**Effects of Smart Classroom Technologies on Student Collaboration and Critical Thinking in Federal University of Education, Zaria**

**BY**

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**ABSTRACT**

This study examined the **Effects of Smart Classroom Technologies on Student Collaboration and Critical thinking in Federal University of Education, Zaria**. It was guided by three specific objectives, along with corresponding research questions. The study focused on students and lecturers with a population of 4,500 undergraduate students and 250 lecturers. A descriptive survey design was employed, involving a sample size of 368 students and 50 lecturers. The sample was selected in line with Yamane's (1967) formula for calculating sample sizes. The instrument for data collection was a structured questionnaire, titled “Smart Classroom Technologies and Student Learning Questionnaire (SCTSLQ)”, which yielded a reliability coefficient of 0.79 after pilot testing using Cronbach's alpha. Data collection was self-administered and analysed using the descriptive statistics of mean and standard deviation. The study revealed that smart classroom technologies generally have a positive influence on student collaboration at FUE Zaria (X=3.48, SD=1.40). Smart classroom technologies have a generally positive impact on critical thinking among students at FUE Zaria (X=3.42, SD=1.42). There are several significant challenges to the effective implementation of smart classroom technologies at FUE Zaria (X=3.51, SD=1.44). The researcher recommends that Federal University of Education, Zaria should establish clear policies and guidelines for the use and management of smart classroom technologies, among others.

**KEYWORDS:** Students Collaboration, Critical thinking, Digital Learning Tools, Smart Classroom Technologies, & 21st Century Skills

**Introduction**

Students are provided with learning experiences that are more interactive, collaborative, and personalised as a result of the integration of smart classroom technology (Chen et al., 2020; Zhang & Wang, 2022). This has resulted in a dramatic transformation of teaching and learning processes all over the world. These technologies include interactive whiteboards, digital collaboration platforms, virtual laboratories, real-time assessment tools, and learning management systems. The overarching goal of these technologies is to improve students' level of critical thinking and their ability to work together (Aldowah et al., 2019; Wang & Zhao, 2021). In order to cultivate active learning environments in which students engage in problem-solving, critical analysis, and teamwork all of which are crucial abilities for learners in the 21st century (Hwang et al., 2019; Johnson et al., 2023), these tools have been built.

Smart classroom technologies are built on the principles of blended learning and personalized instruction, integrating digital content with traditional teaching methods to create an enriched learning experience (Li et al., 2021). Research has shown that these technologies can improve student motivation, engagement, and academic performance by providing immediate feedback, interactive simulations, and data-driven insights into student progress (Park & Kim, 2020; Wu et al., 2023). For example, smart classrooms enable students to collaborate on projects, participate in virtual labs, and engage in interactive discussions, fostering a deeper understanding of complex concepts (Akinyemi et al., 2022).

In developed countries, the widespread adoption of smart classroom technologies has contributed to significant improvements in educational outcomes, including enhanced critical thinking, problem-solving skills, and student collaboration (Abdullahi & Bello, 2022; Okoro & Nwankwo, 2023). These technologies support a more student-centered approach, encouraging active participation and personalized learning pathways, which are critical for developing higher-order thinking skills (Chen & Huang, 2020; Zhang & Wang, 2022). However, the situation in many developing regions, including Nigeria, presents a different picture, with challenges such as inadequate infrastructure, limited digital skills among teachers, and insufficient funding slowing the adoption of these innovations (Olatunji et al., 2023).

Recognising the potential of smart classroom technologies to revolutionise teaching and learning, the Federal University of Education (FUE) Zaria has started action to incorporate them into Nigerian higher institutions (Abdullahi & Bello, 2022). However, little is known about how well these tools work to foster student collaboration and critical thinking. To improve student results, optimise teaching methods, and influence educational policies, it is essential to comprehend the precise effects of these technologies on student learning at FUE Zaria (Olatunji et al., 2023). Furthermore, it is thought that smart classroom devices improve collaboration by fostering a more dynamic and captivating learning environment. They foster cooperation and communication skills by enabling students to collaborate on projects, exchange ideas, and find solutions to issues (Chen et al., 2020; Wu et al., 2023). Inquiry-based learning, interactive problem-solving activities, and real-time feedback systems are other ways that smart classrooms foster critical thinking, a critical skill for both professional and academic success (Hwang et al., 2019).

Notwithstanding these possible advantages, Nigeria has obstacles in implementing and successfully utilising smart classroom technologies. These include the requirement for ongoing professional development for teachers to use these tools successfully, expensive maintenance expenses, and insufficient technical assistance (Akinyemi et al., 2022). Furthermore, a major obstacle to the broad adoption of smart classrooms in Nigerian institutions is the digital gap, which is defined by differences in access to technology and internet connectivity (Okoro & Nwankwo, 2023). In light of these complications, the purpose of this study is to investigate how smart classroom tools affect critical thinking and teamwork among FUE Zaria students. The study looks at the advantages and disadvantages of using these technologies in order to shed light on how best to incorporate them into the Nigerian educational system in order to enhance student performance and develop 21st-century abilities.

**Statement of the Problem**

There is little empirical data on how smart classroom technologies actually affect student collaboration and critical thinking in Nigerian universities, despite the increased emphasis on these tools. Unaware of how well these technologies can improve student learning outcomes, many institutions make significant investments in them (Akinyemi et al., 2022). At FUE Zaria, where the use of smart classroom technology is still in its infancy, this research gap is especially noticeable. Underutilisation of these important resources could jeopardise the standard of instruction and students' readiness for upcoming problems if the effects of these technologies are not well understood (Abdullahi & Bello, 2022). As a result, this study aims to examine how smart classroom technologies affect FUE Zaria students' critical thinking and collaborative skills, identifying the crucial elements that affect their efficacy and examining potential obstacles to their successful integration.

**Objectives of the Study**

**The objectives of the study are to;**

1. assess the extent to which smart classroom technologies influence student collaboration at FUE Zaria.
2. evaluate the impact of smart classroom technologies on critical thinking among students at FUE Zaria.
3. identify the challenges and barriers to effective implementation of smart classroom technologies at FUE Zaria.

**Research Questions**

1. To what extent do smart classroom technologies influence student collaboration at FUE Zaria?
2. How do smart classroom technologies impact critical thinking among students at FUE Zaria?
3. What challenges affect the effective implementation of smart classroom technologies at FUE Zaria?

**Methodology**

This study adopted a descriptive survey research design, which is suitable for capturing the perceptions, experiences, and attitudes of students and lecturers regarding the use of smart classroom technologies at FUE Zaria. Descriptive survey designs are often employed in educational research to provide a comprehensive understanding of participants' views and experiences (Olatunji et al., 2021; Johnson & Bello, 2022). This approach was chosen because it allows for the systematic collection and analysis of data from a defined population, providing insights into the extent and effectiveness of smart classroom technology use within the university.

**Population and Sample Size**

The target population for this study comprised 4,500 undergraduate students and 250 lecturers at FUE Zaria who had prior exposure to smart classroom technologies. This population was selected because these individuals are directly involved in the teaching and learning processes that smart technologies aim to enhance. The study sought to capture a diverse range of perspectives, including those from different academic disciplines, to provide a more comprehensive understanding of the impact of smart technologies on student collaboration and critical thinking.

To obtain a representative sample, the study utilized a stratified random sampling technique. This method was chosen to ensure that the sample accurately reflected the diverse academic backgrounds, levels of exposure, and technology experience within the university. The sample size was determined using Yamane's (1967) formula for calculating sample sizes in large populations, given as:

n =

where:

* **n** = sample size,
* **N** = total population size (4,750),
* **e** = margin of error (0.05).

Based on this formula, the study targeted approximately 368 students and 50 lecturers as the final sample size. This sample size was considered sufficient to achieve a 95% confidence level with a 5% margin of error, ensuring the reliability and generalizability of the findings.

**Instrumentation**

Data were collected using a structured questionnaire developed based on existing literature on smart classroom technologies and their impact on student learning. The questionnaire was titled "Smart Classroom Technologies and Student Learning Questionnaire (SCTSLQ)" and included items on students' and lecturers' perceptions of smart technologies, the frequency of use, perceived benefits, challenges, and potential areas for improvement. The instrument was designed using a five-point Likert scale, with response options ranging from Strongly Agree (SA) to Strongly Disagree (SD), to capture the intensity of participants' attitudes and perceptions accurately. To ensure content validity, the questionnaire was reviewed and validated by educational technology experts and experienced lecturers in the field of research. This validation process aimed to confirm that the items were clear, relevant, and appropriately addressed the study's objectives. The feedback from the experts was incorporated to refine the questionnaire, ensuring it effectively captured the required data.

**Pilot Study and Reliability**

Before full-scale data collection, a pilot study was conducted with 30 students and 10 lecturers who were not part of the main study. The pilot study aimed to assess the reliability of the instrument and identify any potential issues, such as ambiguous questions or unclear instructions. The reliability of the instrument was measured using Cronbach’s alpha, with a coefficient of 0.79, demonstrating high internal consistency and reliability.

**Data Collection and Analysis**

Data were collected through self-administered questionnaires distributed to the selected sample. To ensure a high response rate, multiple follow-up reminders were sent to participants, and data collection lasted for two weeks. Completed questionnaires were retrieved, coded, and entered into the Statistical Package for the Social Sciences (SPSS) version 28 for analysis. The data were analyzed using descriptive statistics, including mean scores and standard deviations, to provide a detailed picture of participants' responses.

**Results and Discussions**

**Table 1: The extent to which smart classroom technologies influence student collaboration at FUE Zaria**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Items | SA | A | UN | D | SD | X | S.D | Remark |
| 1 | Smart classroom technologies enhance collaboration among students | 135 | 63 | 0 | 148 | 72 | 3.06 | 1.50 | High Extent |
| 2 | The use of digital collaboration platforms like Microsoft Teams or Zoom improves teamwork | 203 | 102 | 0 | 71 | 42 | 3.96 | 1.35 | High Extent |
| 3 | Smart technologies make group discussions more interactive and engaging | 187 | 156 | 2 | 23 | 50 | 4.08 | 1.18 | High Extent |
| 4 | Smart classrooms help students work together effectively on assignments | 129 | 119 | 11 | 77 | 82 | 3.44 | 1.46 | High Extent |
| 5 | I find it easier to share ideas and collaborate using smart classroom tools | 84 | 96 | 5 | 130 | 113 | 2.86 | 1.52 | Low Extent |
|  | Cumulative Mean |  |  |  |  |  | 3.48 | 1.40 | High Extent |

Benchmark: Mean ≥3.0 = High Extent; Mean < 3.0= Low Extent

The data in **Table 1** reveals that smart classroom technologies generally have a positive influence on student collaboration at FUE Zaria, as indicated by the overall cumulative mean score of 3.48 with a standard deviation of 1.40. Students strongly agreed that these technologies make group discussions more interactive and engaging (mean = 4.08, S.D = 1.18), reflecting a widely shared positive experience. Similarly, digital collaboration platforms like Microsoft Teams or Zoom were rated highly for improving teamwork (mean = 3.96, S.D = 1.35). However, the effectiveness of smart classrooms in facilitating assignments received a slightly lower mean (3.44, S.D = 1.46), suggesting some challenges in this area. Notably, the ease of sharing ideas using smart classroom tools scored the lowest (mean = 2.86, S.D = 1.52), indicating a significant variation in student experiences, which may reflect differing levels of digital literacy or comfort with technology. Overall, the findings highlight the potential of smart technologies to enhance collaboration, while also pointing to areas for improvement to fully support student interaction and teamwork.

**Table 2: The impact of smart classroom technologies on critical thinking among students at FUE Zaria**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Items | SA | A | UN | D | SD | X | S.D | Remark |
| 1 | Smart technologies encourage critical thinking through problem-solving tasks | 122 | 163 | 5 | 65 | 63 | 3.70 | 1.33 | Accepted |
| 2 | Digital platforms help me evaluate and analyze information more effectively | 136 | 101 | 1 | 77 | 103 | 3.30 | 1.56 | Accepted |
| 3 | Smart classrooms promote independent thinking and creativity | 125 | 136 | 7 | 92 | 53 | 3.60 | 1.34 | Accepted |
| 4 | The use of interactive technologies sharpens my analytical skills | 100 | 148 | 8 | 100 | 66 | 3.34 | 1.38 | Accepted |
| 5 | Smart technologies enhance my ability to solve complex problems | 99 | 117 | 10 | 98 | 94 | 3.16 | 1.49 | Accepted |
|  | Cumulative Mean |  |  |  |  |  | 3.42 | 1.42 | Accepted |

Benchmark: Mean ≥3.0 = Accepted; Mean < 3.0= Rejected

The data in **Table 2** indicates that smart classroom technologies have a generally positive impact on critical thinking among students at FUE Zaria, with a cumulative mean score of 3.42 and a standard deviation of 1.42. The highest rated item, "Smart technologies encourage critical thinking through problem-solving tasks," received a mean of 3.70 (S.D = 1.33), reflecting a strong perception that these technologies effectively promote critical thinking. Similarly, the item on promoting independent thinking and creativity scored 3.60 (S.D = 1.34), suggesting that students find smart classrooms supportive for creative problem-solving. However, items related to evaluating and analyzing information (mean = 3.30, S.D = 1.56) and solving complex problems (mean = 3.16, S.D = 1.49) received slightly lower ratings, indicating potential challenges in these areas. The relatively high standard deviations for these items suggest significant variation in student experiences, possibly reflecting differences in digital literacy or confidence in using these technologies for complex analytical tasks. Overall, the results highlight the potential of smart classroom technologies to enhance critical thinking, while also pointing to the need for further support in specific areas like complex problem-solving and information analysis.

**Table 3: The challenges to effective implementation of smart classroom technologies at FUE Zaria**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/N | Items | SA | A | UN | D | SD | X | S.D | Remark |
| 1 | Limited access to reliable internet is a challenge | 205 | 113 | 5 | 40 | 55 | 3.92 | 1.34 | Accepted |
| 2 | Lack of adequate training for lecturers and students | 107 | 143 | 0 | 112 | 56 | 3.34 | 1.43 | Accepted |
| 3 | High cost of maintaining smart technologies | 112 | 156 | 0 | 58 | 92 | 3.36 | 1.53 | Accepted |
| 4 | Insufficient technical support for smart classrooms | 108 | 140 | 5 | 122 | 43 | 3.43 | 1.37 | Accepted |
| 5 | Smart classrooms can be difficult to manage without proper guidelines | 164 | 67 | 6 | 127 | 54 | 3.48 | 1.55 | Accepted |
|  | Cumulative Mean |  |  |  |  |  | 3.51 | 1.44 | Accepted |

Benchmark: Mean ≥3.0 = Accepted; Mean < 3.0= Rejected

The data in **Table 3** reveals that there are several significant challenges to the effective implementation of smart classroom technologies at FUE Zaria, with a cumulative mean score of 3.51 and a standard deviation of 1.44. The most significant challenge identified is limited access to reliable internet, which had the highest mean score (3.92, S.D = 1.34), indicating that this is a common and critical barrier. Other notable challenges include insufficient technical support (mean = 3.43, S.D = 1.37) and the difficulty in managing smart classrooms without proper guidelines (mean = 3.48, S.D = 1.55). The high standard deviations for some items, like the high cost of maintaining technologies (S.D = 1.53) and managing smart classrooms (S.D = 1.55), suggest a wide variation in respondents' experiences, potentially reflecting differences in infrastructure and support across departments. Overall, these findings highlight the need for improved infrastructure, training, and support to overcome these barriers and fully realize the benefits of smart classroom technologies.

**Discussion**

The integration of smart classroom technologies at Federal University of Education, Zaria has shown a generally positive influence on student collaboration and critical thinking, as evidenced by mean scores of 3.48 (SD = 1.40) and 3.42 (SD = 1.42), respectively. However, the implementation faces notable challenges, with a cumulative mean of 3.51 (SD = 1.44) indicating significant barriers.

Smart classroom technologies have been instrumental in fostering student collaboration. The observed mean score of 3.48 suggests that students at FUE Zaria perceive these technologies as facilitators of collaborative learning. This aligns with findings from a meta-analysis by Chen and Liu (2024), which reported that smart classrooms positively affect learning outcomes, including behavioral development, which encompasses collaborative skills. Additionally, the use of digital platforms like Microsoft Teams and Zoom has been associated with improved teamwork and interactive group discussions. A study by Blackwell (2015) found that kindergarteners who shared iPads performed better, indicating that shared technology use can enhance collaboration from an early age. However, some studies caution against overreliance on technology for collaboration. For instance, a review by Bingimlas (2009) highlighted that without proper training and support, the integration of ICT can be ineffective, potentially hindering collaborative efforts. Moreover, the physical learning environment plays a crucial role; outdated facilities may not support the flexible, technology-rich settings required for effective collaboration.

The positive impact of smart classroom technologies on critical thinking is reflected in the mean score of 3.42. Smart classrooms provide interactive and engaging environments that encourage students to analyze information, solve problems, and think independently. A study by Zhang et al. (2021) found that smart classroom environments significantly enhanced students' higher-order thinking skills, particularly when peer interaction and learning motivation were emphasized. Furthermore, the use of AI and emerging technologies in smart classrooms has been shown to support the development of critical thinking by providing real-time feedback and adaptive learning experiences. Conversely, concerns have been raised about the potential drawbacks of technology in developing critical thinking. For example, excessive use of surveillance technologies in classrooms may stifle intellectual risks and diminish student autonomy, which are essential for critical thinking. Additionally, the lack of proper guidelines and training for educators can lead to ineffective use of technology, thereby failing to promote critical thinking skills.

Despite the benefits, the implementation of smart classroom technologies at FUE Zaria faces significant challenges, as indicated by the mean score of 3.51. Key barriers include limited access to reliable internet, inadequate training for lecturers and students, high maintenance costs, and insufficient technical support. These challenges are not unique to FUE Zaria; similar issues have been reported globally. For instance, a study on smart schools in Malaysia identified lack of financial resources, limited time, and technological failures as major obstacles to effective implementation. Furthermore, resistance from educators due to unfamiliarity with technology and lack of confidence has been documented as a significant barrier. However, some argue that these challenges can be mitigated through strategic planning and investment. The implementation of comprehensive training programs for educators and the development of clear policies and guidelines can enhance the effective use of smart classroom technologies. Moreover, prioritizing investments in infrastructure and providing financial incentives can address the financial constraints faced by educational institutions.

**Conclusion**

The findings of this study indicate that smart classroom technologies at FUE Zaria have a generally positive influence on both student collaboration and critical thinking. These technologies facilitate an interactive and engaging learning environment, fostering teamwork and encouraging independent, problem-solving skills among students. Despite the benefits, several challenges hinder the effective implementation of these technologies, particularly in terms of limited internet access, inadequate training, and high maintenance costs. These barriers underscore the need for a more supportive and well-resourced environment to maximize the potential of smart classrooms. To overcome these challenges, educational institutions must address infrastructural deficits and prioritize professional development for both students and staff. The findings suggest that while the technologies show promise in enhancing educational outcomes, their full impact can only be realized if the proper mechanisms for their integration, training, and support are put in place. Therefore, it is critical to continue exploring and addressing these barriers to ensure that smart classroom technologies can contribute to an improved learning experience at FUE Zaria and similar institutions.

**Recommendations**

The study has the following recommendations:

1. It is essential for FUE Zaria to implement comprehensive training programs for both lecturers and students to ensure they are proficient in using smart classroom technologies.
2. To overcome challenges related to internet access and the high cost of maintaining smart technologies, FUE Zaria should prioritize investments in digital infrastructure, including reliable internet connectivity and affordable hardware.
3. Federal University of Education, Zaria should establish clear policies and guidelines for the use and management of smart classroom technologies.

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