



Implementing Digital Learning Technologies in Mathematics Education in Tertiary Institutions: Challenges and Prospects

¹Nwoke, B. Ihechukwu, ²Uzoma, P. Ozioma & ³Okororie, Chigozie

¹Department of Mathematics

²Department of Computer Science and Robotic Education

^{1,2,3}Alvan Ikoku Federal College of Education Owerri

Corresponding author: bright.nwoke@alvanikoku.ed.ng

Abstract

Technology has eaten deep into all facets of education and its contribution to the development of education and the society at large is visible today. However, some areas of knowledge such as mathematics education in higher institutions in Nigeria are still trailing behind. The present study investigated the implementation of digital learning technologies in mathematics education in higher institutions with respect to their challenges and prospects. The study was a descriptive survey type using a population of 15 mathematics education lecturers in Alvan Ikoku Federal College of Education Owerri Imo State. Based on the objectives, 2 research questions were drawn to guide the study. The instrument for data collection was a researcher-made Likert 4-point type questionnaire titled "Challenges and Prospects of Implementing Digital Learning Technologies in Mathematics Education (CPIDLT)". It had a reliability coefficient of 0.75 determined using the Cronbach alpha formula. The data generated were analyzed using mean and standard deviation. The result of the study revealed the challenges among others to include, inadequate funding, lack of technical experts to handle digital technologies, epileptic power supplies, lecturers' poor attitudes towards the use of digital technologies, while access to virtual manipulatives, collaborative learning, enhanced problem-solving skills, access to mathematics course materials, provides support for individual learners needs, enhances creativity among others were the prospects. Based on the findings, it was recommended that Lecturers should be given in-service training to improve their skills in the application of digital learning technologies in mathematics teaching.

Keywords: Digital learning technologies, mathematics education, challenges, prospects.

Introduction

Mathematics is a very important subject that has great impact on the study of science subjects and it's regarded as the mother of all sciences. The knowledge of Mathematics serves as a springboard to the study of other professions. The power of Mathematics for describing and analyzing the world around us is such that it has become a highly effective tool for solving problems. It is the gateway and key of science. Abubakar, Wokoma and Afebuame (2012) stated that Mathematics is an indispensable tool for the transformation of technological development to reality since technological development communicates the idea of growth expansion and improvement in goods and services emanating from the practical application of science. Mathematics is a branch of science, which deals with numbers and their operations. It involves calculations, computations, solving of problems etc. Its dictionary meaning states that, "Mathematics is the science of numbers and space" or "Mathematics is the science of measurement, quantity and magnitude". It is exact, precise, systematic and logical subject (Jayanthi, 2019). Nwoke and Ajuzie (2021) opined that the

knowledge of mathematics helps in the development of sound minds and prepares individuals to be functional in the development of any society. Mathematics as a subject prepares individuals to proffer solutions to problems associated with daily activities. The study of mathematics prepares individuals to be scientifically and technologically alert as it leads to the scientific and technological development of any nation such as Nigeria. Anaduaka and Okafor (2013) acknowledging the importance of Mathematics posited that Mathematics is a body of knowledge essential for the achievement of a scientific/technological nation. Mathematics reveals hidden patterns that help in understanding the world around us.

Mathematics prepares individuals to become creative, think critically, and problem solvers. It also aims at developing the innate potentials of an individual to the optimal level which makes him useful to himself and the society where he finds himself. Innovations in teaching and learning through digital learning technologies in the 21st century have made the learning of mathematics easy and accessible ().

Clark-Wilson, and Oldknow(2011) refer to digital technologies as a wide range of devices which combine the traditional elements of hardware (processing, memory, input, display, communication, peripherals) and software (operating system and application programs) to perform a wide range of tasks. They include: technical applications; communication applications; consumer applications and educational applications. Saxena, Bhat and Jhingan (2017) stated that technology is a major booster in increasing innovation in teaching-learning activities, providing different learning experiences and providing broader learning opportunities for students. The use of digital learning technologies in the classroom can be done in various fields of science, including mathematics. Loveless (2002) identified six characteristics of digital technology, “provisionality, interactivity, capacity, range, speed and automatic functions”, arguing that these enabled users to do things “that could not be done as effectively, or at all, using other tools”. All of these characteristics have direct application to mathematics education.

The move from traditional paper-based mathematical notations to on-screen notations (including algebraic symbols, but also graphs, tables, and geometric figures) can have a dramatic effect. In comparison to the use of paper and pencil which supports only static, isolated notations, the use of computers allows for “dynamic, linked notations” with several helpful advantages. The National Council of Teachers of Mathematics, in its position statement claims that “Technology is an essential tool for learning mathematics in the 21st century, and all schools must ensure that all their students have access to technology” (National Council of Teachers of Mathematics [NCTM], 2008). Muhazir and Retnawati (2020) stated that the use of technology in learning mathematics creates opportunities for students to access mathematics deeper and connect mathematics with real life. Along with the increasing problems and complexity of mathematics material, the digital learning ecosystem becomes an alternative for students because mathematics learning becomes interactive, dynamic, investigative, and process-oriented due to technological involvement. The availability of digital technologies such as interactive whiteboards, laptops, and handheld digital devices (such as iPads, and iPhones) laced with internet facilities in higher institutions of learning ensures that students don’t have barriers to learning mathematics. Niess and Walke (2010) stated that the use of technology in the form of videos can provide

opportunities for students to explore mathematical ideas and can be used to introduce new mathematical processes and concepts, linking mathematics with nature, arts, and other contexts in real life by involving students to express mathematics that they understand through the given videos. Eze (2015) listed the benefits of new technologies in teaching to include; The use of new technology is more effective for teaching low-cognitive materials than cognitive materials. It is more suitable for teaching young people at digital age than old ones. Economically disadvantaged students benefit more from the use of modern technologies than from conventional aids. Students retain what they have learned better with new technologies than with ordinary teaching aids. It leads to more positive attitudes and independent learning in the e-learning world. The use of new technologies acts as a supplement to conventional instruction for higher achievement.

Access to technology for mathematics learning allows for a more customized learning experience. Since learners are not exactly alike, technology can provide individual students with content and supports that are particularly helpful to their individual needs. Technology provides additional opportunities for learners to see and interact with mathematical concepts. Students can explore and make discoveries with games, simulations and digital tools (Scharaldi, 2020). Golding and Lyakhova (2021) noting the importance of digital technologies indicated that technology has traditionally largely been used for teaching a pre-digital syllabus in traditional face-to-face classrooms, as well as by learners for learning mathematics outside the classroom in preparation for learning in class (such as flipped learning), in the digital (synchronous or asynchronous) classroom, by learners outside the classroom for enriching their experience of mathematics, and for developing teacher knowledge. In teaching mathematics, teachers make use of dynamic geometry software on interactive whiteboards and display screens to model geometric construction, the properties of shapes, symmetry, and transformations. Digital technology can also support inclusion in the mathematics classroom, e.g., through the use of automatic captions during lessons, or the automatic translation of lesson material into learners' first language. Digital technology could also allow learners to pursue topics independently, through reading about mathematical topics of interest, interacting with virtual manipulatives, watching video tutorials, finding interesting problems and puzzles and reading or watching others' solutions to these, or connecting to

other learners (Berry, 2021). Freiman and Tassell (2018) posited that learning mathematics using technology becomes more interesting, motivates, provides opportunities for learning while playing, and encourages students to explore problems, produce guesses, and seek explanations while sharing their findings with their peers and teachers, and increasing opportunities for collaboration.

Irrespective of the unending benefits of utilizing digital technologies in teaching and learning in the 21st century, so many higher institutions are still grappling with the orthodox methods of teaching mathematics that encourage rote learning. Lecturers are still seen as sources of content and the programme is still teacher-centred instead of student-centred (Ezeabii, Ekoh & Okwor, 2020). This situation only leaves the students to graduate without being grounded in the utilization of digital technologies as such, when confronted in the classroom situations, they teach the way they were taught and may not have the ability to solve immediate problems. The situation is no longer acceptable in the 21st century when education is technologically driven. Supporting this Moemeke (2019) opined that students need constant assess to an evolving array of technological tools and activities that will enable them to engage in problem-solving, decision-making, teamwork/collaboration and innovation. There is a need to recognize that mathematical digital technologies are the pencils of today and that we will only fully exploit the benefits of digital technologies in teaching, learning and doing mathematics when it becomes unthinkable for a student to solve a complex mathematical problem without ready access to digital technological tools.

Based on the foregoing, the present study investigated the challenges and prospects of implementing digital technologies in mathematics education in institutions of higher learning.

Purpose of the study

The main purpose of the study was to investigate the challenges and prospects of implementing digital learning technologies in mathematics education in higher institutions of learning. Specifically, the study investigated;

1. The challenges associated with implementing digital learning technologies in mathematics education in higher institutions.

2. The prospect associated with implementing digital learning technologies in mathematics education in higher institutions.

Research Questions

The following research questions guided the study.

1. What are the challenges associated with implementing digital learning technologies in mathematics education in higher institutions?
2. What are the prospects associated with implementing digital learning technologies in mathematics education in higher institutions?

Methodology

The study adopted the descriptive survey research design in investigating the challenges and prospects associated with the implementation of digital learning technologies in mathematics education in higher institutions. The study was carried out in the Imo State of Nigeria. The population of the study consists of all 15 mathematics lecturers from Alvan Ikoku Federal College of Education Owerri Imo State. Based on the size of the population, census sampling technique was adopted in the study. The instrument for data collection was a researcher-made Likert 4-points rating scale questionnaire titled “Challenges and Prospects of Implementing Digital Learning Technologies in Mathematics Education (CPIDLT)”. The responses ranged from Strongly Agree (SD), Agree(A), Disagree(D) to Strongly Disagree (SD). The validity of the instrument was determined by three experts, each from measurement and evaluation, computer science education and mathematics education from the same institution. To determine the reliability of the instrument, 20 copies were administered to lecturers from the school of science within the institution. The data generated was analyzed using Cronbach alpha formula which gave a reliability coefficient of 0.75 which was acceptable for the study. The instrument was administered to the respondents on a face-to-face basis and the instrument was collected on the spot. The entire exercise lasted for a week and a 100% return of the instruments was recorded. The data generated were analyzed using mean and standard deviation to answer research questions, any item with a response mean within and above the criterion mean of 2.50 was accepted while any below was rejected. Standard deviation was used to determine the homogeneity or otherwise of the opinions of the respondents.

Result

Table 1: Mean and Standard deviation of lecturers' response on the Challenges Associated with implementing digital learning technologies in mathematics education in higher institutions

S/N	Challenges of implementing digital learning technologies in mathematics education	Mean	SD	Decision
1	Inadequate funding of higher education	3.25	0.92	Agree
2	Lack of technical experts to handle digital technologies	3.01	0.91	Agree
3	Epileptic power supply in higher institutions	3.61	0.87	Agree
4	High level of corruption among education administrators	2.85	1.03	Agree
5	Lecturers' poor attitude towards use of digital technologies in mathematics classrooms	3.33	0.96	Agree
6	Lack of awareness of the effectiveness of digital technologies in mathematics classrooms	3.41	0.91	Agree
7	Poor digital literacy among lecturers	3.53	0.81	Agree
8	Difficulty in using mathematics software	3.24	0.93	Agree
9	High cost of digital facilities	3.17	0.97	Agree
10	Lack of policy implementations	2.92	1.22	Agree
11	Inadequate professional development and training of lecturers	3.14	0.98	Agree
12	Lack of efficient internet connectivity	3.60	0.76	Agree
13	Lack of motivation of lecturers	2.73	1.23	Agree
14	Limited time of teaching mathematics	2.81	1.20	Agree
	Average mean	3.19	0.97	

Table 1 shows that all the items had response means greater than the criterion mean as such, they were all accepted. Also, the grand mean of 3.19 is greater than the criterion mean and indicates a high positive response. The standard deviation of 0.97

indicates that the respondents did not differ remarkably in their opinions on the items. The result indicates that the items were accepted challenges of implementing digital technologies in mathematics education.

Table 2: Mean and Standard deviation of lecturers on prospects associated with implementing digital learning technologies in mathematics education in higher institutions

S/N	Prospects of implementing digital learning technologies in mathematics education	Mean	SD	Decision
1	Digital technologies enhance collaborative learning	3.10	0.93	Agree
2	They grant access to mathematics course materials	3.21	0.86	Agree
3	They make learning of mathematics interactive	3.05	1.00	Agree
4	They improve Students' attitudes towards mathematics	3.13	0.91	Agree
5	Students are motivated to learn	3.07	0.94	Agree
6	They provide support for Individual learning needs	2.86	1.03	Agree
7	Visualization of concepts is enhanced	2.83	1.11	Agree
8	They make computation easy, fast and accurate	3.30	0.87	Agree
9	They improve students' Problem-solving skills	3.02	0.92	Agree
10	Distance is not a barrier to teaching and learning	3.41	0.81	Agree
11	Time is optimized using digital learning technologies	2.90	1.05	Agree
12	Assessment of students' learning outcomes is enhanced	2.87	1.12	Agree
13	They enhance educators' research development	3.14	0.97	Agree
14	They reduce the burden of teaching mathematics	3.04	1.03	Agree
15	Access to virtual manipulatives	3.13	0.96	Agree
16	Enhances creativity and innovative teaching and learning	2.91	1.13	Agree
	Grand mean = 3.06	SD = 0.98		



Table 2 shows that all the items had response means greater than the criterion mean. Also, the grand mean of 3.06 is greater than the criterion mean and indicates high positive response. The standard deviation of 0.98 indicates that the respondents did not differ remarkably in their opinions on the items. and were all accepted as prospects of digital learning technologies in mathematics education.

Discussion of findings

The result of the study revealed that all the projected challenges of digital learning technologies on the table were accepted as they had response means greater than the criterion mean. The grand mean also indicated acceptance of the challenges as the case may be. These include; inadequate funding, lack of technical experts to handle digital technologies, epileptic power supplies, lecturers' poor attitudes towards the use of digital technologies, poor digital literacy among lecturers and others. The result of the study agrees with the findings of Ezeabii, Ekoh, and Okwor (2020) which identified poor funding of Information and Communication Technology (ICT) facilities in the universities, the politicization of new technology projects in the universities, lack of government support on innovative teaching approaches in business education, low level of supervision of tertiary education programme by relevant authorities, lack of legislative framework on the utilization of new technologies in the universities among others as the challenges to the utilization of new technologies in business education programme of public universities south-east Nigeria. The result is also in line with Zakaria and Khalid (2016) who reported educators' lack of knowledge about technology; minimal training and learning opportunities around ICT; and limited technical support as constraints to implementing Information and Communication Technologies (ICTs) in teaching mathematics.

The findings also revealed the prospects of digital learning technologies in mathematics education to include, access to virtual manipulatives, collaborative learning, enhanced problem-solving skills, access to mathematics course materials, providing support for individual learners' needs, enhances creativity and innovative teaching and learning, and others. This result agrees with Zakaria and Khalid (2016) who indicated that the application of information technology can increase students' motivation and interest towards mathematics, Interaction among students, Knowledge-sharing,

Increased motivation and interest, Generation of higher-level thinking skills and Increased student achievement. It also agrees with the report of Nwoke and Ikwuanusi (2016) which indicated that using information and communication technology (ICT) as a tool, allows students spend time productively creating strategies for solving complex problems and develop a deep understanding of the subject matter

Conclusion

The study investigated the challenges and prospects of implementing digital learning technologies in mathematics education in Tertiary Institutions. The result of the study revealed a series of challenges which have prevented the effective implementation of digital learning technologies in tertiary institutions. Irrespective of the challenges, the study also revealed the prospects of digital technologies in mathematics education. These includes access to teaching and learning materials, collaborative learning, creativity and innovative teaching and learning, improved students' attitude towards mathematics among others.

Recommendations

Based on the findings of the study, the following recommendations were proffered.

1. The government should increase the funding of tertiary institutions to acquire digital facilities.
2. Lecturers should be given in-service training to improve their skills in the application of digital learning technologies in mathematics teaching.
3. There should be alternative power supply in tertiary institutions to enable lecturers use digital facilities in teaching and learning of mathematics.
4. Software for teaching and learning mathematics should be made available in tertiary institutions.

References

- Abubakar, R. B.; Wokoma, S.A.D & Afebuame, A. O. (2012). Mathematics: A pivotal rebranding tool for National Development. *Academic Research International*. 2(3). 344-351.
- Anaduaka. U.S. & Okafor, C.F.(2013) Nigerian School Children and Mathematics Phobia: How the Mathematics Teacher Can Help. *American Journal of Educational Research*. 1(7): 247-251. doi: 10.12691/education-1-7-5.



- Berry, M. (2021). Education technology and mathematics. Retrieved from <https://projecteuler.net/> on 7th August 2022.
- Clark-Wilson, A.& Oldknow A. (2011). Digital technologies and mathematics education. *A report from a working group of the Joint Mathematical Council of the United Kingdom*.
- Eze, L.O. (2015) *Lecturers' perception of strategies for improving teaching learning of business education in college of education in South East Zone of Nigeria*. Unpublished M. Sc Dissertation Presented to Department of Technology and Vocational Education, ESUT, Enugu.
- Ezeabii, I. C., Ekoh, N. A C. & Okwor, N. G. (2020). Challenges to the utilization of new technologies in business education programme of public universities in South East Nigeria. *Nigerian Journal of Business Education (NIGJBED)* 7(1), 388-400.
- Freiman, V. & Tassell, J. L. (2018). Leveraging mathematics creativity by using technology: Questions, issues, solutions, and innovative paths.
- Golding, J. & Lyakhova, S. (2021). School mathematics education and digital technologies. *A discussion paper for Joint Mathematical Council of the UK*.
- Jayanthi, R. (2019). Mathematics in Society Development - A Study. *Iconic Research And Engineering Journals* 3(3), 59-64.
- Loveless, A. (2002). *Literature review in creativity, new technologies and learning*. 4. Bristol: Future lab; Future lab.
- Moemeke, C.D. (2019). 21st century learning technologies use in Nigerian classrooms: Issues, prospects and challenges. *ADECT 2019 Proceedings*.
- Muhazir, A. & Retnawati, H. (2020). The teachers' obstacles in implementing technology in mathematics learning classes in the digital era. *Journal of Physics: Conference Series* 1511 (2020) 012022 doi:10.1088/1742-6596/1511/1/012022
- National Council of Teachers of Mathematics. (2008). The role of technology in the teaching and learning of mathematics. Retrieved from http://www.nctm.org/uploadedFiles/About_NC_TM/Position_Statements/Technology%20final.pdf
- Niess, M. L. & Walker, J. M. (2010). Guest editorial: Digital videos as tools for learning. *Mathematics Contemp. Issues Technol. Teach. Educ*
- Nwoke, B.I. & Ajuzie, N. E. (2021). Multimedia Instructional Approach and Gender Equity in Mathematics Achievement Among Secondary School Students. *Journal of CUDIMAC (J-CUDIMAC)* 9(1), 54-61
- Nwoke, B.I. & Ikwuanusi, E.N. (2016). Impediments to integration of ICT in teaching and learning of mathematics in secondary schools. *International Journal of Advanced Academic Research / Sciences, Technology & Engineering* 2(6), 5-13.
- Saxena, R. Bhat, V. & Jhingan, A. (2017). *Leapfrogging to education 4.0: Student at the core* London: Ernst & Young.
- Scharaldi, K. (2020). What are the benefits of teaching math using technology? Retrieved from <https://www.texthelp.com/resources/blog/> on 7th Aug 2022.
- Zakaria, N. Khalid, F. (2016) The Benefits and Constraints of the Use of Information and Communication Technology (ICT) in Teaching Mathematics. *Creative Education*, 7, 1537-1544. doi: 10.4236/ce.2016.711158.