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Technology-Associated Issues: Distance and Online Undergraduate Mathematics Students' Experiences in Nigeria

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Abstract: ***This study explores the technology-related issues experienced by undergraduate mathematics students enrolled in open and distance learning institutions in Nigeria. Guided by constructivism, the study employed a convergent mixed-methods design involving third-year mathematics students from two purposively selected institutions. Data were collected using a validated 26-item questionnaire (Cronbach's Alpha = 0.93) and interviews. Quantitative data were analysed using descriptive statistics and a one-sample binomial test, while qualitative data were analysed narratively. The findings revealed that unstable internet connectivity, high data costs, limited institutional technological support, and inadequate interactive learning resources significantly affected students' learning experiences. The study recommends strengthening digital infrastructure and expanding institutional support to improve equitable and effective distance and online mathematics education in Nigeria. Keywords: Technology, Distance and online education, Mathematics, Internet, Students Experiences.***

Keywords: Technology-related issues; Open and Distance Learning; Distance Education; Online Learning; Undergraduate Mathematics; Digital Infrastructure; Nigeria

1. Introduction

As integration of technology in education globally increases, the study on how students as the main stakeholders in the use of technology for learning becomes essential. Presently, technology is a key promoter in providing learning activities, learning opportunities and presenting diverse learning experiences for the students (Muhazir & Retnawati 2020). Distance and online education have become sustainable method of delivering instruction with the aim of providing and expanding access to education. Despite the entrance of technology into various aspects of human life, its integration in mathematics distance and online learning still present distinctive issues to the learners in this mode. These issues are heightened where there are limited/lack of digital infrastructures and technological mastery (Viberg et.al. 2023).

Muhazir and Retnawati (2020) affirm that students understand mathematics more deeply, connect the subject with real life situations and become better mathematics learners when they apply technology in learning. Consequently, there is the need to integrate technology in the teaching-learning of the subject concepts in order to facilitate the development of students' abilities. The scholars Radovic et al. (2019) listed some alternative technology activities teachers employ in teaching to include – learning videos, slide presentation, graphic calculators and in some cases blended learning. According to Salami and Spangenberg (2025), the inclusion of online tools like smart learning programmes, interactive websites and virtual models help to engage the students in a personalised learning leading to the understanding of complex mathematics concepts. The introduction of these tools is geared towards increasing not only access to learning but also to ensure progressive success and enhanced experiences of the students learning mathematics in this mode (Reju & Loyiso 2018).

The adaptation of technology in the distance and online education in Nigeria is necessitated by the growing population of students scattered across the geographical locations in the country. Technology in distance and online mathematics education is aimed at meeting the flexible need of the students while keeping them at the centre of the technological advancement. The institutional mandate to offer distance-and-online learning opportunities to students in such a way that if the students cannot go to school, the school attempts to go to them is maintained (Lawal & Awofala 2020). The policy related to the integration of technology in education (mathematics inclusive) as enshrined in Quality Matter (QM) Standard (2014) is a guiding force for higher institutions, facilitators and students toward the effective use of the technology. In most cases, the policy is well stated to address the grave areas like accessibility, digital literacy, professional development of the facilitators and students. However, the infrastructure for effective implementation is either limited or not available completely (Salami and Spangenberg (2025).

Research shows that as good as technology is in supporting and improving the understanding of mathematical concept, some concepts are tough and tricky to learn with the use of technology (Muhazir & Retnawati 2020). Some studies (Bubou, 2021; Muraina et al., 2025) have identified unstable internet connectivity, lack of dedicated and integrated learning management system, unstable power supply, limited interactive learning tools and devices as some of the technology obstacles to distance and online learning of mathematics. This paper tends to explore the undergraduate mathematics students' experiences with the technology-related issues in distance and online mode education. The study is carried out in two prominent distance learning institutions in Nigeria with the aim of contributing to the existing literature in this area by providing evidence of the students' experiences. The students' strategies to navigate

these challenges to avoid drop-out and ensure the completion of the programme were reported.

2. Theoretical Framework and Literature Review

The purpose of this paper is to explore the technology-related issues the undergraduate mathematics students in open and distance learning (ODL) institutions in Nigeria face. The experiences of the students and how technologies affect their mathematics education were examined. The constructivism theory which emphasised that the students create or construct active knowledge experiences through interaction with social contexts, tools and ideas was employed to answer the question raised in this paper, namely, what are the undergraduate mathematics students' experiences with the technology-related issues in distance and online mode education in Nigeria?

Constructivism generally has been recognised as a transformative method in education, especially in mathematics. This is due to the emphasis it placed on active knowledge construction by the students instead of being passive information receiver (Do et al., 2023). Studies have shown that mathematics students learn better when they are engaged in exploration, reasoning, and problem-solving rather than passively receiving information from the facilitators (Fosnot, 2013; Shittu & Alex 2025). In distance and online education, constructivism posits powerful emphasis on technology use that supports interactivity, collaboration and manipulation of mathematical interpretations and demonstrations. However, in most cases, technology related issues in distance and online education impede the actualisation of the principles of constructivism.

A basic requirement of constructivist mathematics learning is access to digital tools like geometry software, graphing applications and virtual manipulatives that allow inquiry and experimentation (Muraina et al., 2025). The instructional model enshrined in constructivism theory are engage, explore, explain, elaborate and evaluate. This model enhances students' engagement, understanding of mathematics concepts and achievement. The study of Hu et al. (2017) indicates that there are significant improvements among the students whose teacher adopts constructive model in mathematics classroom learning. Also, Omotayo & Adeleke (2017) revealed that students taught using this model perform significantly higher than their counterparts, and that they demonstrate improved mathematical abilities, and have greater interest in mathematics.

In general, it is evident from literature that constructivism supports distance and online pedagogical goal of mathematics education but the implementation of it in Nigeria remains an issue due to lack of infrastructures, digital divide and cost of accessing technology among others (Bubou, 2021; Muraina et al., 2025). Finding solutions to these issues are very important in order to build online environment that will sustain students' rich mathematics learning experiences.

Technology-related challenges in mathematics distance and online learning is a global phenomenon that are not limited to Nigerian universities in particular and developing countries in general. In Nigeria, the problem of internet instability, restricted bandwidth and high cost of data limit the students' ability to effectively engage with technology in their mathematics learning. Similar problems have been reported in most of developing countries across the globe where inefficient technology infrastructure impede students' opportunities in participating in mathematics activities (Lawal & Awofala 2020; Muraina et al., 2025). The study on students' eexperiences with distance and online learning of university-level uundergraduate mmathematics in Nigeria (Reju 2016:22) revealed the "deficiencies in the availability of suitable hardware and software, low digital literacy among lecturers, and insufficiently developed learning management systems". Though, technology-related issues in distance and online mathematics education seem to be a global challenge but there are remarkable differences in the scope, severity and root causes between what is obtainable in developing and developed countries of the world as outlined in Table 1.

Table 1: Developed/Developing Countries Technology-related issues Comparison in Mathematics Distance and Online Education

Issue	Developed Country	Developing Country (E.g., Nigeria)	Source
Internet connectivity	Mostly Stable with high-speed broadband	Unstable with limited broadband coverage	Chinn et al (2006); Kokaj et al. (2023)
Power supply	Constant, regular and reliable	Very irregular and unreliable for learning	Udeze & Adesola (2024)
Digital device accessibility	Students' high ownership of tablets and laptops	Limited access to digital devices, rely more on mobile phones	Temitope et al. (2023)
Cost of internet and data	Rather affordable	High data cost	Vargas-Montoya et al. (2023)
Digital mastery	High among the students and facilitators	Mostly low, limited technology competence	Reju (2016)
University infrastructure	Well-developed LMS and good technology support systems	Very poor and weak maintained systems	Udeze & Adesola (2024)

Source: As indicated on the Table

Despite the growth witnessed in learning with technology generally, the study of Lawal and Awofala (2020) in online mathematics education among undergraduates opined that the higher percentage of those that participated do not enjoy online learning of mathematics and consequently, majority prefers the traditional classroom instruction. Inadequacy of infrastructures to support the implementation of technology in mathematics learning is a big challenge, hence, making it difficult for the students to navigate learning management system (LMS) platform effectively (Muhazir & Retnawati 2020). These challenges are the main causes of deferment of semester(s) work or even outright attrition in distance and online mathematics learning.

3. Methodology

This paper aimed at examining the technology-related issues of distance and online undergraduate mathematics students in Nigeria. The work is situated within two prominent (a single and a dual mode purposively selected among the government approved) Open and Distance Learning (ODL) institutions. The institutions were situated at urban areas with students with divers working experiences, and background. The focus was only on third-year mathematics students because, having spent three-years in the programme, it is obvious the students have progressed beyond foundational level to a more advanced level and hence stand better chance to narrate their technological mathematics experiences helpful for the study in particular.

Mixed-methods approach is used in this study to determine the students' experiences in learning mathematics with technology. This is considered the best approach due to the multidimensional nature of technology use in education. It enables deeper insight by allowing the author to combine numerical designs with students' narratives relevant in online mathematics education (Creswell & Plano Clark 2018). A convergent parallel mixed-methods design that allows simultaneous collection of quantitative and qualitative data, analysing them independently and integrating the results to determine the students' experiences, is used.

There is a total of thirty-four (34) approved open and distance learning institutions in Nigeria. Five (5) out of these universities are operating as a single mode and twenty-nine (29) as dual mode institutions (NUC 2025). Purposive sampling was used to select sixty (60) third-year distance and online mathematics students from a single mode and a dual mode institution for this study. The students in third-year of a four-to-six-year study have got and developed substantial academic experiences to participate in this type of research. Thirty (30) respondents representing 50% were selected from each of the two ODL institutions used. The equal representation of respondents from both institutions is to reflect a balanced sampling approach and to strengthen the validity and credibility of findings necessary in mixed methods research approach (Creswell & Creswell 2018).
This sample was used because the mathematics students' enrolment in these ODL institutions are not equal. The single mode ODL university had close to eighty third-year mathematics student who enrolled in the programme at the time of the study, while the dual mode institution had a total of forty-eight (48) third-year mathematics students. In order to maintain meaningful statistical balance and students' experiences in the study, thirty (30) mathematics students each were selected from the two ODL institutions. Five respondents each (total 10) was purposively selected among those that responded to the questionnaire for the interviews. This was done to provide a deeper understanding of technology-related issues of the students learning in this mode (Creswell & Creswell 2018). The intake (enrolment) pattern commonly observed in conventional higher institutions is that the enrolment mainly consists of single and unmarried students and ODL learners are mostly adults, working professionals and married with family responsibilities (Knowles et al. 2015). For this study, 76.7% of the respondents were single, supporting UNESCO (2020) assertion that open and distance education complements conventional higher education by widening access and absorbing excess demand, particularly among recent school leavers.

Quantitative and qualitative approaches are used in this study. For the quantitative approach, the researchers developed Technology Experience Questionnaire (TEQ) which was validated by experienced curriculum experts. The questionnaire was divided into demographic component and twenty-six (26) items used in data collection from the respondents. The responses of all TEQ were measured on five-point Likert scales of strongly agree to strongly disagree. The Cronbach's Alpha Coefficient (CAC) necessary for measuring internal reliability shows 0.93. Sekaran (1992) indicates that such a scale is reliable involving small group of students. The instrument for qualitative approach (interview guide) was self-developed and validated with experts. The data were collected simultaneously, while the analysis was done separately and the results were integrated to give students comprehensive view of the issues in learning mathematics with technology. The quantitative analyses include descriptive statistics such as, frequency, proportion and a one-sample Binomial test, significant at 0.05. The narrative approach that allows the students to describe their technology challenges and experiences was employed to analyse the qualitative data in order to obtain rich results of students' experiences on the issues of technology in distance and online mathematics learning.

4. Findings

The five-point Likert scale is used in this study and regrouped into agree (Agree and strongly agree), Disagree (disagree and strongly disagree) and neutral. These regrouping helps to understand the students' responses to the construct under consideration. Neutral was left out to allow the maintenance of accuracy of non-parametric Binomial distribution. The combined analysis of the two institutions represented by pseudo names A and B was done since the responses of the participants were similar. The combined basic demographic information of the institutions is presented in Table 2.

Table 2: Combined Basic Demographic data of the respondents

Basic demographic information of institution A and B Number of participants, n=60			
Item		Frequency	Proportion
Sex	Male	46	76.7
	Female	14	23.3
Age	Less than 25	18	30.0
	25 - 34	37	61.7
	35 - 44	4	6.6
	45 and above	1	1.7
Marital Status	Married	14	23.3
	Single	46	76.7
Job Status	Applicant	23	38.3
	Employed	37	61.7

Source: Quantitative data

This demographic information gives important contextual insight of the characteristics of the ODL mathematics students who participated in this study. A total of 60 participants (n=60) were involved in the study and the variables

considered were sex, age, marital status and job status. The results indicate that male respondents were predominant (n=46, 76.7%) and the female respondents accounted for (n=14, 23.3%). This is a reflection of persistent gender imbalance witnessed in ODL and mathematics (Ali & Ahmad 2011). Table 2 analysis indicates that most respondents were within the 25–34 age group (61.7%, n = 37). This reflects an indication that more younger adult students adapt better to technology related learning than the older students. Also, Jimoh (2013) indicated that the failure of younger students to secure space in conventional universities in Nigeria has led many to settle for ODL. Marital status shows that high proportion (n=46, 76.7%) of respondents were single. This could be because many singles have less family-related responsibilities that might disturb their studies. The majority of the participants being employed (n=37, 61.7%) strongly supports the role of ODL as a learning choice for adults that are working. The analysis of the demographic variables suggests that male-dominated, young-adults, single and employed of the respondents represent the profile of typical ODL students (mathematics students included).

Table 3: Challenges related to Instructional delivery and facilitation technology

SN	Item of Questionnaire	Response	Frequency	Proportion (%)	Binomial Test (p-value)
1	Computer technologies are provided to meet the mathematical needs of students in my university	A/SA	26	47.3	.787
		D/SD	29	52.7	
		Neutral	5		
2	Internet-based technologies are provided to meet the mathematical needs of students in my university	A/SA	29	56.9	.401
		D/SD	22	43.1	
		Neutral	9		
3	I use university-provided audio and video conferencing platforms to receive mathematics instruction and support	A/SA	12	26.1	.002
		D/SD	34	73.9	
		Neutral	14		
4	Printed mathematics study materials are readily available and integrated with other technology learning resources at my institution	A/SA	43	78.2	.000
		D/SD	12	21.8	
		Neutral	5		
5	My institution provides mathematics instructional content through CDs/DVDs.	A/SA	10	22.7	.001
		D/SD	34	77.3	
		Neutral	16		
6	My institution uses radio broadcasts to deliver mathematics lessons to distance learning students.	A/SA	6	13.3	.000
		D/SD	39	86.7	
		Neutral	15		
7	Television lessons are provided for mathematics students' learning through this mode	A/SA	3	7.0	.000
		D/SD	40	93.0	
		Neutral	17		

Source: Quantitative Data

The results in Table 3 revealed that there is an uneven acceptance of digital instructional technologies for mathematics delivery in distance and online learning space. Less than half of the participants 47.3% agreed that computer technologies are provided, while 52.7% disagreed (p =.787). The views on internet technologies were likewise divided with 56.9% agreeing to its provision. The results of computer and internet-based technologies show no significant harmony with (p>.05). This result revealed that many participants did not support the view that computers are systematically provided for distance and online mathematics students in ODL. Despite that a slight majority noted that internet tools exist, but this lacks statistical significance to support the assertion and hence underscores inconsistent access. This aligns with evidence that unstable connectivity and digital resource inequality remain central issues in higher education digital learning environments. This shows there are gaps in basic Information and Communication Technology (ICT) infrastructure which is a core condition for meaningful digital learning in ODL (Bubou, & Job 2021).

Contrary to the responses obtained in the use of computer and internet technologies, use of audio/video conferencing platforms was remarkably low. Significant majority (73.9%) stated that they do not use instructional audio and video conferencing in their mathematics distance and online instruction (p=.002), instead, printed mathematics study materials were constantly available and integrated (p<.001). This indicates that print remains the most reliably accessible instructional medium, showing consistent blended models where traditional materials balance for gaps in digital readiness, especially where there is limited infrastructure (Agim et al. 2025). The transitional and broadcast-based technologies, like CDs/DVDs, radio, and television were basically not available in distance and online mathematics instructional delivery in the two institutions used for the study. The agreement levels range from 7.0% to 22.7% with differences statistically significant at ($p \leq .001$). Generally, these show continued reliance on print-based materials alongside limited uptake of interactive and digitally mediated technologies. This is a reflection that issues in succeeding toward more advanced technology-supported instructional delivery in open and distance mathematics education as reported in recent ODL literature is a pattern that needs change with time. This is consistent with patterns reported in recent ODL and technology adoption literature (Bubou and Job 2021; Hodges et al., 2020)

Table 4: Challenges related to technology-based Support

SN	Item of Questionnaire	Response	Frequency	Proportion (%)	Binomial Test (p-value)
1	There is adequate technological infrastructure to support 24/7 online mathematics distance learning	A/SA	21	46.7	.766
		D/SD	24	53.3	
		Neutral	15		
2	Technology-based support services for mathematics students are accessible only during official working hours on weekdays	A/SA	16	41.0	.337
		D/SD	23	59.0	
		Neutral	21		
3	Learning Management Systems (e.g., Blackboard, Moodle) are used to support mathematics students in my institution.	A/SA	40	80.0	.000
		D/SD	10	20	
		Neutral	10		
4	On-site tutorials are provided to complement digital and online tools to enhance mathematics learning.	A/SA	26	54.2	.665
		D/SD	22	45.8	
		Neutral	12		
5	There is a central office that offers comprehensive technology admission services for mathematics distance and online students	A/SA	41	87.2	.000
		D/SD	6	12.8	
		Neutral	13		
6	Technology available for mathematics students in my institution support online registration	A/SA	48	90.6	.000
		D/SD	5	9.4	
		Neutral	7		
7	My institution has a designated office or centre that provides one-stop services for mathematics distance and online learners	A/SA	43	86.0	.000
		D/SD	7	14.0	
		Neutral	10		
8	Technology accessible in my school provides one-stop services, including course materials and resources, for mathematics distance and online learners.	A/SA	47	94.0	.000
		D/SD	3	6.0	
		Neutral	10	6.0	
9	Technology related challenges e.g. login problems or software compatibility, etc. for mathematics students are sorted out only at the study centres	A/SA	37	78.7	.000
		D/SD	10	21.3	.000
		Neutral	13		.000
10	Technology in my institution has a designated office or centre that provides one-stop services, including academic support, for mathematics distance and online learners.	A/SA	27	64.3	.090
		D/SD	15	35.7	.090
		Neutral	18		.090
11	There are satisfactory digital library resources and technology tools to support mathematics distance and online students.	A/SA	28	65.1	.067
		D/SD	15	34.9	
		Neutral	17		
12	The digital library resources are accessible to mathematics	A/SA	29	65.9	.050
		D/SD	15	34.1	
		Neutral	16		
13	I am able to access the library resources online from anywhere in the world.	A/SA	22	48.9	1.000
		D/SD	23	51.1	
		Neutral	15		
14	My institution provides access to career counselling for distance mathematics students	A/SA	26	65.0	.082
		D/SD	14	35.0	
		Neutral	20		

Source: Quantitative Data

Table 4 summarises students' responses on technology-based support for mathematics distance and online learning. The results from the analysis show that there was no significant difference between the adequacy of constant (24/7) infrastructure support (46.7% agree; $p = .766$) and and support availability only during official hours (41.0% agree; $p = .337$). These show that many students experience variability in access to reliable technology and support services. The views align with comprehensive evidence on the ongoing digital divide issues and inconsistent technological readiness in distance education spaces (Kashima, 2025). On one hand, the institutional adoption of digital learning platforms was strongly upheld by the respondents with 80.0% agreeing to the use of learning management systems to support mathematics instruction, with highly significant binomial outcomes of ($p < .001$). This is in line with the global trend on the need of integrating learning management systems and interactive environments in distance education (Li et al. 2023).

Although marginal number of participants (54.2%) perceived on-site tutorials as complementary to online tools, this did not reach statistical significance ($p = .665$), suggesting uneven provision of blended support structures. In other case, centralised technology support services like admissions, online registration, and one-stop support offices were significantly affirmed by large majorities ($p < .001$) that participated in the study. These results indicate strong institutional supports in the administration of ODL. Students also reported that technology-related challenges (e.g., login and software issues) tend to be resolved at study centres (78.7% agree; $p < .001$). While this indicates the availability of support structure, it also reflects a reliance on physical centres for problem resolution against ODL demands.

Students' views on digital library resources showed moderate positive response. Approximately, two-thirds of the participants agreed that resources are satisfactory and accessible (65.1% and 65.9%, respectively), but these

findings were marginally significant (p = .067 and p = .050). Notably, accessing library resources from anywhere in the world did not show satisfaction (48.9% agree; p = 1.000), indicating ongoing issues to remote resource access. Lastly from Table 4, 65% agreed that technology-facilitated career counselling support for distance and online mathematics students are offered but without statistical significance (p = .082). This indicates that the students may be unsure or experience inconsistency in non-academic service delivery.

Table 5: Issues related to communication tools among distance and online mathematics students

SN	Item of Questionnaire	Response	Frequency	Proportion (%)	Binomial Test (p-value)
1	E-mail is used as a technology-mediated communication tool for mathematics students in my institution	A/SA	27	50.9	1.000
		D/SD	26	49.1	
		Neutral	7		
2	My university uses telephone media to support mathematics students learning in this mode	A/SA	22	42.3	.332
		D/SD	30	57.7	
		Neutral	8		
3	Chat platforms are available to communicate with lecturers, tutors, or peers for mathematics support	A/SA	21	42.9	.391
		D/SD	28	57.1	
		Neutral	11		
4	Mobile text messages are sent to me to communicate mathematics-related information from my facilitators	A/SA	25	53.2	.770
		D/SD	22	46.8	
		Neutral	13		
5	There is availability of Facebook and other social media platforms to access mathematics learning materials and communicate with instructors and peers.	A/SA	23	50.0	1.000
		D/SD	23	50.0	
		Neutral	14		

Source: Quantitative Data

The analysis on Table 5 presents distance and online mathematics students' perceived issues on technology-mediated communication tools used in institutions A and B. The responses across all the items were evenly distributed between agreement and disagreement. None of the binomial tests attained statistical significance (p > .05). For example, the students' views of email use were almost split between agreement (50.9%) and disagreement (49.1%). Similar response patterns were observed for telephone support (42.3% agreed and 57.7% disagreed), chat platforms (42.9% agreed and 57.1 disagreed), mobile text messaging (53.2% agreed and 46.8 disagreed), and social media platforms (50.0% agreement and disagreement). These findings indicate that communication tools are inconsistently experienced by students. This suggests that there is absence of a clearly defined and uniform implementation of communication system for mathematics students support in distance and online learning contexts in the institutions used for the study.

5. Thematic Analysis of Qualitative Data

The qualitative data which was collected using self-designed interview protocols to support the quantitative analysis is as presented. The students from the two institutions admitted experiencing some technological challenges in learning in this mode: Students stated that they personally finance all the technologies they required (especially internet, data and devices) to learn in this mode. In their words,

"In term of that technology, I buy data through my phone." "Students and students alone provide the technology they study with, like computer, internet and the like." "I provide all the technology I need to study in this mode by myself…"

This indicates that the financial burdens for distance and online learning of mathematics are solely on the students. This may cause inequality in access and participation especially in a subject like mathematics.

Some other issues that emerged include lack of institutional provision of technology and inadequacy of online delivery and interaction. The participants stressed the limited learning technologies in their institutions. For a student from institution B:

"Because since I have been here, I have not received any technology like that."

"…except for some study materials they provide." "The instructional delivery of mathematics which has to do with interaction online with facilitators and through all modern technology assessment… are not available."

This suggests that institutional support is largely limited to content provision, without addressing the technological infrastructure necessary for effective online mathematics learning.

For communication and instructional delivery in distance and online mathematics education, the students' narratives revealed systemic inadequacies in the use of communication tools available for other courses but lacking for mathematics students. Three prominent points they raised include: limited instructor presence; ineffective communication channels, and inadequate multimedia support for mathematics learning.

They stated that structured online engagement such as virtual consultations or live chats were largely absent. One student noted:
"We do meet them but not as regular… there is nothing like that and we don't meet any of our instructors online." This lack of instructional presence constrained opportunities for clarification and guided learning.

Again, formal communication tools such as email and telephone were described as irregular and limited in purpose. Email was mainly used for assignment submission rather than

academic support, while telephone communication was discouraged due to airtime costs, according to a student: *"Nobody wants to use their airtime to call you. The information is placed on the notice board or website."*

Consequently, communication was largely one-directional, and this definitely may limit interaction and feedback.

The students further noted that although they actively used WhatsApp and other social media platforms, these spaces functioned mainly as peer-support networks among themselves, with minimal facilitators' involvement: *"We do chat… among us the students but our facilitators scarcely show up"* Students further emphasized that text-based social media platforms were unsuitable for mathematics, citing the subject's abstract and procedural nature:

"You know how difficult mathematics is, so doing it through Facebook… is difficult for both our teachers and us." Finally, the participants expressed a strong need for multimedia technology resources, particularly recorded video or audio lectures demonstrating step-by-step problem solving of mathematics problems. One participant suggested: *"They should video the lecturer… solve mathematics on the board… students can download and follow the steps."*

However, the existing technology infrastructures were perceived by the students as inadequate and poorly designed for mathematics, with mathematics reportedly excluded from some online and broadcast provisions available to other disciplines.

6. Discussions and implication

The study revealed that mathematics students enrolled in distance and online learning were predominantly male, young adults, single, and employed. This demographic pattern reflects some of the characteristics commonly associated with ODL students and supports previous evidence concerning the flexibility of open and distance learning for adult learners, as well as the gender disparities that may exist within open learning environments (Ali & Ahmad, 2011; Kashima, 2025).

Furthermore, the findings on challenges related to instructional delivery, facilitation, and technology revealed uneven access to and utilisation of digital learning tools. The provision of computer technologies was relatively limited, while access to internet resources was inconsistent among the participants. The use of audio and video conferencing technologies for instructional purposes was also limited. In contrast, printed learning materials remained widely accessible to students. Traditional media technologies, including CDs/DVDs, radio, and television, were also rarely used. These findings suggest that instructional delivery in the ODL environment continues to rely considerably on printed learning materials, potentially as a means of addressing limitations in digital infrastructure, internet connectivity, and access to appropriate learning technologies (Hodges et al., 2020; Bubou, & Job 2021; Vargas-Montoya et al. 2023).

The findings on technology-based support presented in Table 4 revealed mixed experiences among mathematics students from the two ODL institutions used in the study. Students generally acknowledged the adoption of Learning Management Systems (LMS) and the availability of centralised services, such as online registration and one-stop student support offices. However, access to round-the-clock technological infrastructure and remote digital library resources was reported to be limited. Non-academic support services, particularly career counselling, were also experienced inconsistently by mathematics education students who participated in this study. These findings suggest that, although the institutions have made progress in providing technology-based academic and administrative support, some important support services remain uneven and may not adequately address the needs of students studying entirely through distance and online modes as also indicated by (Li et al., 2023).

Furthermore, the findings on communication tools presented in Table 5 revealed inconsistent experiences among the students. The use of email, online chat, telephone communication, text messaging, and social media varied across participants, suggesting that these communication channels may not be uniformly integrated into instructional delivery and student support among mathematics education students and other subjects. Such inconsistencies may affect the frequency and quality of interaction between students, facilitators, and institutional support services, which are generally important in distance and online learning environments and specifically necessary to mathematics education students learning through this mode.

The qualitative data findings confirmed limited instructor presence, one-directional communication, and minimal facilitator engagement on peer platforms such as WhatsApp. Students are the main financiers of the technology they need for their learning, uunderscoring inequities in access and participation (Table 1). Participants emphasized the need for multimedia resources, particularly recorded step-by-step lectures, to support procedural and abstract mathematics learning, revealing systemic inadequacies in current ODL provision. Generally, these findings indicate that while institutional adoption of LMS and centralized support exist, there are significant gaps in concurrent delivery, digital infrastructure, communication, and multimedia resources constraints affecting mathematics distance and online learning in the case study institutions. This aligns with the Bubou, and Job (2021) on Technology Acceptance Model, emphasizing perceived usefulness and ease of use as key determinants for technology adoption in ODL contexts.

The implications of these results are that effective mathematics distance and online learning require robust digital infrastructure, blended instructional strategies and structured communication to enhance engagement and to support conceptual understanding (Agim et al., 2025; Hodges et al., 2020; Bubou, & Job 2021). Additionally, comprehensive student support services and policies that reduce the financial burden of technology access on the students are essential to promote equity, retention, and inclusive participation in ODL mathematics programmes (Ali & Ahmad, 2011; Li et al., 2023; Kashima, 2025).

This study is situated within two prominent government approved Open and Distance Learning (ODL) institutions in

Nigeria and third-year mathematics students. Further study could include more ODL institutions and larger sample of mathematics students.

7. Conclusion

The study demonstrates that undergraduate mathematics students in Nigerian open and distance learning institutions continue to experience significant technology-related challenges, particularly unstable internet connectivity, high data costs, inadequate institutional technological support, and limited interactive instructional resources. Although learning management systems and selected support services are available, important gaps remain in digital infrastructure and communication. Strengthening technological investment, expanding student support services, and improving access to affordable digital resources will enhance student engagement, learning experiences, and academic success in distance and online mathematics education.

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