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Full Length Research

Utilization and effectiveness of the zoom application in teaching and learning of mathematics in tertiary institutions

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ABSTRACT: The paper studied the extent to which the tertiary institution lecturers make use of the Zoom application and how effective the application is in teaching and learning mathematics with Adeyemi Federal University of Education (AFUED), Ondo as the case study. The study's specific objectives were to examine the extent to which Zoom's application enhances students' engagement and motivation in learning Mathematics and assess the impact of Zoom's application on students' understanding and retention of mathematical concepts. One hundred (100) respondents of AFUED students were used as the sample size, and the researchers' self-developed questionnaire was used as the instrument for data collection. Descriptive statistics (mean) were used to answer the research question, while Pearson's product-moment correlation was used to test the stated hypotheses. It was found among others that many Mathematics Lecturers are not currently utilizing the Zoom application. It was also revealed that there was a correlation between students' gender and the extent of Zoom application utilization for teaching and learning of Mathematics, while no significant relationship existed between the students' level and their engagement in the use of the Zoom application for Mathematics learning. It was discovered that Students' age has no significant relationship with participating in the use of the Zoom application for Mathematics learning. The findings present implications for future research, highlighting the need for enhanced utilization strategies, addressing technical challenges, and promoting inclusive teaching practices. Recommendations also encompass continuous training, evaluation of pedagogical approaches, and collaboration with industry partners to optimize the integration of Zoom and similar platforms in tertiary mathematics education. This research contributes to the ongoing discourse on technology in education, emphasizing the importance of a nuanced approach to online platforms for effective teaching and learning of Mathematics in Tertiary Institutions.

Keywords: Gender, Information and Communications Technology, students' achievement, Zoom application.

INTRODUCTION

The sudden emergence and rapid spread of the coronavirus as a global pandemic gave rise to strict measures such as maintaining social distancing. Higher Education has undergone major changes in recent years, driven largely by rapid technological advances that have disrupted the conventional system of teaching and learning. The digital evolution in education is not only about using new hardware and software; it involves cultural and paradigm transformations in teaching and learning. Yes, the shift brings tremendous opportunities as well as serious challenges for educators, students, and education stakeholders (Roehl *et al*., 2013). The 21st century has seen a remarkable evolution in educational practices, largely owing to the digital revolution. Educational institutions, including universities and colleges, have increasingly adopted online and blended learning models to expand access to education and provide students with greater flexibility (Goldschmidt and Msn, 2020; Basilaia and Kvavadze, 2020; Bao, 2020). This transformation has been accelerated by the global shift

towards online and remote learning, which has been especially pronounced by approximately 97% of tertiary institutions in some countries (Dikti, 2020). This shift has been driven by several factors, including the need for lifelong learning, the growing diversity of the student body, and the demand for technology-enhanced education. Tertiary institutions worldwide have been exploring online learning for a variety of subjects, including Mathematics (Hidayat *et al*., 2022; Munna and Kalam, 2021; Okeke, 2024). Traditionally perceived as a subject best taught in face-to-face settings, Mathematics has proven to be adaptable to online environments when the right tools and methodologies are employed (Devlin and Samarawckrema 2010).

As a result, educators are constantly seeking innovative tools and platforms to enhance the teaching and learning experience. Among the myriad of digital tools available, the Zoom application has emerged as a prominent and versatile platform for synchronous online communication and collaboration (Vailshery, 2022; Pedersen and Favero, 2020; Ohiwerei and Nden, 2022). This study is based on the utilisation and effectiveness of the Zoom application in the context of teaching and learning mathematics in tertiary institutions (Devlin and Samarawickrema (2010). Zoom, a cloud-based video conferencing and collaboration platform (Zulu *et al.,* 2021; Ewomaoghene, 2024), was initially developed for business and personal use. However, its scalability, ease of use, and diverse feature set quickly attracted educators and students (Ofosu-Ampong, 2023; Herdiana, 2020). The platform's adoption in education has been catalysed by its capacity to replicate many aspects of the physical classroom in a virtual space. Features such as real-time video and audio communication, screen sharing, and interactive whiteboards enable educators to engage with students, deliver lectures, and facilitate discussions, all while bridging geographical distances (Zulu et al., 2021; Ewomaoghene, 2024; Pedersen and Favero, 2020).

The effectiveness of Zoom as an educational tool has been a subject of increasing interest among educators and researchers, such as Vailshery (2022), Angwaomaodoko (2024), Irele (2021) and Okeke (2024). In the context of mathematics education, Zoom offers distinct advantages since most of the mathematical concepts often require visual representation and interactive problem-solving. Zoom's digital whiteboard and screen sharing capabilities allow instructors to draw equations, diagrams, and graphs in real time (Wang *et al*., 2024). Moreover, the platform facilitates breakout rooms, where students can collaborate on problem sets and engage in peer-to-peer learning, mimicking the group dynamics of an in-person classroom.

This paper then aimed to study how Zoom can enhance student engagement, support personalised learning, and provide a platform for rich communication and collaboration among students and educators. However, its effectiveness in the context of teaching and learning Mathematics at the tertiary level requires investigation. This study is guided by a theoretical framework that integrates principles of online education, technology-enhanced learning, and instructional design. It draws from educational theories that emphasise the importance of interaction, engagement, and active learning in the teaching of mathematics.

Simpong *et al*. (2020) opened that it is generally believed that with the advent of Information and Communications Technology (ICT), Zoom technology is among the catalysts that will drive learning. Hence, Zoom technology should become an integral part of learning in tertiary institutions. Another rationale for Zoom technology could be seen in the fact that the world of the twenty-first century can aptly be called an e-driven world. Studies have generally indicated that the use of traditional didactic lectures alone cannot make students globally literate and succeed in this information age (Adarkwah and Huang, 2023; Qolamani and Mohammed, 2023). There is a need for students to use Zoom technology to complement the efforts of the lecturers and classroom lectures. Awareness of Zoom technology among university students would determine, to a great extent, if Nigeria could have more independent learners, who are problem solvers and who can contribute positively to improving the way things are done in Nigeria and other nations of the world. Ogwunte and Amadi (2020) in their research work Perceived Influence of Zoom Cloud and WhatsApp Technologies on Instructional Delivery in University Business Education Classroom in Rivers State, their result reveals that zoom cloud technology offers educators with the ability to communicate in real time with dispersed students via computers and mobile phones, ability to secure record and store sessions without recourse to third party software, ability to create users specific authentication, ability to create real time encryption of meetings, ability to back up recording to online remote server network, ability to connect synchronously with students over videos and audios, ability to share screen and ability for students to work in group.

Hind and Ahmed (2021) explained that some studies have found that there were no (or negligible) gender differences in the use of technology. For example, a study by Diri and Udo (2025) found that gender differences in computer-related behaviors were small and did not differ as a function of study population. According to Nadezhda (2020), online distance learning in the educational process has become a buzz in medical education, and today it caters to the needs of modern-day learners. Infusing technologies in classroom learning has added to the stimulus and enhanced learners' interaction within the classroom. Distance learning has a vast presence in almost every field. Language teaching is one such field where technology has taken over and improved the ways of learning. As for the strengths of an online distance learning course, the following come to mind. They provide easier access to course resources, offer greater convenience for the teacher and students, and offer

flexibility in scheduling. It can be personalised, that is, teachers can cater to each student's proficiency level and learning goals by delivering different online resources to individual students so they can work on them in their own time.

On the contrary, Haqien and Rahman (2020) revealed that lecture activities using Zoom Meeting are considered less effective for university students in Jakarta and Depok because of the network problem or internet signal as students who do not use Wi-Fi will have an impact on the quality of learning they receive. According to Ifeanyi *et al.* (2021), concerning the challenges of participating in online Zoom, all the participants could complain that buying the data bundle for the internet is expensive and can therefore frustrate them. Using the Zoom platform requires a bandwidth, which will be problematic for participants who lack strong internet connections or have limited data plans and lack of computer/android phone.

Statement of the problem

There are many problems associated with the teaching and learning of Mathematics in tertiary institutions. Addressing these problems can lead to a deeper understanding of the contents that have been a great challenge to students. There is a lack of comprehensive research that specifically examines the utilization and effectiveness of the Zoom application for teaching and learning Mathematics in tertiary institutions, despite its growing popularity in online education. The extent of Zoom adoption among educators and students in tertiary institutions varies, and the factors influencing this adoption need to be explored to understand the barriers and facilitators. The digital divide may limit the equitable access of students to Zoom and online Mathematics education. Investigating disparities in technology access and their impact on learning outcomes is crucial. The readiness and training of Mathematics educators to effectively use Zoom's features for teaching complex mathematical concepts has been one of the major areas of concern. The challenge of fostering effective interaction and collaboration among students and between students and educators in the virtual mathematics classroom needs examination. The design and implementation of assessments that accurately measure mathematical understanding in an online environment posed a problem, along with questions about the integrity of online testing. The aforementioned problems prompted this study of the utilisation and effectiveness of the Zoom application in teaching and learning mathematics in tertiary institutions.

Purpose of the study

The paramount aim of this paper is to examine how effectively the Zoom application is being utilised in teaching and learning mathematics in tertiary institutions. The specific objectives of the study are to:

1. Investigate the current utilisation of the Zoom application for mathematics instruction in tertiary institutions.
2. Evaluate the effectiveness of Zoom in enhancing student performance in mathematics courses.
3. Identify the challenges and opportunities associated with the use of the Zoom application for mathematics education.
4. Provide recommendations for improving the utilisation of Zoom in mathematics instruction.
5. investigate if there is any relationship in the students' gender and the utilization of the Zoom application in facilitating teaching and learning of Mathematics in tertiary institutions.
6. examine if there exists a difference in levels of the students and their engagement in the use of the Zoom application for teaching and learning mathematics courses in tertiary institutions.
7. investigate the existence of the relationship, if any, in students' age and their participation in the use of the Zoom application for mathematics education

Research questions

The paper will seek answers to the following questions:

1. How is the Zoom application currently being utilized for teaching and learning of Mathematics in tertiary institutions?
2. What is the impact of Zoom on students' performance, engagement, and satisfaction in mathematics courses?
3. What challenges and opportunities are associated with using Zoom for mathematics education?

Research hypotheses

This study tests the following hypotheses to determine the level of significance of the study.

H_{01}: There is no significant relationship between the students' gender and utilisation of the Zoom application in facilitating teaching and learning of Mathematics in tertiary institutions.
H_{02}: There is no significant difference between the levels of the students and their engagement in the use of the Zoom application for teaching and learning mathematics courses in tertiary institutions.
H_{03}: There is no significant relationship between the students' age and their participation in the use of the Zoom application for mathematics education.

Significance of the study

As evaluation is an infinite process in curriculum innovation, it could be of diagnostic value to curriculum experts in that it would:

1. Contributes to the ongoing discourse on the integration of technology in education, particularly in mathematics instruction.
2. Provides valuable insights into the current state of Zoom utilisation and its effects on student learning outcomes.
3. Guide educators, institutions, and policymakers in optimising the use of Zoom for mathematics education in tertiary education settings.

Delimitation and limitation of the study

This study will be limited to finding difficult concepts in the use of the Zoom application in learning mathematics instructions at Adeyemi Federal University of Education, Ondo, Ondo state. Some of the major constraints that are bound to be encountered in putting up this research work include finance, time, and in willingness of the respondents to provide accurate and expected information.

METHODOLOGY

Research design

A mixed-methods approach was employed in the study. The design combines both quantitative and qualitative research methods to provide a comprehensive understanding of the subject. Quantitative data was collected through surveys and analytics of learning outcomes, focusing on the utilisation of Zoom features. Qualitative data was gathered through interviews and open-ended questions, exploring the experiences and perceptions of students.

Population and sample of the study

The targeted population for this study comprises students of Adeyemi Federal University of Education, Ondo, who studied mathematics education. The research focused on a diverse sample of 100 to 400 level Mathematics students of the Institution. The sample drawn from the target population for this study comprised students chosen from Department of Mathematics, Adeyemi Federal University of Education Ondo, Ondo state Nigeria with focus on those students that were in Degree one (100L), Degree two (200L), Degree three (300L) and Degree four (400L). A random sampling technique was used to select the number of students in each level, and to ensure a broad representation of the target audience, the sample was made based on the enrolment population of each level at the time of the study, 10 students were selected from the 100 level, 15 students from the 200 level, 35 students from the 300 level, while 40 students were chosen from the 400 level.

Research instrument

The instrument used for the study is a well-structured questionnaire to elicit information from the respondents. This instrument ensures a comprehensive understanding of users' perspectives, aiding in the analysis of Zoom's impact on mathematics learning within tertiary settings for a nuanced and insightful study.

Validation of the instrument

The questionnaire was initially designed by the researchers and was given to a lecturer each in the Department of Computer and Management Information Systems (MIS) personnel of Adeyemi Federal University of Education, Ondo, for scrutiny. This is to ensure content validity before it is used on the subject. In this study, the survey questionnaire was meticulously designed, reviewed, and pre-tested to ensure it effectively measures the intended variables.

Reliability of the instrument

To ensure the reliability of the questionnaire for internal consistency and stability, a test-retest reliability survey was used to ensure that the instruments consistently yield dependable results throughout the study; the survey questionnaire was first administered to some set of students and re-administered to another set of students, after two weeks, in order to ensure its reliability. The reliability coefficient is 0.89, which is above the generally acceptable coefficient of 0.7.

Data collection

Data collection for this study involved administering surveys to gather quantitative data on Zoom utilisation and its impact. Quantitative data was collected through the administration of a questionnaire to the students to explore the experiences and perceptions of students using Zoom in mathematics education in tertiary institutions.

Data analysis

The data collected from the respondents was analysed using the mean of the respondents to answer the research questions raised, and Pearson Product-Moment Correlation

Table 1. Showing the mean on how Zoom's application is currently utilised for teaching and learning of Mathematics in tertiary institutions.

S/N	Item statement	Mean ($\bar{x}$)	Decision
1	The Zoom application is regularly used in my Mathematics courses for live lectures or discussions	2.34	Disagreed
2	The interactive features of Zoom (e.g., chat, polls, breakout rooms) enhance engagement during Mathematics classes	2.23	Disagreed
3	Zoom sessions effectively cater to the visual representation of mathematical concepts, aiding comprehension	2.26	Disagreed
4	The screen-sharing capability of Zoom assists in demonstrating problem-solving techniques in Mathematics	2.54	Strongly agreed
5	Zoom adequately facilitates student-teacher interaction, allowing for timely clarification of mathematical queries	2.83	Strongly agreed
6	The overall reliability of Zoom contributes positively to the learning experience in Mathematics	2.43	Disagreed
7	The scheduling and organization of Zoom-based Mathematics classes are convenient and efficient	2.36	Disagreed
8	Zoom adequately supports collaborative group work or projects in Mathematics education	2.28	Disagreed
9	The internet connectivity and technical stability of Zoom significantly impact the quality of Mathematics instruction	2.64	Strongly agreed
10	Compared to traditional face-to-face methods, using Zoom for Mathematics classes offers added flexibility and accessibility	2.98	Strongly agreed
Aggregate mean		2.49	Disagreed

n (PPMC) to test the hypotheses formulated with the aid of the SPSS package. This method of analysis provides a comprehensive understanding of the utilisation and effectiveness of Zoom in mathematics education.

RESULTS

The results presented were based on the research questions raised, which the study has sought to answer, as well as the hypotheses. The decision value on the findings was guided using the benchmark of 2.50. Item(s) with a Mean ($\bar{x}$) of 2.50 were accepted as agreed, while those that are above were accepted as strongly agreed. Item(s) that are in the range $2.01 \leq \bar{x} \leq 2.49$ were accepted as disagreed and item(s) that are in the range $1.51 \leq \bar{x} \leq 2.0$ were accepted as strongly disagreed while item(s) that are in the range $1.0 \leq \bar{x} \leq 1.50$ were accepted as undecided.

Research question 1. How is the Zoom application currently being utilised for teaching and learning Mathematics in tertiary institutions?

The overall mean of 2.49 from Table 1, which is slightly below 2.50, shows that Zoom is not currently utilised by all lecturers of the Mathematics Department of Adeyemi Federal University of Education, Ondo. Item 10, which has application for mathematics classes, offers added flexibility and accessibility to Mathematics learning. Item 2, with the highest mean of 2.98, shows that using Zoom has the lowest mean value of 2.23, shows that the interactive features of the zoom application did not enhance the engagement of students during Mathematics classes. This could be due to the fact that some lecturers do not use Zoom for teaching, so some of the students were not exposed to the Zoom teaching-learning process. Item 5, which has a mean of 2.83, shows that there is high interaction between students and teachers when using the Zoom application for teaching and learning Mathematics. Also, item 9, with a mean of 2.64, revealed that using the Zoom application for teaching and learning Mathematics provides a quality of Mathematics instruction to the students.

Research question 2: What is the impact of Zoom on students' performance, engagement, and satisfaction in Mathematics courses?

From Table 2, the overall mean of 2.47 indicates that the zoom application has no much impact on students' performance, engagement, and satisfaction in Mathematics courses. Which means that students can even perform well with the use of other means of teaching. Item 16, which has the highest mean of 2.77, shows that Zoom adequately addresses individual learning needs in Mathematics, while Item 12, which has the lowest mean of 2.16, shows that engaging in Mathematics classes through Zoom has little effect on improving the overall performance of the students in assessments. Item 17, with a mean of 2.57, shows that the interactive features of Zoom enhance students' motivation and their interest in learning Mathematics.

Table 2. Showing the mean impact of Zoom on students' performance, engagement, and satisfaction in Mathematics courses.

S/N	Item statement	Mean ($\bar{x}$)	Decision
11	Zoom sessions have positively impacted my understanding of complex mathematical concepts	2.72	Strongly agreed
12	Engaging in Mathematics classes through Zoom has improved my overall performance in assessments	2.16	Disagreed
13	The use of Zoom has increased my participation and active involvement during Mathematics lectures or discussions	2.31	Disagreed
14	Zoom sessions effectively encourage peer interaction and collaboration in solving mathematical problems	2.57	Strongly agreed
15	The convenience of attending Mathematics classes via Zoom has positively influenced my learning experience	2.34	Disagreed
16	Zoom adequately addresses individual learning needs in Mathematics compared to traditional face-to-face classes	2.77	Strongly agreed
17	The interactive features of Zoom enhance my motivation and interest in learning Mathematics	2.57	Strongly agreed
18	The use of Zoom has provided me with a satisfactory level of support for my mathematical inquiries	2.35	Disagreed
19	Overall, I am satisfied with the impact of Zoom on my engagement and learning outcomes in Mathematics	2.48	Disagreed
20	I believe that my performance in Mathematics courses would have been better without the use of Zoom	2.47	Disagreed
Aggregate mean		2.47	Disagreed

Table 3. Showing the mean on challenges and opportunities that are associated with the use of Zoom for mathematics education.

S/N	Item statement	Mean ($\bar{x}$)	Decision
21	Using Zoom for Mathematics classes presents challenges related to maintaining consistent internet connectivity	2.67	Strongly agreed
22	The lack of physical interaction in Zoom sessions poses challenges for in-depth understanding of complex mathematical concepts	2.54	Strongly agreed
23	Zoom sessions for Mathematics courses often encounter technical issues that disrupt the learning process	2.83	Strongly agreed
24	The absence of immediate feedback or clarification during Zoom sessions hampers my learning in Mathematics	2.81	Strongly agreed
25	The use of Zoom encourages the exploration of diverse teaching resources and materials in Mathematics education	2.70	Strongly agreed
26	Zoom sessions in Mathematics allow for increased inclusivity and participation among students with diverse backgrounds	2.84	Strongly agreed
27	The adaptability of Zoom features offers opportunities for innovative teaching methods in mathematics	2.42	Disagreed
28	The challenges faced in using Zoom for Mathematics are outweighed by the benefits it offers for collaborative learning	3.23	Strongly agreed
29	Zoom usage for Mathematics education requires effective training and support to maximize its potential opportunities	2.92	Strongly agreed
Aggregate mean		2.77	Strongly agreed

Research question 3: What challenges and opportunities are associated with using Zoom for Mathematics education?

The overall mean of 2.77, as shown in Table 3, revealed that there are challenges like internet problems, power supply, and there are some opportunities associated with the use of the Zoom application for teaching and learning of Mathematics. Item 29, which has the highest mean of 2.92, shows that students need effective training for them to be able to use the Zoom application effectively for Mathematics learning, while item 27, which have the lowest mean of 2.42 revealed that the adaptability of Zoom features does not offers opportunities for innovative teaching methods in Mathematics.

H_{01}: There is no significant relationship between the students' gender and utilisation of the Zoom application in facilitating teaching and learning of Mathematics in tertiary institutions

From Table 4, the R-calculated value (0.299) was greater

Table 4. PPMC showing the relationship between gender and the use of the Zoom application.

Variable	N	Mean	S.D	Df	R	R-tab
Use of Zoom application	100	2.49	0.418	98	0.299	0.195
Gender	100	1.46	0.501			

Table 5. PPMC showing the relationship between the levels of the students and their engagement in the use of the Zoom application.

Variable	N	Mean	S.D	Df	R	R-tab
Engagement in the use of the Zoom application	100	2.47	0.291	95	0.147	0.195
Levels	100	2.82	0.978			

Table 6. PPMC showing the relationship between the students' age and their participation in the use of the Zoom application.

Variable	N	Mean	S.D	Df	R	R-tab
Participation in the use of the Zoom application	100	2.77	0.534	98	0.081	0.195
Age	100	2.00	0.696			

than the R-table value (0.195). Hence, the null hypothesis was rejected. This indicates that there is a significant relationship between the students' gender and the utilisation of the Zoom application in facilitating teaching and learning of Mathematics in tertiary institutions. Students' gender, either male or female, determines their usage of the Zoom application for Mathematics learning.

H_{02}: There is no significant difference between the levels of the students and their engagement in the use of the Zoom application for teaching and learning Mathematics courses in tertiary institutions

The R-calculated value (0.147) in Table 5 was less than the R-table value (0.195). Hence, the null hypothesis was accepted; this indicates that there was no significant difference between the levels of the students and their engagement in the use of the Zoom application for teaching and learning Mathematics courses in tertiary institutions. Students' level does not determine the rate at which they are being engaged in the use of the Zoom application for Mathematics learning.

H_{03}: There is no significant relationship between the students' age and their participation in the use of the Zoom application for Mathematics education

From Table 6, the R-calculated value (0.081) was less than the R-table value (0.195); hence, the null hypothesis was accepted. This indicates that there was no significant relationship between the students' age and their participation in the use of the Zoom application for Mathematics education. Students' age does not affect or does not determine their participation in the use of the Zoom application for Mathematics learning.

DISCUSSION

This study investigated the utilisation and effectiveness of the Zoom app in teaching and learning of Mathematics in tertiary institutions with a specific focus on Adeyemi Federal University of Education, Ondo. One hundred students were randomly selected as a sample. Three research questions were raised, and three hypotheses were formulated and tested. The questionnaire was used as the instrument for the study. Data collected were analysed using mean to answer the research questions, while the hypotheses were tested using Pearson Product-Moment Correlation (PPMC) via the SPSS package.

The study revealed that the overall mean indicates a disagreement regarding the current utilisation of Zoom in the Mathematics department. This means that most of the Lecturers in the Department of Mathematics do not make use of the Zoom platform for teaching Mathematics. One possible reason why lecturers and students had a negative perception toward the use of the Zoom application in the teaching and learning of Mathematics could be that most of them have never used any Web-based Information Services before in their education system. This is in line with the study of Alkhanak and Azmi (2011), who found that both lecturers and students had a negative attitude towards e-learning.

Examining the impact of the application on students' performance, engagement, and satisfaction, the overall mean indicates that Zoom platform teaching does not have more impact on the performance of the students, meaning that students can still perform very well even with other teaching platforms. This is contrary to the works of Diri and Udo (2025) and Ikwuka and Usifoh (2016), who revealed that students taught the modern system of teaching, which includes online teaching, demonstrate a higher level of academic achievement.

It was also revealed from the study that students face a lot of challenges with the use of the Zoom application for teaching and learning Mathematics. Some of the challenges associated with Zoom included connectivity issues, lack of physical interaction, and technical disruptions, among others. This view is the same as that of Allen and Seaman (2017), who confirm that to access web-based information services, devices such as smart mobile phones, computers, tablets, and so on must be charged. Despite the challenges, opportunities like increased inclusivity and the exploration of diverse teaching resources were acknowledged. With this, students still believe that the Zoom platform could be better for teaching and learning of Mathematics, which is indicated by the overall mean of the third research question. This is supported by Afzal *et al.* (2015), who contended that due to e-learning, students can learn at any time and anywhere, thereby developing new skills in the process, leading to lifelong learning.

However, hypothesis one revealed that there is a significant relationship between students' gender and the utilisation of Zoom, with gender influencing usage patterns. This could be the belief that a particular gender stays longer on the phone and the internet than the other (a hypothesis that has not been tested by any researcher or scientist),

Furthermore, hypothesis two revealed that no significant differences were found based on students' levels. It was revealed that the level of the students does not mainly determine their degree of engagement in the use of the Zoom application for teaching and learning of Mathematics. The study underscores the complex interplay of technology, gender, and educational levels in the adoption and effectiveness of online platforms for Mathematics instruction.

Consequently, it was found from hypothesis three that there is no statistical difference regarding the age in their (students) engagement with Zoom for Mathematics education. That is, students' age does not affect their participation in the use of the Zoom application for Mathematics learning.

Through the statistical analysis, the results are in line with Trakru and Kumar Jha (2019), who concluded that there is no significant difference in e-learning effectiveness among boys and girls. Also, this agreed with the work of Simpong *et al*. (2020), who stated that ICT positively affects the effectiveness of e-learning: digital modules positively affect the achievement of students (Simpong *et al*., 2020).

Conclusion

This research delved into the utilisation and effectiveness of the Zoom application in the teaching and learning of Mathematics in tertiary institutions, specifically examining the context of Adeyemi College of Education, Ondo. The findings shed light on the current state of Zoom usage, its impact on students' academic performance, engagement, and satisfaction, as well as the associated challenges and opportunities. The research indicated a discrepancy in the current utilisation of Zoom in the Mathematics department, with certain aspects, such as flexibility and accessibility, receiving positive responses. Despite these potential advantages, challenges like internet connectivity and technical disruptions were identified, impacting the overall learning experience. Furthermore, the study uncovered a nuanced relationship between gender and Zoom utilisation, showcasing varying patterns of application. While the findings show that there is no significant impact on students' performance and engagement, there were notable positive aspects, including individualised learning support and increased motivation. The research underscores the need for addressing technological challenges, providing effective training, and acknowledging the diverse impact on students based on gender. As educational institutions continue to navigate the integration of online platforms, understanding these dynamics is crucial for optimising the benefits of technology in mathematics education.

Recommendations

The following recommendations were made based on the research findings:

1. Institution Management should develop and implement comprehensive strategies to enhance the utilisation of Zoom in Mathematics education. This could involve targeted training programs for both instructors and students to maximise the platform's potential.
2. Institutions and Governments should invest in infrastructure and support systems to address technical challenges identified in the study, such as internet connectivity issues and disruptions during Zoom sessions. This may involve collaborating with Information technology departments to ensure a stable online learning environment.
3. Institution Management should provide in-service training and professional development opportunities for instructors and students to keep them updated on the latest features and best practices in utilising Zoom for Mathematics education.
4. Further research should be conducted to evaluate specific pedagogical approaches within Zoom, focusing on how different teaching methods can be adapted to the online environment for optimal learning outcomes in Mathematics.
5. Governments should establish robust support services to address students' concerns during Zoom sessions, ensuring timely feedback and clarification. This may involve creating channels for immediate assistance

and academic support.

6. Institution Management should explore and evaluate alternative online platforms beyond Zoom for mathematics education, considering their unique features and potential benefits to diversify the online learning experience.
7. Institution Management and Lectures should conduct longitudinal studies to track the long-term impact of Zoom on students' academic performance, engagement, and satisfaction. This could provide valuable insights into the evolving dynamics of online learning over an extended period.
8. Institutions should collaborate with industry partners to address challenges related to internet connectivity and technical stability. Seeking input from technology companies could lead to innovative solutions and improvements.
9. Institution Management should develop gender-inclusive strategies in the integration of Zoom for Mathematics education, recognizing and addressing the varying patterns of application identified in the study. This could involve tailored support mechanisms and interventions for different gender groups.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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