THE USE OF ICT (E-LEARNING) IN MATHEMATICS INSTRUCTION IN TEACHER EDUCATION: CHALLENGES AND PROSPECTS

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Abstract
The introduction of Information and Communication Technology (ICT) into education has transformed available technologies, the means, methods and activities involved in the teaching and learning process. A fundamental tool that enhances this application of ICT in education is the e-learning. E-learning is a computer based educational tool or system that enables you to learn anywhere and at any time. E-learning can be delivered though the internet, intranet or using a blend of computer-based methods like CD-ROM. It offers the ability to share material in all kinds of formats such as videos, slideshows, word documents, HTML and pdf. E-learning being a technology and its pedagogically neutral, that is, a means and not a mode of education can therefore be applied to different content/subject matter like Mathematics for instance and within any curriculum just like the teacher education curriculum. The paper therefore examines; ICT concept and Teacher Education; e-learning and Mathematics instruction in Teacher Education with specific highlights of areas of Mathematics application and Mathematics e-learning resources. The paper also examined both the challenges and prospects of the use of e-learning in Mathematics instruction in Teacher Education. The paper concludes on the need for mathematics e-learning application in teacher education and recommends among others; a reform in teacher education curriculum and in-service training for teachers to accommodate ICT in education generally and specifically mathematics e-learning application in order to meet the new educational challenges in Mathematics instruction.
Keywords: E- learning, ICT, Mathematics and Mathematics instruction.

Introduction

The world has witnessed series of transformational stages and transition periods in terms of development. These transition periods of societal development range from the nomadic age to the agrarian age; the agrarian age to the industrial age; the industrial age to information age and now entering into knowledge age (Doria, 2014). Although, according to Doria, the information age is still in the process of evolving, and we are, to some degree, still in it. The information age is that stage of human civilization characterized by an explosion of opportunities to not only access but also create vast amounts of information (Doria, 2014). These opportunities are made available to and for the public via communications technology or rather information and communication technology (ICT).

Information and Communication Technology (ICT) according to Adesoji (2005) as cited in Twaki (2016) include the use of communication device or application, encompassing: radio, television, cellular telephones, video, personal computer, and satellite. These devices have made ICT an instrument of dynamic and progressive change in our society and as such, have tremendously influenced development in all facets of human endeavours including the field of education. In Mikre's (2011) description, ICT has revolutionized the way people work today and are now transforming education systems. ICT is helping to increase access and improve relevance and quality of education. Mikre posits that ICTs in education are actually building today's children with requisite skills and technologies that will make them effective and fit in tomorrow's world. The use of ICT in education also known as e-education (electronic education) has shifted the learning approaches as it holds great promise in improving teaching and learning (Uzodinma, 2006). E-education according to Federal Ministry of Education (FME) (2004) in Osemwinyen (2010a) is

the comprehensive framework for the delivery of education using ICT as a tool. Within e-education are such concepts as blended learning and e-learning (electronic learning).

E-learning is a new educational tool or instrument of teaching and learning that is provided electronically. According to Abbad, Morris & Nahlik (2009) e-learning is any learning that is enabled electronically, that is empowered by the use of digital technologies. South Africa Department of Education (SADE) (2003) defined e-learning as structured and managed learning experiences and may be provided partially or wholly via a web browser or through the internet or an intranet or through multimedia platforms such as CD-ROM or DVD, or other media and communications. Today e-learning is mostly delivered though the internet, although in the past it was delivered using a blend of computer-based methods like CD-ROM or DVD. E-learning as a concept covers a range of applications, learning methods and processes (Rossi, 2009). Barret (2006) in Osemwinyen (2010a) posited that with e-learning approach, students can manage their own learning as well collaborate with peers, teachers and experts on meaningful tasks using higher-order thinking. This approach therefore describes a shift from a teacher-centred, task-oriented, memory-based education to an inclusive and integrated practice where learners work collaboratively, develop shared practices, engage in meaningful contexts and develop creative thinking and problem-solving skills, (SADE, 2003). These skills are necessary in all levels and categories of education including teacher education. Teacher education is the professional education of teachers towards attainment of attitudes, skills and knowledge considered desirable so as to make them efficient and effective in their work, in accordance with the need of a given society at any point in time (Ogunyinka, Okeke & Adedoyin, 2015).

According to Adewuyi and Ogunwuyi, (2002), teacher education is the provision of professional education and specialized training within a specified period for the preparation of individuals who intends to develop and nurture the young ones into responsible and productive citizens. It includes training and or education occurring before commencement of service (pre-service) and during service (in-service or on-the-job).
Here, these training and education have to be content relevant, adequate and contemporary to the beneficiaries (teachers and would-be-teachers). The training mode or instruction delivery has to conform to the realities of the current time - ICT age, where the 21st century teacher education demands an approach shift in teaching and learning: a shift from teacher-centred pedagogy to one that is learner-centred using tools such as smartphones, computers, projectors etcetera deployed in the service of education. Teachers' exposure to these realities is vital because they cannot give what they don't have, they have to be exposed to tools which they might likely use when on the real job. This obviously becomes a challenge of the quality of teacher education provided in teachers training institutions all over the country. That is, how adequate and reformed is the teacher education curriculum in meeting the ICT drive in education. ICT (e-learning) being a technology and its pedagogically neutral, that is a means and not a mode of education, can therefore be applied to different content matter - subject areas in the teacher education curriculum including Mathematics.

Mathematics is a core subject in the teachers' education program in Nigeria (Ogunyinka, Okeke & Adedoyin, 2015). And according to Fatima (2012), Mathematics is a branch of science, which deals with numbers and their operations. It involves calculation, computation, solving of problems etc. Mathematics is universal and relevant to the development of all fields: sciences, engineering and technology, social sciences, liberal arts etcetera (Lakshmi & Kundarapu, 2018). Lakshmi & Kundarapu further posit that the importance of Mathematics to individuals in their daily undertaking is so enormous that the knowledge of Mathematics is an indispensable tool for a successful and balanced human existence on earth. It's importance cannot be over emphasized hence, the country's National Policy on Education made it compulsory at both primary and secondary school levels.
Mathematics as a core subject in both primary and secondary school levels has put a sense of urgent responsibility on Mathematics instruction in the teacher education programme because according to Osokoya (2010), one of the goals of the Nigeria teacher education is to produce 'highly motivated,

conscientious and efficient classroom teachers for all levels of education system and secondly there has been some form of consistent decline in Mathematics performance in these levels (Osemwinyen, 2010a; Ayuba, 2011; Omole (2011) and Danjuma, 2015). But this seemingly consistent decline in Mathematics performance calls for several interventions most especially in Mathematics delivery to perhaps help curtail the poor performance. One of such interventions is the exposure and introduction of ICT (e-learning) in Mathematics instruction in teacher education.

As observed by Yushau (2006) and Golden, McCrone, walker & Rudd (2006), e-learning has had positive influence on students' attitudes, interest and mathematics achievements. However, Usman (2006) in Osemwinyen (2010a) found out that majority of Mathematics teachers are not computer skilled and may not be ready to use computer or related devices in implementing Mathematics instructions. This finding and others reflect the level of inadequacy or lack of exposure to ICT in teacher training institutions, probably. Teachers and would-be-teachers should therefore be exposed to e-learning tools in the course of their training in order to enhance productivity for quality education. The paper therefore intends to x-ray the use of e-learning in Mathematics instruction in teacher education; its prospects and problems.

Teacher Education and ICT

Teacher education refers to professional education of teachers towards attainment of attitudes, skills and knowledge considered desirable so as to make them efficient and effective in their work, in accordance with the need of a given society at any point in time (Ogunyinka, Okeke & Adedoyin, 2015). It includes training and or education occurring before commencement of service (pre-service) and during service (in-service or on-the-job). And as it is known that education unlocks the door to modernization and that its teachers who hold the key to that door (Ukeje, 1996 in Ogunyinka, Okeke & Adedoyin, 2015). So how Qualitative and contemporary is the teacher education to meet the needs of a 21st century society? The need for a contemporary means of delivery instruction like application of ICT in education cannot be over emphasized. ICT has changed the practice and philosophy of education and it is a powerful tool for the development of quality teaching and learning (Wali, 2004 in Osemwinyen, 2010a). If the impact of ICT is to be felt in the lives of learners and the society at large, then the teachers who are supposed to be "advocates of change" in the society must first be recipients of the current ICT revolution. According to Byram and Wenrich (1986) as cited in Osemwinyen (2010b), the environment in which the instruction is given is or simulates the working environment to the maximum possible degree. Meaning that, teachers should be acquainted with technology (ICT) replica of the ones in the world of works and the ability to manipulate the ones in the world of works is a reflection of the skills acquired during training. The need to organize and manage content and teach it properly puts the teachers at the forefront of those that need ICT, because this is basically what ICT in education represents. For teachers to be very relevant and successful with respect to changing educational goals, then they must be abreast with proper means of disseminating and communicating with their students.

Wali (2004) as cited in Osemwinyen (2010a) supporting this view maintained that among the most relevant qualities of a good successful teacher include: ability to communicate well and motivate students and ability to create, organize and manage proper learning experiences. Wali further opined that communicating content and ideas to students and proper management of scarce resources remain vital issues to teacher education and training. These two qualities according to Wali can be achieved easily by employing ICTs, since ICTs is all about communicating, using and managing information but in a different way. Basically one of the goals of teacher education as contained in the National Policy for Education (FRN, 2004) is to provide teachers with the intellectual and professional background adequate for their assignment and make them adaptable to any changing situations. But, this is not the case, for instance, Iroha and Ekwueme (2004) observed that the extent of science teachers' awareness of ICT and utilization are low. While Usman (2006) found that, majority of mathematics teachers are not computer skilled and may not be ready to use computer or related devices in the implementation of mathematics curriculum. These findings reflect the level of

inadequacy or lack of exposure to ICT in teacher training institutions. Teachers should therefore be exposed to the use of ICT in the course of their training in order to enhance productivity for quality education.

Concept of E-Learning and Mathematics Instruction

Education and the process of acquiring it have changed drastically over time. Educational systems all over the world are under increasing pressure to use the new ICTs to teach students the knowledge and skills they need in the 21st century (UNESCO, 1998 in Amadi, 2013). UNESCO describes the radical implications the new ICTs have on conventional teaching and learning and predicts a transformation of the teaching and learning process and the way teachers and learners gain access to knowledge and information. This transformation is now a reality through the introduction of e-learning. E-learning according to Wali (2004) in Osemwinyen (2010a) is the main ICT new education tool for teaching and learning. E-learning as a concept covers a range of applications, learning methods and processes (Rossi, 2009). Several definitions by researchers, authors and institutions have emerged on this concept but no common definition can be adduced. According to Oblinger & Hawkins (2005) there is even no common definition for the term. The concept of e-learning seems to be viewed from different perspectives and these perspectives give rise to the several definitions. For instance: Is e-learning an on-line coursework for students at a distance? Does it mean using a virtual learning environment to support the provision of campus-based education? Does it refer to an on-line tool to enrich, extend and enhance collaboration? OR is it a totally on-line learning or part of blended learning (Dublin, 2003)? In an attempt to provide answers to the above questions, the term e-learning could be viewed as follows:

Organization for Economic Co-operation and Development (OECD) (2005) defined the term e-learning as the use of information and communication technologies in diverse processes of education to support and enhance learning in institutions of higher education and includes the usage of information and communication technology as a complement to traditional classrooms, online learning or mixing the two modes. Oblinger and Hawkins (2005) noted that e-learning has transformed from a fully-online course to using technology to deliver part or all of a course independent of permanent time and place. Also the European Commission (2001) as cited in Arkorful & Abaidoo (2014) describes, e-Learning as the use of new multimedia technologies and the internet to increase learning quality by easing access to facilities and services as well as distant exchanges and collaboration. Takiya, Archbold and Berge (2005) opined that e-learning is the delivery of materials electronically with the added value of maintaining standards and quality across the board without limitation of a specific location.

In its broadest sense, Abbad et al (2009) defined e-learning to mean any learning that is enabled electronically, that is empowered by the use of digital technologies and components such as computers, telephones, multimedia, internet or the intranet, CD ROMs, DVD etc. E-learning offers the ability to share materials in all kinds of formats such as videos, slideshows, word documents, HTML and pdf. Conducting webinars (live online classes) and communicating with teachers/lecturers via chat and message forums are also e-learning options available to students. Since e-learning is a means and not a mode of education, that is, a medium of delivering education (a technology), it can be applied in accordance with varying pedagogies (Thorpe, 2002 in Osemwinyen, 2010a) and to different subject matters including Mathematics. Mathematics a core subject in both the primary and secondary school is equally essential in the teachers' education program in Nigeria (Ogunyinka, Okeke & Adedoyin, 2015). The manner of its delivery in the teachers' education program will to some extend reflects same in the lower levels; primary and secondary schools since teachers cannot give what they don't have. And this ultimately could affect students' Mathematics performance. According to (Akanmu, Abinde & Fajemidagba (2015), empirical studies have indicated that students performance to a large extent is dependent on effectiveness of teaching methods and strategies. That is, the teaching methods and strategies being employed could yield either high or poor mathematics performance. The persistent decline in Mathematics performance in both primary & secondary levels (Osemwinyen, 2010; Ayuba, 2011; Omole (2011) and Danjuma, 2015) has put a sense of urgent

responsibility on Mathematics instruction in the teacher education programme because according to Osokoya (2010), one of the goals of the Nigeria teacher education is to produce 'highly motivated, conscientious and efficient classroom teachers for all levels of education system. The conscientiousness and efficiency of these Mathematics teachers would demand the employment of all strategies to improve the poor Mathematics performance of students.

Among the several interventions will include the application of e-learning in Mathematics instruction in teacher education. This application of e-learning in Mathematics instruction, a 21st century teaching strategy would definitely bring about an approach shift: a shift from teacher-centred pedagogy to one that is learner-centred. E-learning is very supportive of the different theories: cognitive, constructivism and behaviourism which guide the teaching and learning of mathematics. E-learning allows learners to undergo the processes of assimilation and accommodation in building knowledge which is very central to learning mathematics. E-learning allows learners to be constructive and creative.
E-learning gives rooms for constructive and abstract thinking. E-learning is learner centered, it is a wide range of opportunities for learners to move from one concept to another allowing the intuitive type of learning and also from the knowledge of a lower concept to a higher one (reflective abstraction). E-learning supports the development of mathematical concepts and also stimulates the interest of learners in learning mathematics (Yushau, 2006) thereby having a positive academic impact on them (Ellbeck, Hewiston, Lima, Culshaw and Stone, 2004 in Osemwinyen, 2010a). That is, with e-learning curriculum-based Mathematics instructions is still maintained and one is not restricted by location (Nichols, 2003 & Wali, 2004).

E-Learning Media for Mathematics Instruction
Basically, the delivery media could be categorized into two types:

- On-line instruction delivering
  - Real time
  - Non-real time
- Off-line instruction delivering

On-line instruction delivering
It is the delivering of Mathematics instruction electronically which could be in the form of text, audio and video via internet (World Wide Web) or intranet. This is either an on-line real time format or non-real time:

On-line real time: This is a form of Mathematics delivering through the net (internet or intranet) where by learners can log in at exactly the same time the Mathematics instruction is being delivered. For instance webinars (live online classes) can be used and learners are hooked directly to the lecturer, while the instruction is being delivered, almost in the form of a face- to- face education. Teleconferencing is still another format of online class.

Non-real time: This is a form of Mathematics delivering through the net (internet, intranet) where by learners are not hooked to 'live' Mathematics instruction as in real time, but rather they access deposited Mathematics materials on the net. It could be in the form of streaming video, recordings or even chat services.

NB: Both on-line real time and Non-real time delivering consist of internet and intranet means. The internet based consists of accessing mathematics instructions through the World Wide Web (WWW). E-mail correspondence courses of mathematics content and file transfer falls within this category. While the intranet based consists of accessing mathematics instructions over an institution's internal network: LAN (Long Area Network) or WAN (Wide Area Network). Browsers are used to access web pages containing Mathematics content, but the pages are only accessible within the institution's intranet.

Off-line instruction delivering

This is actually a blend of computer-based methods. Here, the Mathematics instructions are contained in either a DVD or CD-ROM in the form of a mathematics CAI that can be accessed through the computer or presented with the aid of a projector or any other interactive multimedia tool; video, camera, recorder etc.

Some areas of E-learning Mathematics applications and Mathematics E-learning resources

Specifically, the use of e-learning in Mathematics instruction can be deployed to but not limited to the following:

- Geometry and Trigonometry: Teaching and drawing of shapes & properties; using packages like Ms-word or Desktop packages like Corel draw, Power point etc.
- Simultaneous and quadratic equations can employ the use of special programs like Qbasic, Fortran etc for graphical solutions of quadratic equations.
- The logic circuits of computer can be use to teach truth table and Boolean algebra.
- Computer can help in effective teaching of a three-dimensional geometry.
- Computer also has the facility to draw and scan mathematics images for instructional uses.
- Computer can aid in teaching number bases other than 10 and also in evaluation of determinant.
- Simulation method of teaching.
- With drill and practice software, students can have a better understanding and mastery of mathematical concepts.
- Computer helps to use flow chart in teaching problems solving, construction of coordinates, slopes and interpretation of equations.

Some Mathematics E-learning resources

The following are e-learning platforms for Mathematics resources
Khan Academy: It offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside of the classroom. It guide learners from kindergarten to calculus using state-of-the-art, adaptive technology that identifies strengths and learning gaps.

The Math Forum: The math forum is a leading center for mathematics and mathematics education on the Internet. Encouraging communication throughout the mathematical community, offering model interactive projects, making mathematics related web resources more accessible, and providing high-quality math and mathematics education content

Aplusmath*:* Interactive mathematics resources for teachers, parents, and students featuring free math worksheets, math games, math flashcards, and more.
MathBasis: Helps students with difficulty in basic mathematics concepts like subtraction, multiplication, division, fractions, decimals, and percents? With an emphasis on images and interactives, it makes learning maths easier. The tutorials are like a math workbook, so we can practice what we learn directly within the lessons and learn at our own pace.
AbsurdMath: Absurd Math is an interactive mathematical problem solving game series. The player proceeds on missions in a strange world where the ultimate power consists of mathematical skill and knowledge. This is interactive, also.
Desmos: Desmos helps every student learn mathematics and love learning math.
MathPickle: MathPickle.com is a free online resource of original mathematical puzzles, games and unsolved problems for primary to secondary teachers. It is a practical resource for teachers. Its visually

compelling puzzles and games engage students in tough problem solving. Its puzzles are organized by grade and subject – each designed for a 45-60 minute period.

Benefits of ICT (e-learning) in Mathematics instruction in Teachers Education

There are several benefits of e-learning in Mathematics delivery. Majorly e-learning: changes the traditional process of teaching and learning; a shift from teacher centred to child centred pedagogy: serves as a medium for facilitating and managing learning by way of easy accessibility to course materials by learners or easy communication with learners outside the classroom: is being used as a preparation and presentational tool i.e. creating teaching materials or presenting information in front of the class (as part of face-to-face sessions): could also be a learning tool and could help teacher to motivate students and grow interest in Mathematics learning.

Challenges to the Use of ICT (e-learning) in Mathematics delivery

There are several challenges to the successful use of ICT (e-learning) in Teacher Education. for delivery Mathematics instruction. These include among others:

- **Development Time**: It takes considerable amount of time and expertise to develop a good mathematics e-learning package.
- **Expertise**: Lack of relevant man power; IT specialist and Mathematics teachers/lecturers with relevant expertise for design/building of the Mathematics e-learning platforms and contents. This may be as a result of the structure of Mathematics.
- **Appropriate e-learning tools**: Finding appropriate e-learning tools to represent the conventional Mathematics classroom settings could be tasking and there could also be difficulties in typing accurately mathematical formulas/notations in designed e-learning models or platforms, which in turn hinder mathematical communication. These could prompt students to describe mathematics in words rather than in the established mathematical notations.
- **Development cost and Infrastructure cost -** Initial cost of assembling expert: Course contents experts, computer programmers, instruction design experts and graphics artists are quite expensive. Also, the cost of purchasing equipment (ICT components) e.g Computers and Vsat is high. If not supported by government, provision of internet facilities and others could be difficult to come by.
- **Weak Infrastructure**: In Nigeria a formidable obstacle to ICT (e-learning) is infrastructure deficiency. The country is seriously deficient in reliable electricity supply which is a necessity for the e-learning process.
- **Lack of Technical Skilled manpower**: The country is not only deficient in ICT infrastructure but also lack human skills and knowledge that are prerequisite to the success and realization of the e-learning dream with respect to trained personnel to install, maintain and support the systems.
- **Is E-learning Replacing Teachers**? There is growing fear of e-learning replacing teachers. E-learning compliments teachers and make them more efficient and goals realizable It is interesting to know that not all courses are delivered well by computer. Some training topics such as group projects, team work and any activities that involve emotions require human interaction. E-learning will not replace the classroom, but it has the potentials to change the purpose and function of the classroom considerably.
- **Bandwidth and Limited Access to the Internet**: Inability of users (individuals, private, and government) to make use of large bandwidths makes the process of accessing and working with the net cumbersome. Limited bandwidths make downloading and other activities to be slow and discouraging. Also in Nigeria there are few internet providers that provide gateway services to the populace. The greatest technological challenge in Nigeria is how to establish reliable cost effective internet connectivity.

Conclusion

The application scope of e-learning is rather wide. The important point in e-learning mathematics instruction is its being able to also educate the learners through technological tools either directly (webinars) like the traditional mathematics classroom teaching or otherwise. The idea may not necessary be for mathematics instruction to be completely technologically based but can leverage upon some of the e-learning tools and platforms alongside traditional mathematics classroom teaching which is blended learning, a trend in e-learning. The fact remains, in this 21st century educational realities, the use of ICT or e-learning in teaching Mathematics in Teacher Education cannot just be wished away at least considering it over benefits.

Recommendations

1. Teacher education curriculum should be redesigned and constantly reviewed to accommodate the use of ICT in education and specifically mathematics e-learning applications in order to meet the new educational challenges in mathematics instruction.
2. Provision of necessary infrastructural support: power supply, internet facilities etc. More so, massive training and deployment of skilled manpower to the various teacher education institutions should be encouraged.
3. Mathematics Teachers/lecturers/trainers in teachers training institutions should be encouraged to attend ICT workshops and conferences in order to expose them to current trend of ICT education. Particularly, teachers should be exposed to training in simple software development in order to introduce them to building of courseware.
4. Adequate funding by relevant bodies; Government, international donors etc should be provided for the entire educational sector, particularly, teacher training institutions with emphasis on ICT development.

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