



Application of Technologies in Mathematics Education in the 21st Century

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Abstract

Technology is a term used to describe a wide range of teaching and learning related software and hardware that is increasingly being used in schools, colleges and universities classrooms for purpose of promoting productive learning. In Mathematics Education, technology provides learners with opportunity to visualize and make concrete the general abstract world of mathematics. Using technologies in the 21st century for mathematics education proves beneficial for teachers and students, and it brings diversification in a method of instruction. This paper presents some technological tools used in mathematics education, their functions in mathematics education, benefits and challenges faced by the teachers in integrating technology into the Mathematics teaching and learning process. It is recommended that teachers should be equipped technologically with the appropriate knowledge, skills, and resources, to support them in their teaching and learning process in the classroom.

Keywords: Technology, Information and Communication Technology, Radio, Television and Computer.

Introduction

Mathematics is one of the subjects in schools that have a lot of complex problem and it is often labeled as a difficult subject, poor in innovation, abstract in nature and boring (Achmad & Endang, 2020; Momozoku & Sani, 2017). In the learning of mathematics process, children often have difficulty in carrying out the abstraction process and difficulty in understanding the basic logic mathematics concepts leading to having negative perceptions and its dislike. Other factors are teachers' inability to teach mathematics with zeal, lack of parental support, change in curriculum, ratio of students per teacher in the class and unqualified teachers (Achmad & Endang, 2020; Maidabo, 2020). Various methods had been used to make mathematics easier to learn but with little success. There have been innovative changes in the teaching strategies in recent times and it is interactive. It does not treat all students at the same level of their understanding ability. Mehta (2022) maintained that students need to be taught in a manner which is technology-driven and which requires creative and innovative minds for the progress of individuals, society and nation.

The technology is more activity-based and centre's the learners' minds which involve them entirely into the process of learning. In this way, learners who are the target participate actively in the whole process to build their knowledge and sharpen their skills; this is also termed as a constructivist approach. In this method, the teacher is just a guide. The new technological era promotes cooperation and boost healthy study environment among students and reduce the

competition among them allowing students' who are classified as millennial, learn more about mathematics using technological and communication tools (Vasu, 2018; Ivypanda, 2019; Maidabo, 2020; Zimmerman, n.d; Nyarko, et al., 2021) such as calculators, computers, radio, television, social media, Information and communication technology (ICT) and so on.

Emerging Technologies in Mathematics Education

The development of technology has changed learning style which has more impact on mathematics learning. These technologies which were used in mathematics education for information and communication tools are: Calculators, Computers, Multimedia, Smart Phones, Overhead Projectors, Social media, internet, electronic/smart boards, emails, Radio, Television; and Information and Communication Technology (ICT), and so on (Zimmerman, n.d; Momozoku & Sani, 2017).

Information and Communication Technology (ICT):

ICT in the classrooms have become a window of hope to the educational system. ICT has become a tool for teaching and learning in which communication dependence is high as it is characterized by student-student and teacher-student interactions. Chong et al (2006); Lawal and Awofala (2020) have recommended the use of ICT in Mathematics education which is relatively new in the teaching and learning of Mathematics; and advised teachers to explore the richness of blended learning, a combination of use of ICT and traditional classroom approaches, which has shown to yield a positive and statistically significant increase in students' Mathematics achievement.

Ojaleye and Awofala (2018) believed that ICT materials could be better used as a supplement to classroom-based courses and instructions. It is uncommon in Nigerian schools today possibly as a result of lack or the absence of any government policy on the provision of ICT facilities (Lawal & Awofala, 2020; Momozoku, et al, 2022).

A few studies on teachers' use of ICT revealed that a higher portion of teachers are faced with the challenges of the slow speed of devices owing to viruses, an insufficient number of computers, inadequate time for using e-resources, sluggish internet connectivity, power failure, inadequate skills/training on ICT tools/programme/services, shortage of ICT facilities/devices, teachers' lack of knowledge and skills, unreliable and inadequate power supply, and inadequate funding were identified as major problems constituting a hindrance to the use of ICT in teaching and learning of Mathematics in Nigerian tertiary institutions (Momozoku et al, 2022). Lawal and Awofala (2020) reported that tertiary education students did not participate in online classes of any mode during the COVID-19 lockdown and after COVID-19, no tertiary institutions (public) are involved in the use of ICT for teaching and learning process. Momozoku, et al. (2022) and Lawal and Awofala (2020) observed that the frequency of ICT use in Mathematics education before, during and after lockdown is quite worrisome as a downturn was observed at a time when the rest of the world is deeply immersed in academic ICT activities for gainful study. There is need for a reflection and reappraisal of the existing structures to ensure that adequate provision and attention is given to the existing infrastructures in the colleges.

Radio: The radio is known to be most effective mass media channel for delivering mathematics lessons to learners. Both national and state radio stations broadcast programmes on mathematics education. These programmes are either related to general aspect of mathematics education or regular classes for basic or secondary education. Experience mathematicians or mathematics educators take part in these radio programmes. The radio as a means of communication takes their voices to the millions of students and teachers listening to their programmes.

Teachers of mathematics can make the best use of such programmes by making themselves and their students aware of the programmes and listening to such programmes. Radio can be easily used in the rural areas/setting (Vasu, 2018; Sodiya & Oyekunle,

n.d). It is an inexpensive medium for reaching a good number of rural dwellers in many developing countries. It does not depend solely on electricity for power source and can be carried about because of its small size.

Television (TV): It can be used in mathematics classroom to watch mathematically-based shows. It is good for observation and gives immediacy. Television cater to the different learning styles of students, by offering a unique combination of sight, sound, motion and emotion, which can give students a greater understanding of the world around them (Wood, 2003; Vasu, 2018; Sodiya & Oyekunle, n.d). Television is a great way to encourage Mathematics skill practice of students as watching TV is away children love to pass their time. It reaches large populace of students and can be used to teach any Mathematics content(s) as it magnifies demonstration

Television has the greater advantages as it is not only conveying the messages through sound, but also depicts the content with relevant pictures, figures and scenes. The teacher can supplement his regular teaching by making use of relevant educational programmes telecast by national and state television stations. These programmes will be based on students' level and capability to understand before the students view the programmes. They need to be properly motivated, told what to look for, how to view the programme and how to pick up the key points. After viewing the programme, the teacher can discourse with the students about the important points and ask questions for clarification and summarization. Teacher can record the programme and views it along with the students, interacting and clarifying issues when the need arises. (Vasu, 2018)

Multimedia: is the field stressed over the computer organized networks, structures, representations, immobile and moving pictures (video), animations, sound and whatever other media where each type of material can be addressed, secured, communicated and organized sensibly (Alfred, 2021; Nyarko et al, 2021; Ananga & Akayure, 2016). It is the usage of more than one form of media tools or resources ranging from simple media apparatus to technological media designed purposely for hands-on manipulation.

Multimedia tools are multi-media images projectors, Digital Video Disks (DVD), Interactive White Board (IWB), memory cards, Public Address Systems (PAS), smart phones, compact disks, televisions and radios for electronics, digital & mobile learning opportunities in

zooms, Skype's, wet 2.0, and other learning formats that can provide pictures, motions & sounds to match the time, pleasure & aspiration of the learners.

Computers: These are visual medium of communication. Computers can be used for many things in the mathematics classroom. They can be used to show virtual models of mathematics, to create graphs more easily by using Excel, Spreadsheet and to practices mathematics skills on websites. It can be used to design, calculate, graphing, make materials for other media. Teachers can also use excel or a grade book program to keep track of students records and skills. It is a training tool used to store information which can easily be retrieved. Computers are also used to communicate with individuals through the electronic mail (e-mail). This is very fast and efficient.

Calculator: is a small hand-held computer electronic hardware or software or device with a keyboard and a visual display capable of performing mathematical calculations ranging from basic arithmetic to complex mathematics. Some of them can perform simple text editing and programming. More sophisticated calculators can handle exponentials, roots, logarithms, trigonometric functions and hyperbolic functions.

Calculators can be vital tools for encouraging students mathematically curiosity and conceptual understanding. The use of calculators in classroom eliminates student's burden of doing lengthy calculations. Use of calculators in teaching and learning of mathematics enhances the understanding of mathematical concepts and students orientation towards mathematics. Calculator are tools students use to help solve problems since they eliminate tedious computations and algebraic manipulations that discourage many students from learning mathematics. Calculators allow more students to solve problems and appreciate the power and value of mathematics in the world today. There are five types of calculators: basic, scientific, graphing, printing and financial/business students need to know how to use calculators effectively. Using calculators help them for the real world. Ones students have mastered basic mathematics concepts and basic operation; they will not have problems in operating the calculators.

Video Tape Recorder: This media is good for observation and magnifies demonstration. It can be used to teach any Mathematics content(s). Video Tape Recorder can be used to record specific programmes and later used to teach the students. This equipment can be internally paused to explain the presentation in

details. Documentaries and features can be produced and played for students to view.

Over head projectors: This technology allows teachers and students to write normally and then to have the image projected onto a screen so that all students may see it easily. It can be used to teach mathematics content (s). The message to be projected is prepared on transparency sheets which are made of acetate plastics. The pens used in writing are in different colours. It is used to provide in formations in a systematic developmental sequence. The lighting situation in the room has no influence on the picture produced. The teacher can be writing and be facing the students at the same time. Teachers can re-use overhead transparencies (clear paper) or can save the ones for important lessons.

Multimedia projectors: With aid of computer, the message to be prepared is made into slides and stored either in diskette or flash drive. Using the multimedia projector and a computer, the message is projected on to a large screen. This media can be use in the teaching and learning of mathematics at various level of education.

Smart Board: Smart boards are the bridge between the computer and the old-fashioned chalkboard or white board. Teachers can use digital pens to write on the boards and then save the writing on their computers, so that no matter what lesson you teach in mathematics, if you use the board, you have a record of it. The smart board is also connected to the classroom computer so that all programmes on the computer are available on the board. This way you can teach students how to use software and website easily, with all students being able to see the board.

Technologies served as teaching aids as some of them provide audio, visual or both audio-visual including hands-on minds-on activities. However, it was the radios and televisions that were mostly used in Nigeria by very few states during the CIVID-19 pandemic period while in the developed countries of world, ICT, social media, internet, radios and televisions inclusive were used throughout the period (Momozoku, Audu, Niyi & Alagbe, 2022).

Qualify teachers who can assemble, operate, handle and maintain technology tools, equipment or components that will stimulate the visual, esthetic or auditory aspect of learning will be an asset to mathematics education. Technology offers much usage in mathematics education. Though its usage in Nigerian education system is very limited but promising. Technology tools were not in use in

mathematics education presently and where they were used, it was not done effectively. Ananga & Akayure (2016). As such, it hindered the development of competences expected from students. This may be due to teachers unfamiliar with the usage of these technological tools or lack of knowledge on the use of these technological tools as teaching and learning instruments.

There are ample opportunities that are abounds in the use of technology for boosting mathematics education in Nigerian education system. This is the more reason why mathematics educators have to explore all available channels to maximize technology usage in teaching and ensure that students key into exploiting the most valued aspect for their academic progress.

Function of Technology in Mathematics Education

1. They enrich teaching by making it more meaningful and effective
2. They stimulate interest thereby creating room for motivation and willingness in the learners to learn
3. They draw learners' attention to specific concepts and provide a focal point for them to organize what they are learning to its retention
4. They tie verbal concepts together by bringing all the talking and explanation by the teacher into reality
5. They make visualization possible, clear possible misunderstanding and deepen insight
6. They teach, serves as source of information and consolidate learning.
7. Contribution of human senses to the way we learn

Challenges of the use of Technology in Mathematics Education

The use of technology in mathematics education faces a lot of challenges which brought set back in its utility in the classroom (Akpanudi & Agbo, 2020). These challenges are:

1. Poor funding by its government *Poor power supply * Lack of training of staff
2. Inadequate qualified teachers/institutor/personal and supporting staff at all level of education
3. Emphasis on theoretical subjects rather than practical knowledge due to lack of entrepreneurial education centre
4. Inadequate motivation for available teaching and non-teaching staff which affect staff efficiency, retention, creativity and initiatives.
5. Lack of adequate security of the technology tools
6. Poor maintenance culture in the system and infrastructural delay
7. Lack of enabling environment, access to credit/loan facilities, inflation of technological infrastructures

The Advantages and Disadvantages of using basic Technology for Mathematics Education

Teaching Mathematics in the era of technology has made the task of the teacher easier and lighter. However, learning Mathematics in this era by incorporating technologies tools has advantages and disadvantages as listed below: -

	Advantages	Disadvantage
1	It excite learners/student and raise their interest	Multi-tasking by learners disturbs flow of learning
2	It brings learning to life	Dependent on the expertise of the teacher
3	It prepare students for the future	Technical faults e.g. electricity or circuit shot
4	It can support student learning	Lack of supporting resources (infrastructure)
5	It offers deep mathematical thinking	It cost a lot of money
6	It increases students access to learning	It can distracts students from learning
7	It encourages spontaneous learning	It can make it easy to cheat
8	It enable students to interact with mathematical concepts	It can disconnect students from face-to-face relationships
9	Provides self-paced learning	It can put some students at disadvantage
10	It offer mobility, multimodality (using various sensory modalities: sight, touch, sound)	It can cause students to use unreliable resources for learning
11	Encourages learning outside the classroom	It can create fear and stress
12	Empowers learners with voice and choice	It discourage creativity in students

13	Enables coding and computational thinking	It requires management, maintenance and training
14	Teacher is facilitator of knowledge not custodian of knowledge	It leads to technology disparity
15	Allows teachers to access expertise knowledge	Insufficient qualified teachers to man these tools
16	It support visualization mathematical concepts in various ways of expressions	unavailability of resources at home for students to access the necessary educational materials.
17	It can assist students exploring, discovering and developing mathematical concepts	
18	It enables interaction between teacher and learner	

Sources: Hegedus, et al; 2016; Ivypanda, 2019; Scharaldi, 2020; <https://www.researchgate.net/post>

Conclusion

It has been established that when technology is used for mathematics education, there is strong tendency of producing mathematicians and mathematics educators that are responsive to the academic needs of the 21st century an innovative mathematics education. Technology usage is more activity-based and centres the learners mind which involve them entirely into the process of learning. It encourages the students to want to learn more mathematics themselves, improves learners critical thinking, creativity and innovative; promote cooperation and boost healthy study environment among students and reduce the competition among them. Qualify teachers who can assemble, operate, handle and maintain technology tools, equipment or components that will stimulate the visual, esthetic or auditory aspect of learning will be an asset to mathematics education. Technology tools were not in use in mathematics education presently and where they were used, it was not done effectively and is very limited but promising. This may be due to teachers unfamiliar with the usage of these technological tools or lack of knowledge on the use of these technological tools as teaching and learning instruments.

There are ample opportunities that are abounds in the use of technology for boosting mathematics education in Nigerian education system. This is the more reason why mathematics educators have to explore all available channels to maximize technology usage in teaching and ensure that students key into exploiting the most valued aspect for their academic progress.

Ways forward

The following are suggested as way forward in the twenty first century mathematics classrooms:

1. Mathematics teachers should be trained with the ability to handle the teaching of Mathematics using technology tools.
2. Mathematics teachers using technology tools, equipment or components must avoid too much information on any single topic/content to be presented to the students.
3. Government should provide all the necessary technological tools, equipment or components to schools in large quantities for use by teachers and students as at when due.
4. Government should provide adequate fund to education sectors to enable it provide all the needed technology, equipment, tools, gadget, materials and functional infrastructure to mathematics departments at all level of education in Nigeria.
5. Government should provide enabling environment for the teaching and learning of mathematics using the relevant associated technology.
6. Supporting staff should be up to-date on how to use these technological tools and equipments

References

- Achmad, H. & Endang, S.(2020). The Affect of the internet and social media; Mathematics learning environment context. *International conference on environment and technology. IOP Conference series; Earth and Environmental Science* 469(2020)012080 D01:10.1088/1755-1315/469/012080 Retrieved on 29/05/2022 at 18:46hrs IP address 197.210.53.126
- Akpanudi, G. A. & Agbo, L. E (2020). Mainstreaming the Bloom's digital taxonomy for productive

- learning towards a knowledge and service-driven economy. *Nagwamatse Journal of Research & Innovation (NJRI)*, 1 (1), 216-230
- Alfred, K. K. M. (2021). Use of Multimedia resources in teaching and learning measurement in Mathematics at primary schools in Kericho country-Kenya. Unpublished M. ED Thesis in Mathematics Education; School of Education, Kenyatta University.
- Ananga, P. & Akayure, P. (2016). Integrating interactive multimedia into mathematics course modules for distance education. *African Journal of Educational Studies in Mathematics and Sciences*, 12, 35-44.
- Chong, C-K; Keong, S; Horani, J & Daniel, J. (2006). A study on the use of ICT in mathematics. *Malaysian Online Journal of Instructional Technology (MOJIT)*, 2(3), 43-51
- Hegedus, S; Laborde, C; Brady, C; Dalton, S; Siller, H-S; Tabach, M; Trgalova, J. & Luis, M-A. (2016). Uses of Technology in upper secondary mathematics education. *Springer Link*, 1-36. Retrieved from <https://link.springer.com/chapter>
- Ivypana (2019). The impact of technology on the learning and teaching of mathematics. www.ivypanda.com/essay/the-i 30/04/22 at 15.35hrs
- Lawal, R. F. & Awofala, A. O. (2020). Online Learning of mathematics among Nigerian undergraduates: the COVID-19 experience. *Journal of Mathematical Association of Nigeria (Abacus)*, 45(1), 310-324
- Maidabo, L. I. (2020). Curriculum innovation in mathematics: A Remedy to contemporary issues in science and technology education. *Nagwamatse Journal of Research & Innovation (NJRI)*, 1 (1), 389-404
- Mehta, S. (2022). Modern teaching methods – It's time for the change. *Eduvoice India*.
- Momozoku, U. S. & Sani, S. (2017). Impact of Technology in Mathematics Classroom instruction in Colleges of Education in Nigeria. A paper presented at a mini conference organised in honour of Dr. Abdussalam Abubakar Sambo. Held at Faculty of Education, Abubakar Tafawa Balewa University of Technology, Bauchi. Date 11th-13th July, 2017
- Momozoku, U. S; Audu, A. O; Niyi, O. O. & Alagbe, S. O. (2022). Challenges facing Mathematics Education after the COVID-19 Pandemic Lockdown. *Prestige Journal of Counselling Psychology*, 5(1), 83-92.
- Nyarko, J; Agyeman, K. D; Asare, S. & Gyampoh, S. A. (2021). Multimedia as a pedagogical tool for teaching and learning mathematics in colleges of education. *International Journal of Mathematics Trends and Technology*, 67(7), 64-70. Doi:10.14445/22315373/IJMTI-V67I7P5803
- Ojaleye, O. & Awofala, A. O. A. (2018). Blended learning and problem-based learning instructional strategies as determinants of senior secondary school students' achievement in Algebra. *International Journal of Research in Education and science (IJRES)*, 4(2), 486-501. DOI:10.21840/ijres-428286
- Scharaldi, K. (2020). What are the benefits of teaching Mathematics using Technology? *Texthelp*.
- Sodiya, C.I. & Oyekunle, O. (n.d). Production and use of audio visual aids. Retrieved from www.unaab.edu.ng on Wednesday 15/06/2022
- Vasu, D. J. (2018). Pedagogy of Mathematics: Mass media. Retrieved from pedagogybyvasu.blogspot.com/ on Friday, 17/06/2022 08:46hrs
- Wood, M. (2003). Using television to educate, stimulate and disseminate. *Curriculum and Leadership Journal*. Retrieved from www.curriculum.edu.au/leader/ Friday, 17/06/2022; 12:09hrs
- Zimmerman, J. (n,d). What are the types of technology in a mathematics classroom? Retrieved from <https://sciencing.com/what-are-the> 30/04/22 at 15.58hrs