Mathematics Lecturer's Adaption to Online Teaching in Response to COVID-19

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Prior to the COVID-19 pandemic, the university educational system in Nigeria largely employed traditional, face-to-face classroom approaches for teaching. This study examines how mathematics lecturers adapted to online teaching in response to COVID-19 restrictions. A mixed methods approach was used to obtain both qualitative and quantitative data from ten mathematics and mathematics education lecturers, using questionnaires and semi-structured interviews. The results highlight mathematics and mathematics education lecturers' use of virtual boards, writing pads, and WhatsApp to improve interactions while teaching online via Zoom.

The online medium has created an entirely new landscape of educational opportunities (Sven & Julie, 2020). The globe is rapidly becoming more interconnected and online education is growing rapidly (Okyere et al., 2022). As a result, students can access a high-quality education at a reduced cost, regardless of their location or schedule (Xu & Xu, 2019). In Nigeria, online teaching and learning practices are at the developmental stage. Socioeconomic, sociocultural, and IT infrastructural factors are recognised challenges hindering the adoption of online learning in Nigeria (Abdulmajeed et al., 2020). The global outbreak of COVID-19 greatly impacted educational systems worldwide, including Nigeria, where institutions were compelled to close in response to the pandemic (Lawal, 2020; Oyedotun, 2020). This closure necessitated a shift to online delivery methods, utilizing various platforms such as radio, TV, *WhatsApp*, *Zoom*, *Google Meet*, *YouTube*, and other internet-based learning (Lawal, 2020). This transition was a significant move from traditional reliance on in-person teaching methods, prompting educational institutions to adapt online approaches for their content dissemination (Lawal, 2020). Prior to the pandemic, Nigeria had only 13 approved distance learning centres among its 221 universities and 123 affiliate campuses (National Universities Commission [NUC], 2023). Amidst the COVID-19 pandemic, lecturers and students adapted from a face-to-face instructional approach to teaching and learning remotely using online media (Lawal, 2020). Consequently, lecturers and students had to adapt to the new teaching and learning approaches (Sabitu et al., 2022) and utilise technology in the teaching and learning process (Sven & Julie, 2020). In addition, educational institutions had to upgrade their IT infrastructure to enhance students' synchronous and asynchronous learning experiences (Lawal, 2020).

According to Lawal (2020), educational institutions and providers have the primary responsibility for creating an enabling environment for online teaching, offering sufficient materials and resources to support the flexibility of online teaching. Adaptation involves making adjustments to teaching and learning methods, enabling teachers to devise strategies suitable for operating in the new teaching environment (Mardiana, 2020). The pandemic necessitated the widespread adoption of online teaching and learning as an alternative method of education.

Undergraduate mathematics courses necessitate students' comprehension of the taught concepts, which often entails engaging in various activities during lecture sessions. Mathematics is a subject that is often not preferred by many students (Sven & Julie, 2020). The technical nature of mathematics can make it difficult to teach online (Trenholm, 2013), although Borba et al. (2016) see online mathematics teaching as an opportunity to disrupt traditional teaching processes to the benefit of students and their learning. Teaching using online media

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and technology is not new, but online teaching approaches are thought to be more suited for non-mathematical courses (Hamdan & Amorri, 2022). Mathematics holds considerable importance in Nigerian tertiary education, serving as a fundamental unit across various undergraduate courses, particularly in STEM fields (National Universities Commission [NUC], 2015). All first-year undergraduate students are required to take a mathematics course as part of their general studies curriculum. This course is crucial as it equips students with essential mathematical and computational skills necessary for their studies. In Nigerian universities, mathematics lecturers typically belong to two categories: those teaching mathematics courses and those focusing on mathematics teaching methodology, covering primary and secondary mathematics content. The mathematics education curriculum includes both mathematics and methodology courses, with students being taught by both types of lecturers (NUC, 2015).

Onyema (2020) advocated for educators to incorporate and utilise emerging technologies in their teaching and learning. He observed that utilizing technology is now essential due to the need for flexibility in methods. The influence of technology on education shows the growing need for adaptable teaching methods to promote creativity and innovation in the teaching process (Lawal, 2020). The COVID-19 pandemic prompted a shift from traditional face-to-face teaching to online instruction. This transition led to modifications in the teaching approaches of lecturers, highlighting the importance of understanding their methods and actions during online interactions with students (Muir et al., 2022). The rapid switch from face-to-face to online teaching within a short period had its impact on lecturers (Tella & Obim, 2022). The impacts identified included lecturers' inability to communicate their intended learning content to students via the online mode, and the inability to effectively use the technological devices and platforms provided for effective teaching and learning (Lawal, 2020). Trenholm (2013) had already identified lack of student-teacher interactions as an issue for teaching and learning of mathematics online.

According to Trenholm, teaching mathematics online presents a challenging environment for instructors to effectively adapt their teaching methods to promote students' understanding of mathematics. To address this challenge, lecturers should utilise devices and tools that facilitate interaction during the teaching process (UNESCO UNICEF, 2020). Tella and Obim (2022) identified several barriers to online teaching and learning in Nigeria, including limited access to electronic devices, inadequate internet connectivity, power, challenges in time management, and financial constraints associated with hosting online lectures.

Therefore, this study investigates how lecturers in Nigeria adapted their teaching from face-to-face to online. The study explores mathematics and mathematics education lecturers' transition to online teaching as caused by responses to COVID-19. This study discusses how lecturers adopted online teaching tools for mathematics teaching, their perspectives about the nature of teaching mathematics online, and their knowledge and use of online teaching tools during the pandemic. This study seeks to answer the research question:

How did mathematics and mathematics education lecturers in a Nigerian university adapt their teaching approach to online teaching during the COVID-19 pandemic?

Methodology

This study, which comes from the first author's ongoing PhD research project, adopted a mixed-methods approach (Creswell & Clark, 2017) to obtain in-depth information about the lecturers' online teaching experiences. The study was exploratory and both qualitative and quantitative data were collected. A case study approach was adopted to explore the phenomenon of transition to online mathematics teaching among mathematics education lecturers (MEduL) as Case 1 and mathematics lecturers (ML) as Case 2. The research took place at a private university in southwestern Nigeria, involving five participants each from Case 1 and Case 2, who had prior experience or had recently transitioned to online mathematics teaching due to

COVID-19. The selection of these groups was based on the involvement of both mathematics and mathematics education lecturers in teaching the undergraduate mathematics education curriculum. Full ethical approval was obtained from the researcher's university and the participating institution.

A survey was conducted and followed up with a semi-structured interview; these were used to explore the experiences, interactions, perspectives, and technological knowledge in both cases. Semi-structured interviews allowed for tailored questions and prompts, facilitating in-depth discussions (Galletta, 2013) on topics such as previous teaching experiences, engagement processes, challenges and successes in online teaching, and perspectives on the transition to online mathematics education. Purposive sampling was used to select five participants from each case, and interviews were conducted at convenient times for the participants. Prior to the interviews, all ten lecturers indicated varying levels of agreement with specific survey questions. These questions covered statements such as "I find it easy teaching mathematics face-to-face", "I prefer to teach mathematics face-to-face than online", "I spend more time preparing to teach mathematics online than face-to-face", "My ability to use technology impacts my teaching abilities", and "Teaching online has helped to improve my overall teaching of mathematics".

Data analysis involved transcription of interviews, confirmation of transcribed data by participants, and thematic analysis using NVivo software. The iterative process included familiarization with the data, generating codes, identifying initial themes, reviewing and refining themes, and writing the final report (Clarke & Braun, 2021). The findings presented the experiences of mathematics education and mathematics lecturers during the transition to online teaching. Quotations from participants' interview transcripts were included with anonymization to protect participant identities.

Findings

Table 1 details participants' demographics, and their pre-COVID-19 online teaching experiences. Table 1 indicates that among mathematics education lecturers, three had previous experience using online tools for teaching, while two had no prior online teaching experience before COVID-19. Similarly, among mathematics lecturers, only two had previously utilised online tools for teaching. The semi-structured interview responses indicated that prior to COVID-19, all lecturers and students engaged with online tools or content asynchronously rather than in real-time (synchronously). This was due to the challenges associated with conducting real-time classes. However, students were able to access or search for online content at their own convenience, facilitating deeper understanding. The discussion below gives examples of participants' experiences with online tools prior to the pandemic, "I give students tasks and assignments from online material to encourage their internet use and search for materials on their own. To further motivate students, I conclude my classes by providing additional links to concepts taught" (ML2).

While not all lecturers explicitly provided links, some assigned students tasks that involved online research and assignments. Additionally, ML2 emphasised that these links exposed students to various learning materials related to the concepts taught. He believed this approach motivated students and accommodated different learning styles "Yes, sometimes I use online content to provide students [pre-service teachers] with additional explanations and examples on the approach to teaching children [in school] with high-level need" (MEduL3).

All lecturers attributed their limited usage of online tools for teaching before the pandemic to challenges such as poor internet infrastructure and power supply.

Table 1

Participants' Information

Participant information	Highest qualification	Teaching experiences (years)	Computer and internet skills usage	Using online platforms (years)	Used online tools for teaching prior to COVID
ML1	PhD	7	Proficient	5	Yes
ML2	PhD	8	Proficient	3	Yes
ML3	PhD	12	Proficient	5	No
ML4	PhD	6	Proficient	3	No
ML5	PhD	8	Intermediate	3	No
MEduL1	Masters	5	Proficient	3	Yes
MEduL2	PhD	6	Intermediate	2	No
MEduL3	PhD	27	Proficient	4	Yes
MEduL4	PhD	16	Proficient	4	Yes
MEduL5	PhD	8	Intermediate	1	No

Table 2 identifies the three key themes in the data along with the corresponding generated codes, illustrating how mathematics and mathematics education lecturers adapt to online teaching during the pandemic. The themes were developed through reflexive thematic analysis, derived from the dataset without any preconceptions (Braun & Clarke, 2019), and emerged from generated codes about the mathematics and mathematics education lecturers' adaption to online teaching. The themes represent the combined results from both Case 1 and Case 2, reflecting participants' responses regarding the themes explored in this study.

Table 2

Themes and Codes

Themes	Codes
Online teaching engagement	Approach to teaching, interactions with students, class control, and time management
Perspectives about online mathematics teaching	Nature of mathematics, beliefs, readiness, and capacity to teach
Knowledge and use of technology for teaching	Software used, use of internet to teach or learn, use for professional development

Online Teaching Engagement

The theme "Online teaching engagement" emerged from codes generated during the study, capturing lecturers' approaches to teaching, interactions with students, class control, and time management while teaching online during COVID-19. All participants acknowledged challenges during the initial transition to online teaching, including technical difficulties, poor internet reception, and adjusting to fully online teaching. For example, ML3 said "I transferred my usual face-to-face method to online, but less interaction made it one-sided." He added:

> Unlike the educational system in other parts of the world, our educational system is still developing. So, the experiences are new to most of our students since teaching and learning is usually in face-to-face. It was a fine experience but difficult during the initial lockdown.

Mathematics lecturers mentioned that they create recorded versions of their face-to-face lectures by teaching on the board in the university's ICT centre, with the sessions being recorded. These videos were accessible to students on the university portal before live lectures, aiding comprehension and allowing for questions on areas of difficulty and making the lecture

interactive. One participant mentioned that his lack of technical skills, combined with poor internet and power at home, hindered his use of university-provided platforms for online teaching (MEduL2). Another participant expressed concerns about the educational infrastructure's limitations for online teaching, citing challenges such as power generation costs, internet access, and infrastructure expenses beyond the university's control (MEduL3). He further noted:

> As for me during the lockdown, my recorded lectures are online, I used demonstration method and during my presentation I will deliver a summarized lecture utilizing slides … Additionally, I will incorporate gestures to enhance communication, and occasionally, I will play video clips demonstrating responses and actions used for teaching pupils with special needs. Furthermore, students will have access to recorded Zoom lectures, allowing them to re-view the content at any time.

All participants expressed their concern about the level of interactions they had with students. They all expressed the importance of interaction in a mathematics class. ML1 stated:

> Considering the fact that mathematics science requires a lot of interactions during the teaching process. Lecturers' students, relationships on difficult aspects cannot be achieved due to timing in an online class. So, the direct observation of students' understanding through their facial gestures and interactions is missing.

MEduL2 shared similar sentiments regarding facial expressions, gestures, and interactions with students. In contrast, ML2 expressed that, "I feel online teaching has brought students closer to me in terms of interactions and at any time ... They are happy to communicate and resolve pressing problems outside lecture periods with me or their colleagues if need be". Additionally, MEduL1 noted how the breakout room enhanced students' interactions and collaboration while teaching and observed an increased confidence in students presenting the groups viewpoints despite being shy or hesitant in a regular face-to-face setting. MEduL3 mentioned challenges he observed and using *WhatsApp* to increase students' interactions despite students using the application to chat socially. He also said, "Teaching online also presents challenges as it consumes time, and I find it difficult to monitor or assist slow learners' progress". WhatsApp was used more by mathematics education lecturers due to better tolerance with poor internet connectivity.

Perspectives About Online Mathematics Teaching

The theme "Perspectives about online mathematics teaching" emerged from the generated codes, covering aspects such as the nature of mathematics, beliefs, readiness, and capacity to teach mathematics online. Both groups of lecturers expressed similar beliefs regarding online mathematics teaching, as reflected in the codes. Their attitudes align with the findings of Hamdan and Amorri (2022) and Trenholm (2013) who highlighted the technical nature of mathematics as a significant challenge in online teaching. MEDuL4 "With my background in mathematical science, I feel there are difficult branches of mathematics that are not suitable for online teaching". Both Case 1 and 2 participants talked about considering the nature of mathematics in the teaching and learning processes. Specifically, ML5 talked about "the content should be from simple to complex for students to understand". He noted that "Personally, I find teaching mathematics online particularly challenging due to the lack of appropriate teaching tools and the delayed response to and from students' questions".

The lecturers had varying views on how difficult they thought it was to teach mathematics content and mathematics pedagogical content online. ML4 noted that "online teaching platforms are more suitable for theoretical courses" and he relied on students' facial expressions and the questions asked to measure the level of understanding. The assertions of ML2 and MEduL2 supported ML4's view on mathematics teaching processes as they engaged with the contents. Additionally, ML3 noted:

> I cannot observe students' work in an online class, I cannot guide or give student hints when they are hooked [stuck] with steps while finding solution to the question. Unlike face-to-face where facial expressions, questions asked, collaborative solutions of problems on the board by students speak volume to their understanding of the concept taught".

In contrast, MEduL5 noted that "Teaching mathematics methodology online was easier compared to teaching mathematics content for secondary schools". Other participants made similar reference to the difficulty of teaching mathematics education content online, "My concern is how to equip undergraduate students with the practical skills and methods required for teaching mathematics to children [in schools]. These I feel are not exclusively available while teaching online" (MEduL4).

MEDuL3 commented on the significant role that interaction plays in the teaching/learning process. He further identified interactions between the lecturers and students as the major difference between teaching mathematics face-to-face or online.

Knowledge and Use of Technology for Teaching

All ten lecturers were familiar with the use of computers and the internet as shown in Table 1. The semi-structured interviews further revealed participants' use of the internet to search for information, use of emails, and use of online platforms such as *Zoom* and *Google Meet* for presentation at conferences, workshops, or seminars. Mathematics lecturers used additional tools like *Latex, Math Lab*, and equation editors for their research papers, and ML1 said he lectures students on how to use these tools and others to build software.

Three mathematics education lecturers and two mathematics lecturers identified using online teaching platforms prior to COVID-19. This was a result of their IT experience, and/or their use of asynchronous tools to teach or learn during their further studies. For example, ML2 said "I used most of these facilities during my studies in United States, therefore I found it much simpler" and MEduL1 said "I am familiar with the tools provided by the university. This is due to my experience with IT tools and some I learned with my current PhD colleagues."

Their passion for teaching, coupled with their experiences and the necessity for research, drove them to utilise online tools. However, this came at a personal expense, particularly regarding providing alternative power sources, and internet subscription fees for home and office use, especially during instances of university internet downtime or poor quality.

Generally, both mathematics and mathematics education lecturers shared similar opinions on their personal learning gains during lockdown in respect to teaching and learning. For example, MEduL5 said "The lockdown gave me more experience in teaching using online platforms. Because I never believed that mathematics and mathematics-related concepts could be taught online with our present IT infrastructure and skills". Similarly, ML1 noted "My experience with teaching online has encouraged the development of my understanding of online teaching processes and has boosted my confidence in utilizing online tools for teaching and research purposes."

Discussion and Conclusion

This study examined the perspectives of mathematics and mathematics education lecturers and their adaption of online mathematics teaching in response to COVID-19. Three themes were derived from the data analysis of ten interviews. The findings centred on the viewpoints of individual lecturers regarding their adoption and involvement in online mathematics teaching. The perspectives on online mathematics teaching and the level of technology utilization among both groups of lecturers were influenced by their prior experience with the internet and various online platforms. Personal and professional development with online tools played a key role during the transition to online teaching. Both groups of lecturers noted challenges in adapting face-to-face teaching methods to an online format, particularly among

those with no prior online teaching experience, but there were some positive views on online mathematics teaching. Mathematics education lecturers were concerned about how to teach students (pre-service teachers) the practical approach required for teaching in schools. These findings are consistent with the observations of Hamdan and Amorri (2022) and Trenholm (2013) on the constraints of online courses in fostering students' understanding of mathematics.

The quality of lecturer-student interactions during the teaching process was identified a major concern while teaching mathematics online. That students had difficulty being able to give timely responses during lectures was a challenge. Both groups of lecturers emphasised the need for two-way communication between the students and the lecturer. Trenholm (2013) suggests the importance of synchronous interaction to enrich teaching and learning mathematics online. As a result of this, mathematics lecturers were provided with virtual board software and the use of tablets as a writing pad to improve illustrations of what the lecturers might write during online lectures. Others used the facilities at the university ICT centre. Similarly, mathematics education lecturers used video clips for further clarification. Also, both groups of lecturers noted the use of WhatsApp for synchronous voice and image interaction in conjunction with Zoom and Google Meet to enhance teaching. In situations when internet connectivity was poor, lecturers utilised WhatsApp to enhance interaction. Also, mathematics lecturers prepared pre-recorded lectures to mirror their face-to-face lectures. Additionally *Zoom*-recorded lectures, alongside the pre-recorded lectures, were uploaded on the university learning management system to enhance students understanding. This aligns with the findings of Muir et al. (2022), which examined the strategies and actions employed by lecturers to achieve success in an online mathematics course.

All the lecturers endorsed the blended approach to teaching mathematics, emphasising that online platforms ought to complement face-to-face instruction, which aligns with the conclusions of Adnan and Yaman (2015). Previous utilisation of online resources for teaching or learning, as reported by both mathematics and mathematics education lecturers, had a substantial impact on their teaching. The utilisation of online technologies, whether for their continued education or for academic endeavours such as conferences, workshops, and seminars, also had a substantial impact on their teaching. Enhancing professional development in the context of online teaching and learning will significantly contribute to the advancement of online teaching methodologies. Both mathematics and mathematics education lecturers expressed a strong desire to continue utilising online teaching methods, provided the necessary infrastructure is readily accessible. Given the lecturers' worried over conveying the nature of mathematics, it would be interesting to ascertain which facets of mathematics pose challenges in terms of instruction using online platforms.

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