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Timothy M. Akintayo, Mariam A. Adebayo, Afeez O. Oyediran
Department of Science and Technology Education, University of Lagos, Nigeria
akintayotimothy92096@gmail.com

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Abstract

A significant criticism of the pre-service teacher education program is that it fails to prepare pre-service teachers to effectively use ICT in the delivery of mathematics instruction in the classroom. Even worse, ICT reforms in Nigeria mainly focus on providing ICT infrastructure and combating other barriers to ICT use rather than creating a blend between pedagogy, content knowledge and ICT competence. Considering this, the study considered student-teachers lived experiences with ICT courses taken in their teacher education program. A mixed-method approach consisting of quantitative and qualitative instruments, including questionnaires and semi-structured interviews, was used to obtain the necessary data to cover all the research questions and objectives, covering 150 pre-service teachers and 165 senior secondary school students using purposive sampling. The study concluded that the benefits of using ICT in the classroom are not conceivable without the pre-service teachers being equipped with ICT competence. Therefore, it was recommended that the teacher education program should furnish its curriculum with courses teaching pre-service teachers how to use the latest ICT innovations in the delivery of mathematics instruction right from their teaching practice.

Introduction

The usability of mathematics in various fields such as businesses, health, and education has resulted in it being a compulsory subject in most developed countries (Kashyap et al., 2020). Moreover, it has played a prominent role in the transition and development of contemporary technologies. There is almost no important Information and Communication Technology (ICT) tool that does not involve using mathematical algorithms and mathematics. Aydin and Kaya (2016) 's study intimated this by stating that mathematics is an essential substance of ICT, and ICT greatly supports mathematics; therefore, the outcome of ICT is more dependent on mathematics than any other discipline.

ICT has experienced significant progress in the last few decades, and there have been steps taken to modernize the teaching of various subjects using ICT. Most especially in secondary schools, which is a significant level of formal education that stands between the primary and higher level of education Information. Thus, with ICT being renowned for being a tool that has transformed the global education system and has helped educators worldwide in achieving their learning objectives, it is strongly recommended to be used in the delivery of mathematics instruction (Olafare, Lawrence & Fakorede, 2017, p.1).

ICT helps to engage mathematics learners in the classroom, improves memory retention, and ensures that complex concepts are made comprehensive. According to a quote by Ben Franklin: "Tell me, and I forget; teach me and I remember; involve me and I learn" (Hogue, 2021). ICT is a viable tool to involve students because it supports student-centred mathematics learning. Yeo (2009) posited that an extensive range of symbols, theorems, axioms, graphs, and formulas sometimes makes the demonstration of mathematics for students' understanding an arduous task for teachers. The presentation of these formulas on a blackboard makes them incomprehensible and often makes students and parents see mathematics as an abstract and difficult subject (Jameel and Ali, 2016). However, in recent years, the presentation of these formulas, graphs, and instructions in 2D, 3D, and charts using ICT tools has improved the students' understanding of mathematics.

Nevertheless, the benefits that accompany the use of ICT in the delivery of mathematics instruction in Nigeria are limited; because of problems such as lack of infrastructure and equipment. To add to the list "ICT Competence" of the supposed mathematics teacher, which is the focus of this study. Undoubtedly, Nigerian secondary schools lack ICT facilities, making its use in the delivery of mathematics instruction difficult; this has been the focus of most research, with little or no understanding that these schools are filled with "ICT incompetent teachers". Only in the best schools do you see teachers with basic ICT competence that cannot even suffice or compete with the 21st-century expectation in developed countries. Let alone possess the competence to match up with teachers in other countries who use ICT to deliver mathematics instruction. In addition, limited studies have been carried out to expose stakeholders to Nigerian teacher education programs producing more ICT incompetent teachers, adding to the already existing ones. So, the question now is, what is ICT competence, and why is ICT competence necessary in teaching mathematics? According to Romani (2009), "ICT Competence" is the confident and critical ability to use electronic media to visualize and communicate various mathematical topics by intricately connecting hardware and software, utilizing a range of productivity applications, spreadsheets, and using a database management tools to store and retrieve information. It should be noted that although ICT has proven to be a potent tool for eradicating the abstract nature of mathematics, integrating it into mathematics instruction is not easy; it requires "competence" (Wusqo et al., 2018). Therefore, teachers need to have the needed "ICT Competence" in their repertoire to utilize ICT and adequately use it to support students' learning and understanding of mathematics (UNESCO, 2008).

While countries like Germany, France, and Japan have succeeded in making ICT a core part of their teacher education curriculums (Eurydice, 2004) and have used these curriculums to effectively prepare their future teachers by incorporating ICT's practicality in their educator to pre-service teacher training (Eurydice, 2001); leading to successful transitioning of pre-service teachers in these countries into ICT competent in-service mathematics teachers. However, Nigerian teacher education programs still foreground the content of mathematics and pedagogy knowledge ahead of ICT knowledge to deliver mathematics instruction or rather a blend of ICT with the content and pedagogical knowledge (Sarmah et al., 2020). Not to mention, ICT is mainly introduced as a stand-alone course in the teacher education programs of Nigerian colleges and universities, leading to the production of teachers with a surface knowledge of ICT in place of teachers with ICT competence (Garba, 2014). Since the teachers that these programs produce are not ICT competent, they cannot efficiently utilize appropriate ICT tools for the different needs of the students and teach various mathematical concepts comprehensively, making secondary school students disinterested in mathematics. Students now have a perception that since they cannot understand most of the mathematics concepts, then mathematics is genuinely an abstract and difficult subject as it is being proclaimed. They proceed to a higher institution of learning with this mindset, and sometimes their education gets affected. Since mathematics is an essential subject at all levels, they pay dearly for not having the requisite knowledge to succeed in some courses (Simonaitienė, Greenrod, 2009).

Numerous research has focused on the integration and role of ICT in the delivery of mathematics instruction; Kayshap et al. (2020), Joshi (2017), Nenji (2013), and other studies all examined the role of ICT In the teaching of mathematics in various countries. Still, we have a paucity of research on "ICT competence of pre-service teachers and its influence on the use of ICT in the delivery of mathematics instruction in Nigeria". This is a gap in ICT use in the delivery of

mathematics instruction delivery in Nigeria; within the construct of the quality of the teacher education in preparing them for the expected ICT competence. Thus, this study aims to fill these gaps by determining the level of competence of pre-service teachers and the perception of pre-service teachers on how the teacher education program prepares them to use ICT in their future mathematics classroom. This study examined the competencies of pre-service teachers in ICT and how this competence influences the use of ICT in the delivery of mathematics instruction. Furthermore, it will examine how improving mathematics education programs in Nigeria can improve pre-service teachers' ICT competence, consequently influencing its use in the delivery of mathematics instruction. The problem of this study is to imbibe ICT competence in pre-service teachers and ensure that mathematics educational programs are prepared so that ICT competent future teachers are produced.

Objectives of the Study

The research found out pre-service teachers' ICT competence and its usage in mathematics instruction.

Research Questions

The following research questions guide this research.

1. What is the competence level of pre-service teachers of mathematics?
2. What is the extent of using ICT for instructional purposes by pre-service mathematics teachers?
3. How do pre-service teachers perceive the use of ICT for mathematics Instructional purpose??
4. What are the ICT interventions that can help in the improvement of the ICT competence of pre-service teachers?

Methodology

This study used the survey study design through questionnaires complemented with semi-structured interviews. This is known as a mixed-method approach to data collection, which combines the qualitative and quantitative approach, and is inclined towards basing knowledge claims on a pragmatic stance using multiple realities (Creswell, 2003). It was manifested with the explanatory sequential mixed method, which involved conducting the quantitative research first using a questionnaire, analyzing the result, and then using the qualitative research to explain the results (Creswell & Plano Clark, 2011) through unequal sample sizes at each phase. The respondents were streamlined to 315 senior year students, which consisted of 150 senior year pre-service teachers and 165 senior secondary school students around Akoka using the purposive sampling technique; this research method is used with numerous considerations and constraints such as time and resource constraints.

The demographic information was obtained through the section A of both the pre-service teacher, and student questionnaire and the section B, C, D, E, F were adopted from the study of Agyei and Voogt (2010), Zyad (2016), Dike (2014), Amini and Oluyide (2020), Kariuki (2013). The items adopted were deemed valid by the researchers, having carried out their face and content validities. The questionnaire comprised demography, Level of Competence of Pre-Service Teachers (16 items), the extent to which ICT is used for instructional purposes in senior secondary schools (6 items), Pre-service teachers' perception of the education programs in preparing teachers to use ICT in their future mathematics instruction (10 items), Perceived challenges are affecting the adoption, deployment and effective use of ICT in mathematics instruction (9 items), as well as suggested ICT interventions. The reliability values reported in this study are (b) α: 0.865, (c) α: 0.931, (d) α: 0.72, (e) α: 0.80; (b) α: 0.74, (c) α: 0.93 and (d) α: 0.67. The study used the collective administration method to administer the research instruments to capture many the respondents and get a high response rate. Since the focus was on the ICT competence of pre-service teachers in the delivery of mathematics instruction, the study interviewed ten pre-service teachers. Collected data were analyzed with the SPSS (Statistical Packages for Social Science) version 23.

Results

Research Question 1:
What is the competence level of pre-service teachers of mathematics?
Table 1:
Level of Competence of Pre-Service Teachers

S/N	Items	Mean	SD
1	Ability to search for information on selected topics in Mathematics using Google search engine, You-Tube, MathWay	3.50	0.72
2	Ability to minimize, maximize a window page as I teach Mathematics contents to my students using the window minimize/maximize option	3.48	0.73
3	Accuracy in sourcing information on a Mathematics topic using a search engine	3.46	0.75
4	Accuracy to download from download file options on the internet	3.44	0.73
5	Ability to identify and locate inbox notifications from my students within a minute	3.35	0.86
6	Accuracy in using Microsoft word to draw frequency table	3.31	0.88
7	Ability to design a lesson plan on a topic in Mathematics using a computer	3.25	0.86
8	Ability to organize my students into groups and give them assignments to solve online using a computer system	3.24	0.81
9	Ability to use projectors comfortably to teach my class on a selected topic in Mathematics	3.23	0.83
10	Ability to guide your students using computer system to draw charts and tables	3.22	0.94
11	Ability to guide your students on how to use a computer to perform simple arithmetic on a selected topic in Mathematics	3.22	0.86
12	Precision in harnessing information from different sources to form a single body of knowledge	3.21	0.85
13	Precision in typing a page of assignment and e-mailing to your students within five minutes	3.18	1.09
14	Ability to use Microsoft excel or any other software to compute arithmetic mean, measure central tendencies, graphs, charts in teaching desired topics in Mathematics	2.97	1.12
15	Accuracy in locating desired software package(s) on Mathematics contents and icons	2.81	1.01
16	Accuracy in using power point presentation to teach desired contents in Mathematics	2.69	1.02

This table revealed that pre-service teachers could search for information on selected topics in Mathematics using Google search engine, YouTube, and MathWay in preparation for their classroom teaching and can minimize and maximize a window page while teaching Mathematics. Sometimes, specific mathematics topics can prove complicated even for a competent teacher; the quest for clarity to ensure understanding of certain concepts before teaching leads to search for information using Google search engine, YouTube, and Mathway. Although being able to minimize, maximize a window page while teaching might seem like a relatively simple and basic competence one should be equipped it; arguably, there are pre-service teachers who cannot perform this task and not being able to perform such essential operation is equivalent to not being able to perform advanced operations using ICT. Seeing that ability to use Microsoft excel and accuracy in locating desired software and PowerPoint demonstrates that pre-service teachers are still very much acquainted with using traditional methods. While Excel can offer benefits such as the average score of students to track students' performance and attendance in class, PowerPoint can offer an amazing presentation of mathematics content to students. The inability to use this tool puts effective learning at a disadvantage.

Research Question 2: what is the extent of using ICT for instructional purposes by pre-service mathematics teachers?
Table 2:
Extent of usage of ICT resources

S/N	Items	Mean	SD
1	Word processing packages (Microsoft Word, Word Perfect)	3.24	0.94
2	Use of E-mail	3.24	0.93
3	Internet (YouTube, Math way, Wolfram Alpha)	3.14	0.90
4	Spread sheet (MS Word, Google Docs, Word Perfect)	2.88	0.94
5	Presentation Software (PowerPoint, Keynote)	2.59	0.96
6	Graphical Application (Microsoft Excel, Google Charts)	2.33	1.09
7	Graphical Calculators (Desmos, Texas Instrument)	2.25	1.01
8	Database software (Microsoft Access, My SQL)	2.24	0.93
9	Application of multimedia (Adobe Photoshop, Picasa)	2.20	1.13

The presented table shows the extent at which ICT is used for instructional purposes in senior secondary schools. Based on the response of the pre-service teachers, the world processing packages are the most used ICT resources in secondary schools, and Database software, e.g. Microsoft Access, My SQL and multimedia, e.g. Adobe Photoshop, Picasa, are seldom used. The typographic quality of Microsoft Word places it at the forefront; it is used as a text tool that teachers use to prepare lesson notes. This finding is in line with the study of Becker et al. (1999); the most frequently used software by teachers is the Word Processing and World Wide Web (WWW), irrespective of the subject. Email is a powerful, customizable, rapid, economical, and effective tool for correspondence and communication between student-student, teacher-student, parent/guardian-teacher, and teacher-administrators.

Research Question 3: How do pre-service teachers perceived the use of ICT for mathematics Instructional purpose?
Table 3:
Pre-service teachers' perceived use of ICT for mathematics Instructional purpose

S/N	Items	Mean	SD
1	Coverage of computer skills was adequate	4.61	0.70
2	The program was removed from the blend between pedagogy and ICT	4.57	0.79
3	The quality of instructional materials is satisfactory	3.58	1.12
4	I acquired several computer literacy skills	3.50	1.00
5	The quality of the equipment was satisfactory.	3.48	1.22
6	I was satisfied with the quality of ICT integration	2.95	0.47
7	Practicum assessment included demo lesson of how to use ICT in the classroom	2.44	0.89
8	The quality of the ICT in the pre-service technology was satisfactory	2.22	0.80
9	The modeling focused on student-centered use of ICT	1.50	0.69
10	There was enough modeling of how to use ICTs in the classroom	1.47	0.62

There was enough modeling of using ICTs in the classroom from the table; pre-service teachers perceived that the teacher education program's coverage of computer skills was adequate, and the program was removed from a blend between pedagogy and ICT. Pre-service teachers are exposed to basic computer skills adequately since they offer several ICT related courses at different levels before the end of their program that teaches them theoretically what ICT is about with little or no practicability. Additionally, pre-service teachers believe that "The program was removed from the blend between pedagogy and ICT", implying that the programs have not been prepared to incorporate ICT into the various methods and approaches to teaching what they have been taught.

Research Question 4: What are the ICT interventions that can help in the improvement of the ICT competence of pre-service teachers?

Table 4: ICT interventions that can help improve the ICT competence of mathematics pre-service teachers

N	ICT Interventions	Frequency	Percentage
1	pedagogy framework should be detailed in such a way that it integrates different use of ICT for curriculum and assessment	5	7.7
2	Full exploitation of the changing technological innovations and possibilities	3	4.6
3	Making ICT competence certification/knowledge a criterion for math teacher employability	2	3.1
4	Provision of appropriate infrastructures and resources	6	9.2
5	Regular use and update of mathematics learning content based on technological developments	5	7.7
6	Coherence between what is taught, what is being in practiced outside classroom and envisioned in the study programme	18	27.7
7	The practicum grading should be done based on pedagogical, content and ICT knowledge	12	18.5
8	Making time in the table for the teachers to integrate ICT in their teachings	14	21.5

The table has clearly shown that pre-service teachers would like the teacher educational program to include a pedagogy framework that would be detailed in such a way that it will integrate different use of ICT for curriculum and assessment. This is because having the right pedagogy alone is not enough; having the right pedagogy incorporated with ICT is pivotal for effective learning of mathematics. Secondly, full exploitation of the changing technological innovations and possibilities is important; it is necessary that you establish a continuum of effort towards ensuring that the teachers' knowledge is constantly updated in line with latest technological advancement.

Discussion of Findings

Having basic ICT knowledge or undertaking theorized ICT courses that form the bulk of the ICT curriculum of the teacher education program is not sufficient for pre-service teachers to utilize ICT in the delivery of mathematics instruction effectively. Still, they need to be ICT competent because we can only have competent in-service teachers if we produce competent pre-service teachers and vice-versa. Therefore, for the system to produce ICT competent teachers in line with 21st-century technology, there is a need for the teacher education programs to redesign their education programs to help pre-service teachers move from teacher-centric outlooks to a more student-centered outlook using ICT tools during their undergraduate program. This is in line with Kariuki's (2013) study, which stated that teacher education programs should continuously redesign their programs in line with ICT advancement.
Although Akinoso (2018) corroborated this study's findings that multimedia helps make teaching easy and improves students' understanding, sadly, it is less used. This is supported by the findings of Kariuki, (2013) which stated that that the teacher education program should continually upgrade its teaching curriculum as technology continually experiences development.
Another perceived ICT intervention is provision of appropriate infrastructures and resources; if a teacher possesses necessary skills and knowledge to integrate ICT in the pedagogical practice and the needed infrastructure is not in place, then it is impossible to utilize ICT in the instruction delivery of mathematics. This is supported by the view shared by one of the pre-service teachers:

> *Even if we have most of the schools most especially public schools lack the needed ICT tools for learning mathematics. Government needs to ensure provision of the latest ICT resources and infrastructure, and proper maintenance of these tools to avoid constant damage and degradation of their quality.*

The lack of the blend of pedagogy with ICT has left pre-service teachers with a framework that cannot appropriately incorporate the use of ICT in their teaching method for different topics (Baker, 2011).
Furthermore, pre-service teachers are of the opinion that the teacher education programs failed to focus on student-centered method instruction or teach pre-service teachers to utilize in enabling lifelong learning and promote independent problem solving to students.
This is backed up by the view shared by one of the pre-service teachers:

> *Suppose the teacher education program teaches pre-service teachers student-centered use of ICT. In that case, they will be able to give students a "Wow experience" and draw their attention in the*

classroom, increase interactivity; thereby improving the learning of mathematics will lead to better student performance.

The study also found that MOCPED pre-service teachers had lesser ICT competence among the three schools examined. This infers that some schools have somehow gradually improved ICT competence in their curriculum, but some do not see this as necessary. Additionally, in Nigerian secondary schools, the extent of usage of ICT for instructional purposes is low; the study by Neyland (2011) backs up this finding by stating that there is low usage of ICT in developing countries and a major blockade to the integration of ICT in the educational process in developing countries is their lack of ICT infrastructure. This is also supported by the view shared by one of the pre-service teachers; from the interview:

> *I think that most schools are not well equipped with ICT tools, and some students are not exposed to the use of ICT tools; the supposed school where they are meant to be taught how to use ICT tools does not have ICT tools. There is also the dwindling state of electricity in the country, which is a big dilemma coupled with the lack of the necessary ICT resources.*

Finally, the study established that there exists an insignificant negative relationship between the ICT competence of the students and students' application to ICT; this can be attributed to the fact that the ICT competence of the student is not enough to drive student's application to ICT, the ICT competence of their educator (teacher) is essential to improve their application of ICT, and it is a necessary component needed to increase student's application of ICT. This is supported by the study by Australian National Training Authority (2000); when an ICT competent teacher integrates ICT into educational practices, it prepares students to participate and actively contribute to the 21st-century development, which requires an extraordinary level of literacy, numeracy, competence with technology, and a high creativity spirit.

Conclusion

The study concluded that the benefits of ICT can only be enjoyed when pre-service teachers are ICT competent, necessitating the need for adjustment in the curriculum of the teacher-education programs. More so, effective integration of ICT into the delivery of mathematics instruction depends on the competencies of both the teacher and the student in using the available technology. Additionally, for ICT to be effectively used in the delivery of mathematics instruction other than ICT competence, which is the central focus of this study, infrastructure is equally important and must be complemented by ICT competence. ICT will only be deemed usable for instructional practice if the proper infrastructure is provided because a lack of ICT infrastructure will hamper the application of ICT by the pre-service teacher even if they possess the competence. They will have no choice but to utilize traditional teaching methods in their teaching practice; as it were, technology is continually experiencing development in developed countries, and Africa cannot be an exception. Suppose we want our students to be globally competitive. In that case, the mathematics learning content that the pre-service teachers will be taught must include how they can teach in line with the latest technology.

Recommendations

Based on the study findings of the study, it was recommended that:

1. The teacher education program practicum assessment should be done based on pedagogical and content knowledge of delivering mathematics instruction and on ICT to ensure that the knowledge acquired in the program leads to transformative classroom practices.
2. The teacher education program should present an integrated technique to prepare pre-service teachers for lesson planning effectively, design and delivery of mathematics instruction, and the approach should be under review because of the rapidly changing nature of ICT to align the curriculum teachings with the latest ICT innovation in the classroom.

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