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An Investigation of the Correlation between Lecturers' Instructional Practices and the Level of ICT Tools Use in Teacher Training Programmes

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Abstract

This study investigated how lecturers' instructional practices and ICT tools usage relate to the teaching and learning of mathematics at Kyambogo University in Uganda. A questionnaire was used to collect the data (n=50), and Pearson's correlation analysis was used to analyze the results. Using SPSS 25, we obtained a Cronbach's alpha coefficient (α) of 0.728. The study employed a quantitative research methodology and a correlation research design. The null hypothesis for the study was rejected by the analysis, which showed that lecturers' instructional practices are significantly impacted by the usage of ICT tools ($r = 0.796$, $p<0.01$). ICT integration into teacher preparation courses could greatly enhance mathematics instruction in Uganda. According to the above results ($r = 0.796$, $p<0.01$), there is strong interdependence between ICT tools and lecturers' teaching practices, which portrays the essence of integrating ICT tools into mathematics education curricula. The implication is that adopting ICT for teacher education improves lecturers' teaching methodology and, eventually, their learners' attitudes toward mathematics.

Keywords: Correlation, ICT Tools, Instruction, Lecturers, Mathematics, Practices

1. Introduction

The components and infrastructure that make up modern computing are known as information and communications technology (ICT) (Kouser et al., 2022). ICT tools in education include devices such as laptops, tablets, and software programs that are utilized to improve instruction and learning in the classroom (Mooij, 2007). These technologies have become increasingly popular in mathematics education because they can increase students' motivation to learn, improve their comprehension of mathematical ideas, and improve their overall performance on the subject. Due to the growing integration of technology into daily life, students must acquire excellent digital literacy abilities to succeed in the modern world (Lei et al., 2014).

There are numerous ICT tools available for teaching mathematics, including interactive whiteboards, apps for learning mathematics, online simulations, virtual manipulatives, and graphing calculators (Aggarwal, 2020). For example, mathematical concepts can be visually represented on an interactive whiteboard, making learning more dynamic and interesting. Similarly, student comprehension and motivation can be increased by using instructional mathematics apps such as Khan Academy or Mathletics, which offer tailored practice and feedback. Through virtual experiments and visualizations, online simulations such as the PhET Interactive Simulations project can assist students in exploring mathematical topics. Students can gain practical experience in handling mathematical objects with virtual manipulatives such as the National Library of Virtual Manipulatives, which can enhance their comprehension. Graphing calculators such as Desmos or TI-Nspire can enable students to graph and analyze mathematical functions, making complex concepts more accessible.

According to the study by Sung et al. (2016), if applied properly, digital technology in education can improve students' mathematics achievement and accelerate and deepen the pace of instruction. It is crucial to remember that teachers' knowledge and expertise using digital technology strongly influence their efficacy in the classroom. Teachers who are well trained and knowledgeable about using digital technology can effectively integrate this technology into their lessons, increasing their engagement and interactivity with their learning experience. However, the fear of change and lack of training in utilizing these technologies effectively may hinder the willingness of mathematics teacher trainers to incorporate them into their teaching methods. Educators need to receive proper support and professional development opportunities in regard to innovative instructional practices to enhance their teaching skills and stay updated with the latest educational trends.

In most cases, lecturers in teacher training institutions in Uganda are strongly inclined toward traditional lecturing, textbooks, and learning and writing assignments (Baguma, 2018). These practices usually entail passive learning in which students attend lectures and take notes without much active involvement. The use of ICT tools in mathematics teaching has remained low, and most lecturers still prefer traditional methods of instruction (Pongsakdi et al., 2021). Nevertheless, there is an emergent understanding of how ICT tools could improve student-centered learning. Moreover, ICT tools can be used to bridge the gap between urban and rural universities in Uganda since some students in rural areas rarely enjoy quality academic resources. Teacher training institutions may incorporate the use of technology so that trainers (lecturers) can understand how best they can utilize those particular tools and then transfer their knowledge to students in comfort of their places. This guarantees equal learning opportunities for all learners and prepares them for a world where technology is playing a greater role in shaping the future.

This study aimed to identify effective teaching practices involving ICTs in mathematics education. Improving how technology is implemented in instructional processes, can improve the teaching and learning of mathematics.

1.1 Hypothesis

H_o: Lecturers' instructional practices are not affected by the incorporation of ICT tools in teaching and learning mathematics in Uganda.

2. Literature Review

Because of the potential advantages that ICT tools can provide for both teaching and learning, the incorporation of ICT tools during instruction has grown in popularity in mathematics classrooms (Bray & Tangney, 2017). Studies (Attard & Holmes, 2022) have demonstrated that using ICT tools in mathematics instruction can lead to practice problems and tailored feedback, allowing lecturers to monitor students' development and more efficiently attend to individual requirements. Instructors may foster a more dynamic and engaging educational setting for the learners they teach by using ICT resources in their instructional strategies.

Furthermore, Nurjanah et al. (2020) contend that the use of ICT tools by lecturers in teaching and learning mathematics helps students develop a deeper conceptual understanding of mathematical concepts. Some students may find it challenging to understand the abstract explanations and symbolic illustrations that are frequently used in traditional teaching approaches. Nevertheless, these ideas are represented visually and interactively through the use of ICTs and successful teaching strategies, which makes them more understandable and approachable. This approach can be especially helpful for learners who find it difficult to learn using conventional teaching approaches. ICTs can support learners' development of critical thinking and analytical abilities by exposing them to real-world events and allowing them to try various solutions (Hafeez, 2021). This hands-on approach to learning can also help students develop a deeper appreciation for the practical applications of mathematics in everyday life.

In a study exploring the will, skill and tool model, Agyei & Voogt (2011) reported that lecturers who were confident in the use of computers when training their students were more familiar with using ICTs in instruction, and their learners reported a more positive attitude toward the instructional effectiveness of ICTs. The overall instructional approaches of lecturers contribute a great deal to ICT use as a learning tool and portray how to adopt ICT as a learning tool in the future. The authors recommended that pedagogical concerns regarding the integration of technology into instruction be covered in the curricula of teacher education institutions. This approach ensures that future lecturers are equipped with the necessary skills and knowledge to effectively incorporate technology in their classrooms. By addressing these concerns early on, teacher education institutions can play a crucial role in preparing student teachers for the digital age.

Kisalam and Kafyulilo (2012) reported that the way teacher trainers perform instructional delivery in mathematics at teacher training institutions in Uganda, we are aloof from achieving effective teaching and learning using ICT tools. The effective incorporation of ICT in instructional delivery depends on teacher trainers' practices. Due to a lack of familiarity or apprehension about technology, some lecturers may be reluctant or resistant to adopting ICT in teaching mathematics. To prepare for the learning environment, teacher trainers' instructional practices should be the first step because the failure to utilize ICT by teacher trainers in the instructional delivery of mathematics in teacher training institutions could also affect the preparation of future teachers to incorporate ICT in learning in their careers. There is a monumental analysis internationally concerning this subject. However, this drawback is underresearched in Uganda. Therefore. teacher preparation should guarantee that it is not left behind.

According to Keengwe et al. (2008), lecturers with a positive attitude toward educational technology are better equipped to provide valuable insights into the integration of ICT into teaching and learning processes. Teacher trainers who support this method of teaching can enable their students to critically assess how the use of ICT has affected both instruction and the learning of mathematics. Learners can improve their instructional strategies by incorporating educational technology tools into their lessons. This can enhance student engagement and facilitate a more interactive and hands-on learning experience. Nevertheless, teacher trainers' instructional practices ultimately determine the effectiveness of incorporating ICT tools in the classroom. By modeling the effective use of technology and providing guidance on its integration, teacher trainers can empower learners to effectively utilize ICT to enhance instruction and promote meaningful learning experiences.

3. Methodology

This study adopted a quantitative methodology and employed both descriptive and correlation research designs.

3.1 Research Paradigm

A positivist philosophical school of thought served as the foundation for our investigation. The positivist paradigm is predicated on the idea that knowledge can be acquired only through scientific procedures and empirical observation (Kekeya, 2019). The researcher used a positivist methodology in this study, gathering data using questionnaires and drawing results via statistical analysis. By using this method, the researcher was able to gather unbiased data and test the proposed hypothesis, guaranteeing that the conclusions of the study were supported by solid evidence.

3.2 Research Design

Research design is a plan of action taken to answer the set of research questions of a study accurately and precisely (Rahi, 2017). This study adopted descriptive and correlational research designs to understand the correlation between lecturers' practices and ICT tools usage in teaching and learning mathematics in Uganda. Correlational research is a quantitative design that seeks to establish the existing relationship between two or more variables. By using this design, the study aimed to determine whether there is a significant relationship between teacher trainers' practices and ICT tools usage in mathematics instruction. This approach allowed for the analysis of the data to identify any patterns or trends that may exist between these two variables.

3.3 Study location

The study was carried out at Kyambogo University in Uganda. For purposes of minimizing costs, Kyambogo University was chosen because it was convenient for the researcher to collect data from lecturers during the COVID-19 pandemic lockdown. This study is part of a broader study that the researcher is conducting for the award of a PhD in mathematics education.

3.4 Study Population

The study population included mathematics lecturers at Kyambogo University and its constituent campuses, Bushenyi and Soroti, in Uganda.

3.5 Sample population

The study was performed at Kyambogo University. Sixty (60) questionnaires were distributed to lecturers, and fifty were returned, reflecting an 83.3% response rate. The response rate was high enough for statistical purposes (Cano & Cardelle-Elawar, 2004).

3.6 Sampling Procedure

For the study, the researcher used an online questionnaire to collect data from 60 respondents. All 60 lecturers received an online questionnaire, which made it easy for them to submit their responses. Upon collecting the completed questionnaires, the researcher analyzed the data and established that 50 lecturers had answered the study questions. The researcher subsequently selected the 50 lecturers who had responded for further analysis. The use of this method guaranteed the random selection of lecturers for the research, thus increasing the validity of the results.

3.7 Research Instruments

This study utilized online questionnaires to collect research data, allowing for quick interaction with the respondents. Overall, these steps were taken to enhance the validity and reliability of the measurement instrument used in this study. The survey questions were developed following the body of literature published on the use of digital platforms and ICT tools in the teaching and learning of mathematics.

3.8 Data collection methods

To collect data regarding the correlation between lecturers' instruction practices and ICT tools usage for teaching and learning mathematics, a questionnaire was administered among lecturers. The feedback from the questionnaires was analyzed to investigate whether there was a correlation between lecturers' instructional practices and ICT tools application for mathematics teaching and learning. The survey questions were developed in accordance with the body of literature published on the use of digital platforms and ICT tools in the teaching and learning of mathematics.

3.9 Data analysis techniques

The relationship between ICT tool usage and lecturers' instructional practices was analyzed using Pearson's correlation and regression analysis (Pearson. K, 1920).

3.10 Reliability and validity of the research instrument

Cronbach's alpha was used to analyze the reliability of the research instrument using SPSS 25. The analysis of reliability using Cronbach's alpha resulted in an α =.728. In addition to its reliability, the instrument was also validated (Bond, 2003). Apart from using reliability as one criterion, validity was typically established by conducting a thorough analysis of the data collection methods (Lodico, M., Spaulding, D. Voegtle, 2013). A team of five experts in the field of ICT in Education provided suggestions for rephrasing certain questions to make them more understandable and unambiguous. These revisions were implemented to enhance the overall quality of the questionnaire. The study ensured that the items covered a range of technology tools and teacher trainers' instructional practices commonly used in mathematics education.

3.11 Ethical considerations

Ethical issues are crucial in research involving human participants. Creswell (2021) emphasizes the importance of anticipating and addressing potential issues. This study upholds integrity, respect for persons, and justice at all levels. A research permit with permit number NS376ES was obtained from the National Council of Science and Technology of Uganda, an independent body that clears researchers to carry out research involving human interaction. The confidentiality and anonymity of the participants were strictly maintained throughout the study to ensure their privacy and protection of their identities. Relevant documentation on ethical issues was obtained from the University of Rwanda College of Education Research and Innovation Unit. Additionally, all the appropriate measures were taken to securely store and handle all the collected data following ethical guidelines.

4. Results

Table 1 displays the demographic information of the mathematics lecturers who completed the questionnaires. There were 40 males, accounting for 80% of the lecturer responses, and only 10 females, accounting for 20% of the lecturer respondents. One implication of the above information is that there is a significant gender imbalance among mathematics lecturers, with males composing the majority and females constituting the minority. This gender imbalance may have implications for the diversity and representation within the field of mathematics education. The possible reason might be the preexisting gender stereotypes and biases associated with mathematics as a discipline. These stereotypes can deter women from seeking careers in mathematics education, thus decreasing the number of female respondents. In addition, such prejudices might stem from the existing biases within culture and society, such as an unequal provision of education for girls and women. As such, several of these factors may lead to fewer females being willing to become lecturers in mathematics.

Table 1. Distribution of mathematics lecturers by gender

Demographic characteristics of Lectures		
Gender	**Number of Participants**	**Percentage (%)**
Male	40	80
Female	10	20
Total	50	100

Table 2. Descriptive statistics for Lecturers' ICT tools Usage

Tool	**N**	**M**	**SD**
Smart Classrooms	50	2.6800	1.30055
Social media	50	2.9000	1.09265
Mathematical Software	50	1.5200	1.21622
Websites	50	1.3600	.48487
Microsoft Office Package	50	2.3200	1.49065
Spreadsheet package	50	3.4000	.98974
Mobile Apps	50	3.8800	1.37974
Internet	50	3.7000	1.16496

Table 2 shows descriptive statistics relating to the differing levels of use of ICT tools in teaching mathematics by lecturers. Information about the frequency of use of each ICT tool and how it was used in mathematics instruction is made possible by these statistics. The use of mathematics software (M=1.52, SD=1.21622) and websites (M=1.36, SD=0.48487) had the lowest utilization scores obtained on a 5-point Likert scale. This finding indicates that lecturers have limited experience using these specific ICT tools for teaching and learning mathematics.

Other ICT tools, such as smart classrooms, social media, mobile apps, the internet, and spreadsheets, had values within or above the instrument's threshold mean. It is thought that lecturers recognize the significance of ICT tool usage in improving mathematics teaching and learning and are enthusiastic about further integrating technology into classroom practice. Mathematics lecturers believe that some tools inspire learners and improve their grasp of mathematics through improving investigative practical activities.

Table 3. Descriptive statistics for lecturers' instructional practices

Instructional Practice	N	M	SD
Interactive lessons enhance the teaching of mathematics concepts in more effective ways	50	3.2400	1.18769
Using virtual reality technology and AI is conducive to good teaching of mathematics	50	4.100	0.58029
Blended learning in teaching mathematics speeds up the learning process	50	2.260	0.87622
Using the design-thinking process helps to solve mathematical problems with ease	50	3.940	0.81841
Inquiry-based learning enhances and speeds up mathematics instruction	50	2.7000	1.24949
Project-based learning helps to meet the various needs of a mathematics Lecturer	50	3.980	0.99980
Cloud computing teaching helps lecturers and allows them to access classes and materials from thousands of miles away	50	3.700	0.95298
3D printing makes mathematics lessons more fun and gives the experience to teach new things better	50	2.8400	1.16689
The use of jigsaw puzzles leads to enhanced teamwork in a mathematics classroom	50	2.1400	1.24556
Flipped classrooms give sufficient opportunity to work with different technologies	50	3.5400	1.16426

Table 3 indicates how lecturers responded on a 5-point scale to indicate how they found ICT instructional practices were beneficial in mathematics, with 1 indicating strongly disagree and 5 indicating strongly agree. Lecturers expressed that interactive lessons enhanced the teaching of mathematics concepts in more effective ways (M=3.24, SD=1.18769). They believed that the interactive nature of ICTs allowed for more dynamic and interactive learning experiences. They also reported that using virtual reality and AI leads to a conducive teaching and learning environment and reduced mathematics workload (M=4.1, SD=.58029), ultimately leading to improved understanding and retention of mathematical concepts. The majority of lecturers had mixed reactions and reported that blended teaching of mathematics does not speed up the learning process (M=2.26, SD=.87622). The vast majority of lecturers concurred that using the design-thinking process helps people solve mathematical problems with ease (M=3.9400, SD=.81841). Moreover, the majority of the lecturers agreed that inquiry-based learning does not enhance or speed up mathematics instruction (M=2.7, SD=1.24949). Additionally, lecturers highlighted that project-based learning helps them meet the various needs of mathematics lecturers (M=3.98, SD=.99980). This allows lecturers to engage with mathematical concepts more dynamically and visually, catering to different learning styles and abilities. In the opinion of the majority of lecturers, cloud computing teaching helps lecturers and allows them to access classes and materials thousands of miles away (M=3.7000, SD=.95298). They disagreed that 3D printing makes mathematics lessons more fun and provides the experience of teaching new things better (M=2.84, SD=1.16689). The majority of lecturers held the negative opinion that using jigsaw puzzles leads to enhanced teamwork in a mathematics classroom (M=2.14, SD=1.24556). Furthermore, they found that flipped classrooms provide sufficient opportunity to work with different technologies (M=3.54, SD=1.16426). They felt that these practices provided opportunities to explore and apply mathematical concepts in real-world contexts, ultimately deepening their understanding of the subject.

4.1 Correlation Analysis of Lecturers' Instructional Practices and ICT Usage

To establish the relationship between ICT use and lecturers' instructional practices, Pearson's correlation analysis was used, and the results in Table 4 indicate that ICT use is significantly positively related to lecturers' instructional practices ($r=0.796$, $p<0.01$). This finding implies that the more that lecturers use ICT tools in teaching and learning mathematics, the more instructional practices there are. The ICT tools used by lecturers improve their instructional practices.

Table 4. Pearson's correlation analysis results

		ICT USE	PRACTICES
ICT USE	Pearson Correlation	1	
	Sig. (2-tailed)	.000	
	N	50	
PRACTICES	Pearson Correlation	.796**	1
	Sig. (2-tailed)	.000	
	N	50	50

**.Correlation is significant at the 0.01 level (2-tailed).

We, therefore, reject hypothesis Ho: Lecturers' instructional practices are not affected by the incorporation of ICT tools in teaching and learning mathematics in Uganda.

4.2 Conclusion

Based on the data and analysis presented, it is clear that the incorporation of ICT tools in teaching and learning mathematics in Uganda has a significant impact on lecturers' instructional practices. Therefore, we reject the null hypothesis (Ho) that suggests that there is no effect. The findings suggest that ICT tools play a crucial role in shaping instructional practices and should be further integrated into teacher training programs to enhance mathematics education in Uganda. These findings align with previous published studies (Attard & Holmes, 2022) that have shown the positive impact of ICT tools on teaching and learning outcomes in various educational settings.

4.3 Limitations of the Study

The limitations of this research approach call for caution in interpreting the results because there is no way to verify the veracity of respondents' statements. Based on their interpretations, the participants independently articulated their own experiences and viewpoints. Another flaw in this study is that online questionnaires were exclusively used as a research instrument because the data were collected during the COVID-19 lockdown in Uganda's education sector. While a rationale for this methodology is given, it is important to note that not all the information required was obtained because a few responses necessitated follow-up inquiries through interview sessions.

4.4 Recommendations

Policymakers and education stakeholders in Uganda need to prioritize the integration of ICT tools in teacher training programs to ensure that mathematics education is effectively delivered and that students are equipped with the necessary skills for the digital age.

Availability of Data and Materials

Upon request, I will share data materials since this aspect is a draft of my PhD thesis. Nonetheless, when my dissertation is over, to help expand the scientific community's shared knowledge base for public use, I intend to publish the whole dataset and any other associated material. Transparency and open access will not only increase the potential of this work for others but also help build confidence in the scientific community.

Competing Interests

The authors declare no conflicts of interest.

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