neuman 2016; Barasa, Barasa, & Omulando 2020; Rvachew 2021) revealed that the use of multimedia in preschools provokes the interest of young learners in learning, simplifies their

understanding of abstract and difficult concepts, boosts their confidence in approaching new issues creatively, and improves their problem-solving skills.

Statement of the Problem

Early childhood education in Nigeria is struggling to adopt and implement best practices required to educate young learners in ways that motivate them to engage in learning activities. The Covid-19 pandemic crises exposed the low level of integration of digital technologies in early education and training. In Nigeria, the young learners, who were locked down at home due to the Covid-19 pandemic, were mostly taught remotely through radio broadcast, and in some cases, with the use of WhatsApp to post scanned notes or written texts. These deprived children who learn through animated interactive audio-visual materials of quality learning during the pandemic era.

Some other challenges faced in teaching young learners include the use of foreign-based cartoons that are not appropriate for African culture since most of them teach children violence, sex abuse (or pornography), as well as the challenge of language barrier, among others. Furthermore, the production of indigenous digital contents for early childhood education has not been given adequate attention it deserves. In Nigeria, content creators often focus mainly on creating contents for secondary and tertiary education (Adetona, Ogunyemi & Oduntan, 2021), with little or no attention given to early childhood education. Little wonder Patti (2008) revealed that literacy achievement scores have been declining in Africa; and that young children drop out of school without acquiring the basic literacy skills. These concerns could be addressed by developing interactive multimedia-based indigenous courseware for early childhood education that will complement the face-to-face mode of teaching and learning.

Purpose of the study:

Generally, the study focused on the development of interactive multimedia-based courseware (IMBC) for early childhood education using the authoring systems. Specifically, the study:

1. developed IMBC for teaching literacy and numeracy in early childhood education
2. validated the functionality of the IMBC in teaching literacy and numeracy.
3. determined the level of user satisfaction with the developed IMBC.
4. determined the level of interest of preschoolers in using IMBC for learning literacy and numeracy.
5. determined the challenges facing effective use of IMBC in preschools

Research Questions

1. What is the level of functionality of IMBC based on expert validation?
2. To what extent are users satisfied with the developed IMBC during the trial-testing phase?
3. What is the level of interest of preschoolers in using IMBC for learning literacy and numeracy?
4. What are the challenges facing effective use of IMBC in preschools?

Hypotheses

The null hypotheses formulated to guide the study, which were tested at 0.05 level of significance, are:

HO_1: There is no significant difference between the mean responses of parents and preschool teachers on their level of satisfaction with the developed IMBC.

HO_2: There is no significant difference between the mean responses of parents and preschool teachers on the children's level of interest in using IMBC in learning literacy and numeracy.

Literature review

The use of computers in teaching and learning has been globally advocated in various disciplines of life. The early childhood education is not an exception. According to UNESCO (2022), the period from birth to eight years old is one of the remarkable brain developments for children and represents a crucial window of opportunity for education. Literature has established that the present generation of children who attend institutions of early learning were born in a completely computerized environment (Scott, 2021). They love playing computer ganes, watching cartoons, appreciate colourful presentations, and love hearing sound that keeps them motivated throughout the learning process. A number of digital tools are used to create digital contents that serve as instructional resources used in promoting learning performance in children. One of these digital contents or resources is the interactive multimedia-based courseware (IMBC).

Studies have found that the use of IMBC in early learning provokes the interest of young learners in learning and simplifies their understanding of abstract and difficult concepts (Baird, 2022; Nwangwu, 2024). Furthermore, studies by Zulfitrah (2020) and Gong (2022) revealed that IMBC were very effective in influencing early learning positively; improving efficiency; and enhancing the quality of classroom learning and academic achievement among preschoolers.

Nwangwu (2021) developed an interactive PowerPoint presentation design training package (IPPDTP) for lecturers of tertiary institutions. The findings of the study revealed that the contents of the training package were adequate and appropriate for the package; there were positive ratings of the package by ICT experts based on its level of acceptability; and the respondents were very satisfied with the use of the training package in mastering PowerPoint design and presentation. Akinbadewa (2020); and Mahawar and Bansal (2022) investigated the effect of multimedia instructional packages on students' academic achievement in Biology. The findings revealed that multimedia instructional packages significantly enhanced students learning of Biology concepts than the conventional strategy, regardless of gender and the preferred learning style of students. Similar studies have reported the increased academic success of students where multimedia techniques are applied, and this success was attributed to the ability of multimedia technology to capture students' interest and get them engaged in the course of learning (Park et al., 2019; Son & Simonian, 2016). Son and Simonian (2016) opined that supplementing traditional teaching classroom with multimedia learning tools could enhance students' motivation to learn, and make them active in the learning process, thereby, improving practice. A study on analysis of software

interactivity revealed that the iC-COM courseware conducted by Bahrudin et al. (2011) revealed that the multimedia courseware provides opportunity for interaction with standardized icons and allows learners to discover information through active exploration. According to Eze (2021), multimedia contents have the capability of attracting children to learning contents, through the presentation of multimedia elements such as cartoons, characters, dialogues, sounds and movies that are able to stimulate the curiosity of younger users in learning new things.

Monserate (2018) conducted a study on the impact of technology on teaching effectiveness and academic performance of students. Results showed that students' academic performance was highly influenced by the teacher's effective teaching and by the teacher's computer literacy nor by their competence in technology; and no significant difference was found on self-efficacy among students' levels. Studies by Wong and Neuman (2016), Barasa, Barasa, and Omulando (2020), and Chuang and Jamiat (2023) revealed that educational media has the potential to foster early literacy and problem-solving skills in children, provoke their interest in learning, and simplify their understanding of abstract and difficult concepts.

On the issue of satisfaction with training packages in different disciplines, a study by Bahrudin et al. (2011) revealed that the users of an interactive courseware for learning basic computer system components rated the courseware content reliable, the interactivity sessions standardized, and the screen design helpful in manipulating the courseware. Similarly, a study by Salve-Opina (2014) revealed that users were satisfied largely with a developed computer-based online college English instruction. Nwangwu et al. (2021) assert that a well-developed computer-based interactive package or courseware plays a vital role in promoting active participation of learners during the instructional activities, leading to an increase in their learning achievement since many of such courseware are user-friendly, interactive, educative, and usable at one's own pace.

On the other hand, researchers had conducted studies on the challenges of implementing digital technologies in the early childhood schools. These challenges include lack of access to digital learning tools, distractions, increased workload of teachers, non-professional development of teachers, cost of purchasing modern digital technologies, internet connectivity issues, time factor, limited supply of electricity, and poor funding, etc. (Johnson, et al., 2016; Nwangwu, 2018b ; Nwangwu et al., 2024; Hermanto & Srimulyani 2021; Yildiz et al., 2022; Nikolopoulou 2022; Markuna 2022; Le 2022; Hau et al. 2022). According to Bent and Katja (2013), using multimedia can be time consuming. In terms of competencies, Boardbar (2010) revealed that teachers' computer competence is a major predictor of integrating ICT/multimedia technologies in teaching. The literatures reviewed in this study revealed that there was a consensus among authors and developers on the benefits of multimedia in teaching and learning. However, to the best knowledge of the researchers, no studies addressed the use of authoring system for the development of an IMBC in early childhood education in Nigeria, with particular focus on literacy and numeracy.

Methodology

The Research and Development (R&D) design that is based on the theoretical foundation of Multimedia Waterfall Process (MWP), was adopted for the study. The participants for the study

comprised 5 ICT experts, 9 lecturers in the Department of Computer & Robotics Education, 69 parents, and 35 preschool teachers. Purposive sampling technique was adopted in selecting the respondents and the schools that were involved in the study. This was because of the busy schedule of the respondents, which made the researchers to select only those that agreed to participate in the study. At the Kindergarten level, each class has two teachers: one teacher and one nanny. Both staff were given an equal opportunity to participate in the study. The instrument for data collection was a structured questionnaire developed to elicit information from the respondents on the functionality of the IMBC, their level of satisfaction with the IMBC, the level of interests of the preschoolers in using the IMBC for learning literacy and numeracy, and the challenges encountered during the implementation of the IMBC in preschools. Five experts validated the instrument: two experts from the ICT unit, two preschool teachers that teach the kindergarten section, and one expert from the academic planning unit, all from the University of Nigeria, Nsukka. The reliability of the instrument was determined using the Cronbach Alpha method, and an overall reliability coefficient of 0.83, was obtained. Mean and standard deviations were used to answer the research questions while t-test statistic was used to test the null hypotheses at 0.05 level of significance. For the interpretation of research questions, items >= 3.50 are Strongly Agree (SA); items >=2.50 and <= 3.49 are Agree (A); items >= 1.50 and <= 2.49 are Disagree (D); and items <= 1.49 are Strongly Disagree (SD). On the other hand, when the p-value is less than the significance level of 0.05, the null hypotheses were not upheld. However, the null hypotheses were upheld when the p-value is greater than the significance level of 0.05.

The Basic Contents of Literacy and Numeracy

The researchers conducted a preliminary investigation in the preschools selected for the study in order to find out the contents of the literacy and numeracy subjects that are taught to preschoolers. The literacy and numeracy curricular that are offered by the private and public early childhood schools vary slightly. However, based on the interactions with the preschool teachers, the researchers were able to harmonize the contents according to NERDC recommendations (NERDC, 2013). The literacy and numeracy concepts that were covered in this study include:

1. **Numeracy:**
   a. Identification and Reading of numbers
   b. Writing of numbers
   c. Recognition of numbers
   d. Counting for value

2. **Literacy:**
   a. Reading of letters
   b. Writing of letters
   c. Recognition of letters
   d. Word building

IMBC Development

The development of the IMBC began with the requirements gathering/needs assessment, which involves selection of the basic literacy and numeracy contents for preschoolers, and in seeking permissions from teachers and head teachers to participate in the study. The researchers first approached the head teachers to permit the preschool teachers to select and share with the researchers the areas (contents) of literacy and numeracy for incorporation into the IMBC to be developed. Although the contents vary among the participating early childhood education centres, the researchers harmonized all contents to address those peculiarities.

The study involved four phases: Phase I (Needs assessment/requirements gathering); Phase II (Development of the IMBC); Phase III (Validation of the IMBC) and Phase IV (Trial-testing the IMBC). The Multimedia Waterfall Model (MWP) model (See Figure 1) developed by Henning (2001) was adopted for the development of the IMBC. It is a four-phase model of interactive multimedia product development comprising Integration Planning (Analysis and Design), Multimedia Asset Production (text, images, video, music, animations, etc.), Asset Integration (Edit, Compile, Test), and Rendering (production of the final version of the multimedia product). The IMBC was developed using a number of software and authoring systems: Camtasia Studio (video editing and production), MS PowerPoint 2019 (creating 3D text, screen recording, color scheme and visual layout), Adobe Animate (Animation creation), Photoshop (image creation and editing), Audacity (Audio recording, editing and production), VB.Net (Integrated Development Environment). Smith (2024) identified the three stages of multimedia video production: pre-production (planning), production (shooting or integrating assets into multimedia development platform), and post-production (editing, compilation, testing). ICT/Computer & Robotics Education experts validated the functionality of the IMBC. The experts responded to the "IMBC Functionality" questionnaire and made useful suggestions that led to the final review of the package. The final product was deployed to preschools for use in teaching literacy and numeracy to pupils.

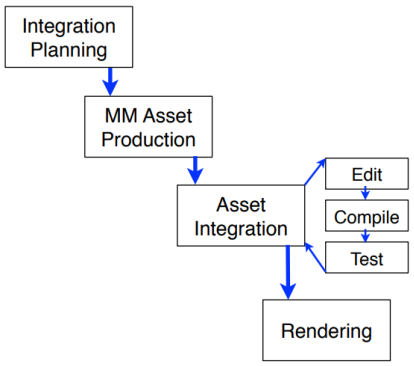
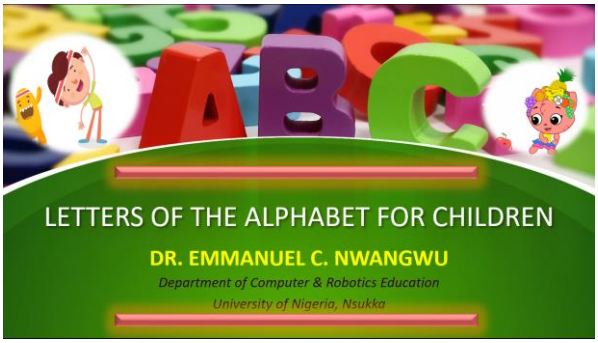


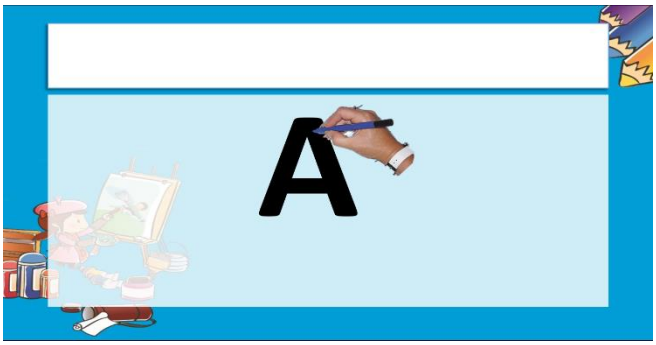
Figure 1: Multimedia Waterfall Process by Henning 2001 (adapted)
Source: https://www.medien.ifi.lmu.de/lehre/ss10/mmp/mmp8.pdf

IMBC Deployment

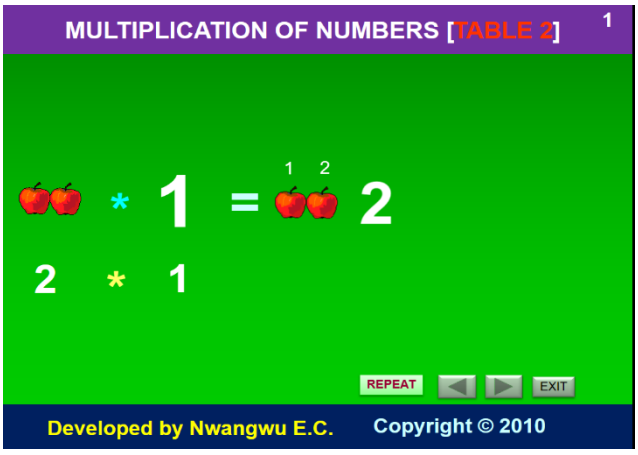
After the phases of development and validation of the IMBC, the researchers deployed the package to the participating preschools. With the permission of the head teachers, the researchers approached the preschool teachers to demonstrate how IMBC works and how it can be projected for students to view using a multimedia projector. The researchers and the preschool teachers agreed on the best ways to teach with the IMBC so as not to disrupt the normal school activities. The IMBC was further deployed to teachers' mobile smart phones through WhatsApp or Xender app. This enabled the preschool teachers to share the IMBC with parents in their respective WhatsApp group platforms while some parents received the IMBC through Xender app. WhatsApp and Xender apps were chosen for IMBC deployment because, Nigerians mostly use WhatsApp for online communication (Statista, 2024) while Xender app does not require the internet for file sharing. The parents were followed-up by the teachers through WhatsApp platform in order to ensure that they use the IMBC at home. After a week of deployment and use of the IMBC, the researchers shared the Google Forms questionnaire to the teachers and parents.



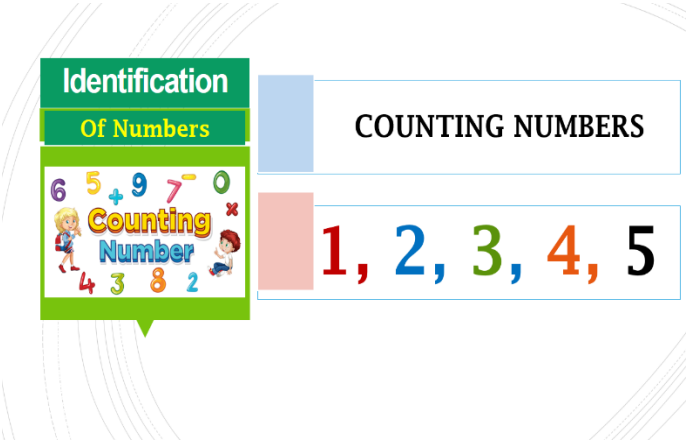
Learning Letters of the Alphabet



Writing Letters of the Alphabet (A)

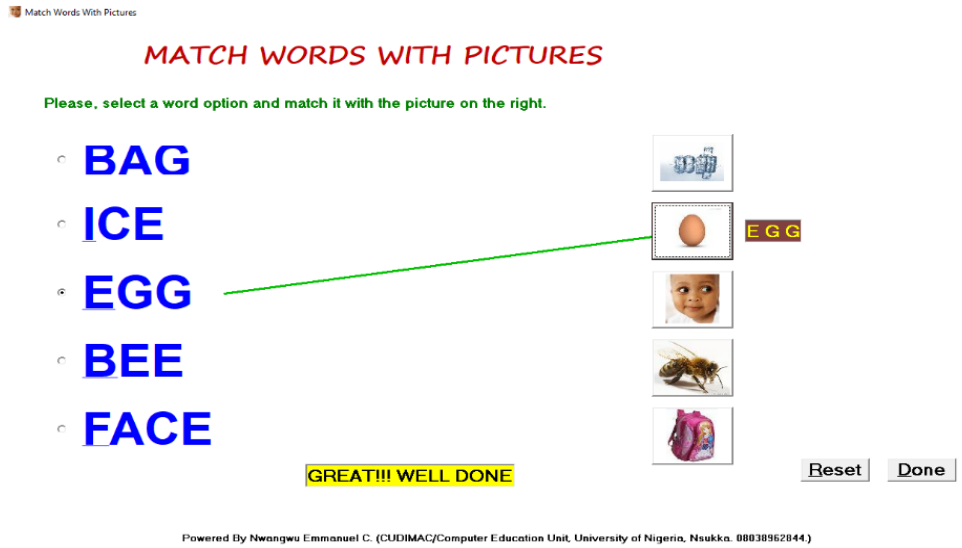


Basic Multiplication of Numbers (2)

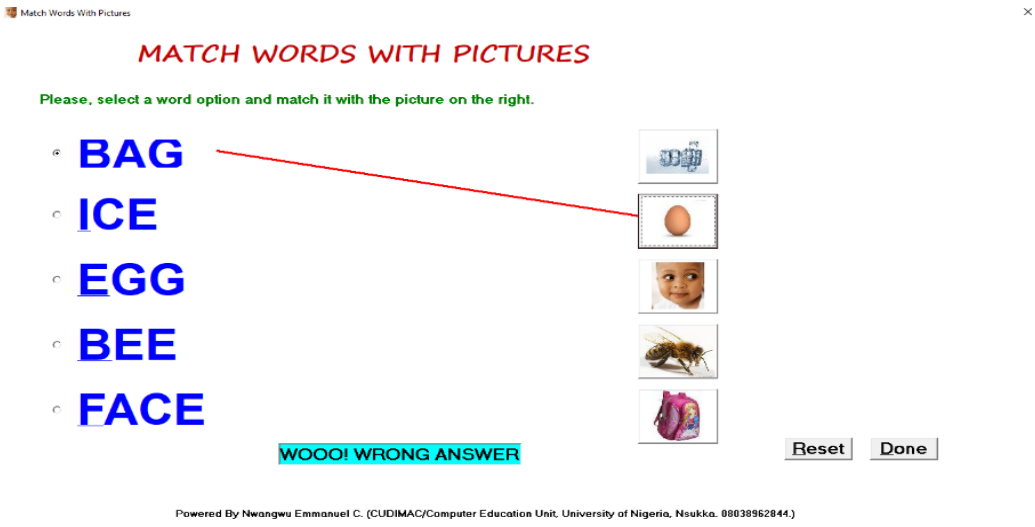


Identifying Numbers 1 - 5

Counting Numbers 1 - 5

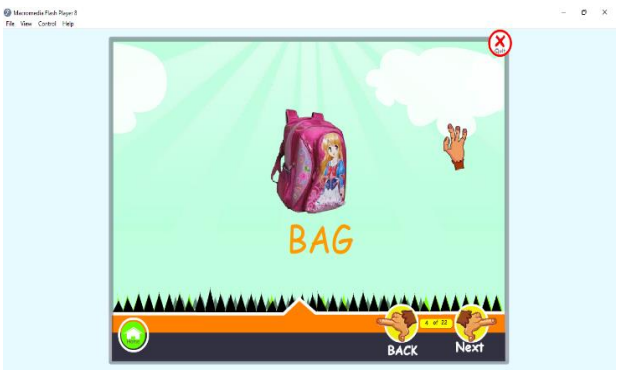


Matching Words with Pictures (Correct Answer)



Matching Words with Pictures (Wrong Answer)

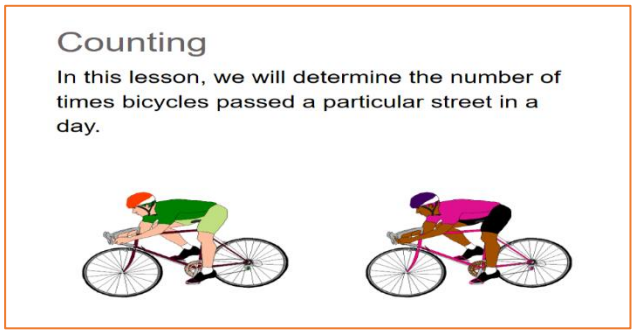
Word Formation Intro Screen



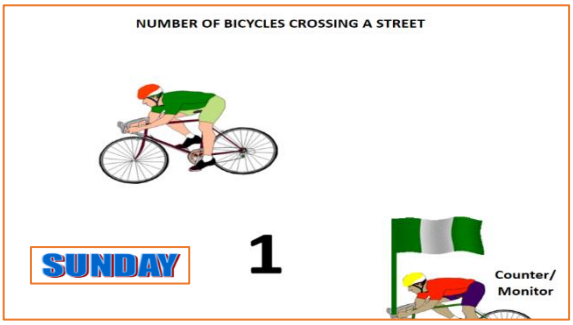
Writing of Words, e.g. "BAG"

Spelling and Pronunciation Intro Screen

Spelling/Pronouncing of Words, e.g. "BAG"



Learning How to Count Objects



Recording the Number of Objects Counted

Presentation of Results and Discussion of Findings

This section presents the results of the data analysis, findings and discussion of findings for the study. The presentation was organized according to the research questions and null hypotheses formulated to guide the study.

Research Question 1: What is the level of functionality of IMBC based on expert validation?

Table 1: Mean Ratings of Responses of Respondents on the Level of Functionality of IMBC based on Expert Validation

S/No	Items Statement	$\bar{x}$	SD	RMK
1	The IMBC accomplishes tasks efficiently	3.62	.50	SA
2	The performance of the IMBC was impressive	3.57	.51	SA
3	Navigating through the IMBC was a herculean task	1.43	.68	SD
4	The documentation or user guides for the IMBC is comprehensive, adequate and self-explanatory.	3.43	.60	A
5	I experienced system malfunction when operating the IMBC	1.12	.84	SD
6	The overall navigation experience was interesting	3.43	.51	A
7	The error messages or prompts embedded in the IMBC, was very helpful	3.38	.50	A
8	The IMBC's interface was user-friendly and easy to understand	3.58	.63	SA
9	It was easy to find the features I need in the IMBC	3.52	.51	SA
10	The IMBC produced accurate test results or answers to questions	3.53	.50	SA
11	The IMBC quickly responds to inputs and actions	3.58	.52	SA
12	The IMBC works well on digital devices like computer, phone, etc.	3.48	.51	A
13	The layout of the IMBC is intuitive and easy to navigate	3.48	.51	A
14	The icons and buttons in the IMBC are functional and easily located	3.58	.61	SA
15	The IMBC loads faster and performs tasks within an acceptable time frame	3.54	.65	SA
16	The IMBC design is consistent across different modules	3.29	.78	A

***Key**: $\bar{x}$ = Mean; SA = Strongly Agree; A = Agree; SD = Strongly Disagree; Rmk = Remark; N = 14*

The results in Table 1 revealed the perceptions of the respondents on the level of functionality of IMBC based on expert validation. The findings indicated that eight items had their mean scores greater than or equal to 3.50 ($\bar{x}$ >=3.50) representing "strongly agree"; six items had mean scores less than 3.50 but greater than 2.49 ($\bar{x}$ <3.50 and $\bar{x}$ > 2.49) representing "agree"; while two items had mean scores less than 1.50 ($\bar{x}$ <= 1.49) representing "Strongly Disagree". From the results in Table 1, it was observed that item 1 ($\bar{x}$ = 3.62); items 8, 11, 14 ($\bar{x}$ = 3.58); and item 2 ($\bar{x}$ = 3.57), had higher mean scores; while item 3 ($\bar{x}$ = 1.43) and item 5 ($\bar{x}$ = 1.12) had the lowest mean scores. These findings are in line with Nwangwu (2021), whose study revealed high level of acceptability with a developed Interactive Training Package by ICT experts. The findings in Table 1 also indicated that the IMBC's interface was user-friendly and easy to understand. This is in agreement with Nwangwu (2018a), Park et al. (2019) and Nwangwu et al. (2021) who revealed that a well-designed interactive multimedia training package that is user-friendly appeals to learners' interest to learn and improves their academic performance. Bahrudin et al. (2011), whose analysis of software interactivity, revealed that the iC-COM courseware provides opportunity for interaction with standardized icons and allows learners to discover information through active exploration. According to Eze (2021), multimedia contents have the capability of attracting children to learning contents, through the presentation of multimedia elements such as cartoons, characters, dialogues, sounds and movies. This indicates that navigating through the IMBC was not a herculean task as agreed by the respondents and that there was no experience of any form of system malfunction when operating the IMBC. Furthermore, the items in Table 1 had their standard deviations ranged from .50 - .84, which is an indication that the respondents were not far from mean and were close to one another in their opinions.

Research Question 2: To what extent are users satisfied with the developed IMBC during the trial-testing phase?

Table 2: Mean Ratings of Responses of Respondents on their Level of Satisfaction with the IMBC during the Trial-Testing Phase

S/No	Items Statement	$\bar{x}$	SD	RMK
17	The IMBC offers good and quality teaching on literacy and numeracy to pupils	3.29	.72	A
18	I am satisfied with IMBC's documentation and help resources	3.33	.66	A
19	The color scheme in the IMBC is capable of attracting pupils to use the package	3.53	.53	SA
20	The IMBC match my children's/pupils' expectations	3.43	.68	A
21	IMBC is easy to use in learning literacy and numeracy	3.52	.51	SA
22	The contents of the IMBC are very understandable	3.54	.52	SA
23	I am willing to recommend IMBC to teachers, parents and preschools	3.33	.66	A
24	The interface of the IMBC is very visually appealing and captivating	3.52	.51	SA
25	There are distracting or unnecessary elements in the IMBC	1.10	.87	SD
26	I often experience lag or delays while using the IMBC	1.13	.81	SD
27	I liked the video clips in the IMBC because they are highly educative and played smoothly to support learning	3.71	.64	SA
28	The IMBC is user-friendly and enjoyable	3.58	.57	SA
29	The audio narrations/voiceover are very audible and easy to understand	3.52	.60	SA
30	I want more of this type of multimedia courseware to be developed for Nigerian pupils	3.62	.50	SA
31	I think the IMBC is not appropriate for the Kindergarten children	1.33	.76	SD

***Key**: $\bar{x}$ = Mean; SA = Strongly Agree; A = Agree; Rem = Remark; N = 104; SD = Standard Deviation*

The results in Table 2 revealed the perceptions of the respondents on their level of satisfaction with the IMBC during the trial-testing phase. The findings indicated that eight items had their mean scores greater than or equal to 3.50 ($\bar{x}$ >=3.50) representing "strongly agree"; four items had mean scores less than 3.50 but greater than 2.49 ($\bar{x}$ <3.50 and $\bar{x}$ > 2.49) representing "agree"; while three items had mean scores less than 1.50 ($\bar{x}$ <= 1.49) representing "Strongly Disagree". From the results in Table 2, it was observed that item 27 ($\bar{x}$ = 3.71); items 30 ($\bar{x}$ = 3.62); and item 28 ($\bar{x}$ = 3.58), had higher mean scores. These are followed by item 22 ($\bar{x}$ = 3.54); 9 ($\bar{x}$ = 3.53) and items 21, 24, 28 ($\bar{x}$ = 3.52); while item 25 ($\bar{x}$ = 1.10); 26 ($\bar{x}$ = 1.13) and item 31 ($\bar{x}$ = 1.33) had the lowest mean scores. The findings are in agreement with Atreja et al. (2008) whose study revealed that the overall course satisfaction in a web-based training was good with more than 75% of the respondents satisfied with the training and 65% preferring web-based training over traditional instructor-led training. Furthermore, a study by Nwangwu (2018a) found that lecturers were highly satisfied with an interactive training package used for mastering PowerPoint design and presentation. The findings in Table 2 also revealed that the respondents strongly agreed that the interface of the IMBC is visually appealing and captivating. This is consistent with Koltow (2018) who asserts that the most visible element of a software is its user interface - the screens, dialog boxes, buttons, panes, and other parts of the application window. However, the respondents strongly disagreed that there are distracting or unnecessary elements in the IMBC. This is in contrast with a study by Knight (2021) who revealed that digital media and technologies are seen as great distraction tools in Australian family life because nine out of ten parents thought digital

devices negatively distracted their own lives, while 83 percent thought that their children were also negatively distracted by digital gadgets. Furthermore, the items in Table 2 had their standard deviations ranged from .50 - .87, which is an indication that the respondents were not far from mean and were close to one another in their opinions.

Research Question 3: What is the level of interest of preschoolers in using IMBC for learning literacy and numeracy?

Table 3: Mean Ratings of Responses of Respondents on the Level of Interest of Preschoolers in Using IMBC for Learning Literacy and Numeracy

S/No	Items Statement	$\bar{x}$	SD	RMK
32	The children/pupils were happy spelling and pronouncing words	3.63	.68	SA
33	The children always smile whenever IMBC was displayed on the board or shown to them on tablets	3.62	.60	SA
34	The children/pupils were able to clearly write letters of the alphabet on their "Learn How to Write" practice books	3.52	.69	SA
35	The color scheme in the IMBC captivates the children's interest in using the package	3.79	.61	SA
36	The movement of the objects on the screen (animated pictures, texts, videos, etc.) keeps the children engaged with the learning contents	3.52	.51	SA
37	The facial expressions of the students indicate that they love learning with the IMBC	3.71	.64	SA
38	After interacting with the package, the children continues to recite what they learn from the IMBC	3.42	.69	A
39	The children/pupils enjoyed all the modules in the IMBC	3.63	.68	SA
40	The IMBC is not appropriate for the pupils, hence, they lost interest in using it for their learning	1.43	.81	SD

***Key**: $\bar{x}$ = Mean; SA = Strongly Agree; A = Agree; Rem = Remark; N = 104; SD = Standard Deviation*

The results in Table 3 revealed the perceptions of the respondents on the level of interest of preschoolers in using IMBC for learning literacy and numeracy. The findings indicated that seven items had their mean scores greater than or equal to 3.50 ($\bar{x}$ >=3.50) representing "strongly agree"; one item had a mean score less than 3.50 but greater than 2.49 ($\bar{x}$ <3.50 and $\bar{x}$ > 2.49) representing "agree"; while one item had a mean score less than 1.50 ($\bar{x}$ <= 1.49) representing "Strongly Disagree". From the results in Table 3, it was observed that item 35 ($\bar{x}$ = 3.79); item 37 ($\bar{x}$ = 3.71); and items 32, 39 ($\bar{x}$ = 3.63), had higher mean scores. These are followed by item 33 ($\bar{x}$ = 3.62); and items 34, 36 ($\bar{x}$ = 3.52); while item 40 ($\bar{x}$ = 1.43) had the lowest mean score. This is in agreement with Park et al. (2019); and Son and Simonian (2016) who revealed that multimedia technology capture students' interest and get them engaged in the course of learning. According to Son and Simonian (2016), supplementing traditional teaching classroom with multimedia learning tools could enhance students' motivation to learn, and make them active in the learning process, thereby, improving practice. Furthermore, studies by Wong and Neuman (2016), Barasa, Barasa, and Omulando (2020), and Chuang and Jamiat (2023) revealed that educational media has the potential to foster early literacy and problem-solving skills in children, provoke their interest in learning, simplify their understanding of abstract and difficult concepts, and build in them the strong will to approach new issues creatively. The results in Table 3 further revealed that the

standard deviations of the items ranged from .51 - .81, which is an indication that the respondents were not far from mean and were close to one another in their opinions.

Research Question 4: What are the challenges facing effective use of IMBC in preschools?

Table 4: Mean Ratings of Responses of Respondents on the Challenges Facing Effective Use of IMBC in Preschools

S/No	Items Statement	$\bar{x}$	SD	RMK
41	The electricity supply in the school or at home has not been stable for effective implementation of IMBC in teaching and learning	3.63	.68	SA
42	The children/pupils displaying some characteristics of addiction with digital technologies	2.56	.75	A
43	The children found it difficult to write letters and words after learning with the package (IMBC)	1.13	.83	SD
44	The video clips in the IMBC load and play slowly because of their large storage capacity	1.48	.76	SD
45	Due to other class activities, there was no enough time for the children to have full and steady access to the IMBC	3.52	.51	SA
46	The IMBC is incompatible with my device which prevented it from working well in my device	1.57	.66	D
47	The video clips embedded in the IMBC plays so fast that it was hard for the children/pupil to comprehend.	1.71	.63	D
48	The activities in the IMBC are not enough to build pupils' cognitive, affective and psychomotor skills	1.43	.68	SD
49	Classrooms have limited ICT gadgets for sustainability of the project	3.33	.58	A
50	Installing or saving IMBC multimedia files take up a lot of space which affects the functionality of my device (e.g. smartphones)	2.21	.71	D
51	The children often got distracted with the visual layout, color scheme and animations included in the IMBC	1.58	.74	D
52	Nigerian teachers don't have the zeal to implement digital technologies in the classroom because of lack of motivation	3.42	.69	A

***Key**: $\bar{x}$ = Mean; SA = Strongly Agree; A = Agree; D = Disagree; Rem = Remark; N = 104; SD = Standard Deviation*

The results in Table 4 revealed the perceptions of the respondents on the challenges facing effective use of IMBC in preschools. The findings indicated that two items had their mean scores greater than or equal to 3.50 ($\bar{x}$ >=3.50) representing "strongly agree". Three items had mean scores less than 3.50 but greater than 2.49 ($\bar{x}$ <3.50 and $\bar{x}$ > 2.49) representing "agree"; four items had mean scores greater than 1.49 but less than 2.50 ($\bar{x}$ >1.49 and $\bar{x}$ <2.50) representing "Disagree"; while three items had mean scores less than 1.50 ($\bar{x}$ <= 1.49) representing "Strongly Disagree". From the results in Table 4, it was observed that item 41 ($\bar{x}$ = 3.63); and item 45 ($\bar{x}$ = 3.52) had higher mean scores. These are followed by item 52 ($\bar{x}$ = 3.42); item 49 ($\bar{x}$ = 3.33); and item 42 ($\bar{x}$ = 2.56); while item 44 ($\bar{x}$ = 1.48); item 48 ($\bar{x}$ = 1.43); and item 43 ($\bar{x}$ = 1.13) had the lowest mean score. The findings in Table 4 revealed that electricity supply in the schools or at home was not stable, which affects effective implementation of multimedia in teaching and learning. Findings also revealed that limited time and limited ICT gadgets in the classrooms are factors inhibiting effective use of multimedia in the classroom. These findings are in line with Bent and Katja (2013) who revealed that using multimedia could be time consuming. The findings of

the study are also in agreement with Johnson, et al. (2016), Nwangwu (2018b), Nwangwu et al. (2024), Hermanto and Srimulyani (2021), Nikolopoulou (2022), and Hau et al. (2022), who highlighted the challenges of implementing multimedia in the early childhood schools, to include lack of access to digital learning tools, non-professional development of teachers, time factor, limited supply of electricity, poor funding, among others. However, the results in Table 4 disagree/strongly disagree with statements like IMBC not compatible with digital devices, slow loading of the IMBC, video files in the IMBC playing faster than the level of comprehension of the pupils, etc.

Hypothesis 1: There is no significant difference between the mean responses of parents and preschool teachers on their level of satisfaction with the developed IMBC.

Table 5:
Summary of t-test Analysis on the Mean Responses of Parents and Preschool Teachers on their Level of Satisfaction with the Developed IMBC

Respondents	$\bar{x}$	SD	t	df	Sig. (2-tailed)	Rmk
Parents	3.55	.30	1.66	19	.11	NS
Teachers	3.34	.25				

Key: *$\bar{x}$ = Mean; SD = Standard Deviation; t = t-calculated; df = Degree Freedom; Rmk = Remark; NS = Not Significant*

The data presented in Table 5 revealed that the p-value is .11, which is greater than the significance level of 0.05, indicating that there was no significant difference in the mean responses of parents and preschool teachers on their level of satisfaction with the developed IMBC. Therefore, the null hypothesis of no significant difference was upheld. This is in line with Nwangwu et al. (2024), who found no statistically significant difference on stakeholders' perceptions of their level of satisfaction with online learning during the COVID-19 era.

Hypothesis 2: There is no significant difference between the mean responses of parents and preschool teachers on the children's level of interest in using IMBC in learning literacy and numeracy.

Table 6:
Summary of t-test Analysis on the Mean Responses of Parents and Preschool Teachers on the children's level of interest in using IMBC in learning literacy and numeracy

Respondents		SD	t-cal	df	Sig. (2-tailed)	Rmk
Parents	3.45	.34	.82	19	.42	NS
Teachers	3.34	.25				

Key: *$\bar{x}$ = Mean; SD = Standard Deviation; t = t-calculated; df = Degree Freedom; Rmk = Remark; NS = Not Significant*

The data presented in Table 6 revealed that the p-value is .42, which is greater than the significance level of 0.05, indicating that there was no significant difference in the mean responses of parents and preschool teachers on the children's level of interest in using IMBC in learning literacy and numeracy. Therefore, the null hypothesis of no significant difference was upheld.

Conclusion

The study focused on the development of an interactive multimedia-based courseware (IMBC) for early childhood education using the authoring systems. The findings of the study, based on the level of functionality of the IMBC, revealed that the respondents (ICT/Computer & Robotics Education experts) acknowledged that IMBC met the requirements and objectives for which it was developed. They agreed that IMBC accomplishes tasks efficiently, the IMBC performance was impressive, navigating through the IMBC was not a herculean task, the IMBC quickly responds to inputs and actions, among others. The study also surveyed the level of satisfaction of the respondents (parents and preschool teachers) with the IMBC. The findings revealed that the respondents were very satisfied with the IMBC in terms of color schemes, visual layout, ease of use, user-friendliness, presentation of high educative video clips, provision of clear documentation and help resources, among others. Furthermore, the study investigated the interest of children/pupils on the use of IMBC in learning literacy and numeracy. The findings revealed that the pupils developed interest in the use of the IMBC for their learning. They were happy spelling and pronouncing words, the visual layout and the color scheme of the IMBC attract the pupils to the package, the animated elements embedded in the IMBC keeps the children engaged with the learning contents, their facial expressions indicate that they love learning with the IMBC, among others. Also determined in this study are the challenges facing effective use of IMBC in preschools. These challenges include limited electricity supply in schools and at home, the children displaying some characteristics of addiction with digital technologies, limited ICT gadgets for sustainability of the project, and the Nigerian teachers do not have the zeal to implement digital technologies in the classroom because of lack of motivation, among others. The null hypotheses tested at .05 level of significance revealed that there was no significant difference in the opinions of parents and preschool teachers on their satisfaction with the IMBC as well as on the children's level of interest with the IMBC.

Recommendations:

Based on the findings of the study, the following recommendations are made:

1. Preschools should be equipped with modern ICT gadgets to encourage the integration of innovative products into the curricular of early childhood education.
2. The government and philanthropists should regularly train and retrain Preschool teachers on courseware development and ICT implementation in schools.
3. Steady electricity should be provided in preschools by the government to encourage and sustain the regular use of ICT in the classroom.
4. School administration and the government should always motivate preschool teachers through provision of free modern ICT gadgets, scholarships for further studies, stipend for data subscription, among others.

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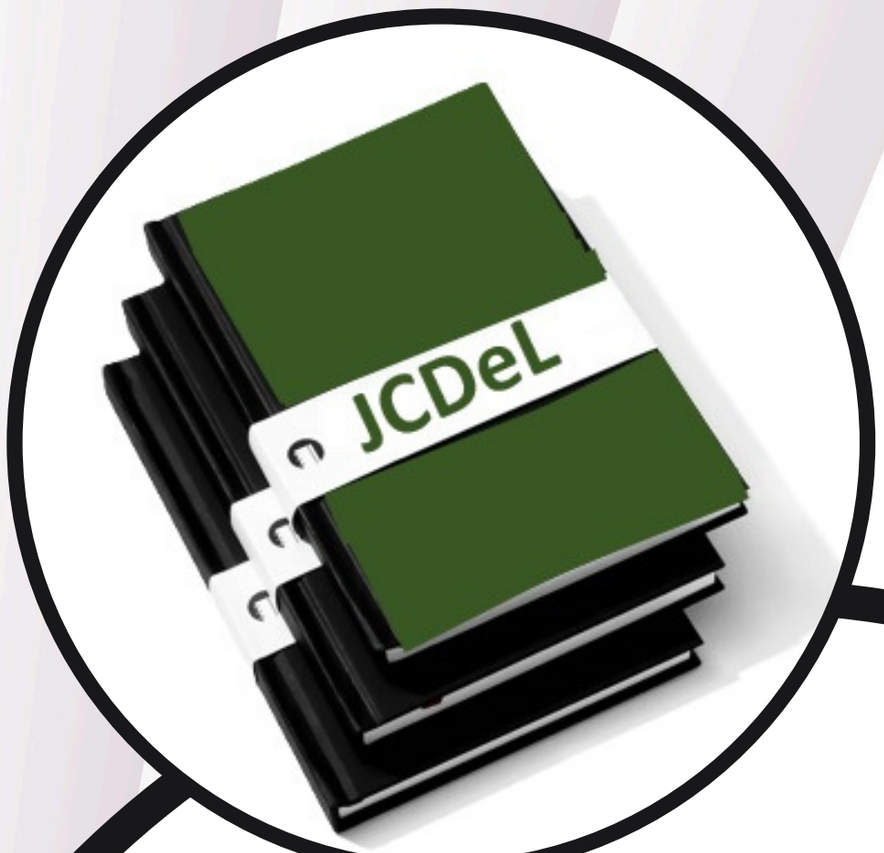

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