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Integration of Digital Tools and Methods for Improving Students Performance: Innovative Digital Education

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Abstract

This study investigates the integration of digital tools to enhance student's academic performance in senior high schools within Zorzor District of Lofa County, Liberia. Education is recognized as a fundamental human right, particularly during global emergencies such as the COVID-19 pandemic, which exposed critical gaps in access to quality learning. Using quantitative research design, data were collected from Grade 11 and 12 students and teachers in two high schools through structures questionnaires and interviews. The findings reveal limited access to digital learning resources, inadequate research and collaboration platforms, and insufficient technological infrastructure, all of which negatively affected classroom performance and national examination outcomes. To address these challenges, the study proposes an innovative digital education framework incorporating learning management system, collaborative platforms, and adaptive technologies to support diverse learning needs. The findings contribute practical insights for educators, school administrators, and policymakers seeking to strengthen digital education and ensure continuity of learning during crises.

Keywords: - Digital Integration, Academic Performance, Innovation, COVID-19 Response,Educational Technology

I. INTRODUCTION

In the era of digital advancements, the study "Innovative Digital Education" addresses the imperative need to investigate the integration of digital tools in educational settings. As COVID-19 has underscored the importance of continuous learning, ensuring access to innovative technology tools becomes crucial in upholding students' right to education during global emergencies (COVID-19 response, n.d.). The high schools in the district face a challenge of poor academic performance due to the inadequate use of recommended technologies. Students lack technology tools to improve their learning process, impacting their engagement and performance. This study aims to identify and address these challenges by exploring the integration of digital tools. The purpose is to assess the current state of digital technology integration in high schools, focusing on its impact on students' academic performance and learning experiences. By identifying challenges and opportunities, the research aims to contribute insights that will guide the development of an innovative education.

1.1 Research Questions:

- What is the current academic performance of students in various high schools in the district, as evidenced by classroom assessments and national exams?
- How did the recent high school quizzing competition highlight the lack of proper digital technology innovation, and what were the observed challenges faced by students and teachers?
- To what extent are digital technologies currently integrated into the education system of high schools in the district?
- What were the challenges experienced by students and teachers in conducting research during the COVID-19 period, particularly in the absence of proper digital tools?

1.2 Research Objectives:

- Evaluate the academic performance of students in various high schools in the district.
- Examine the impact of recent quizzing competitions, highlighting challenges in the absence of proper digital technology.
- Explore the extent of digital technology integration in high schools.
- Investigate challenges faced during COVID-19 without adequate digital tools.

1.3 Significance of the Study:

The integration of digital tools in Zorzor district's high schools enhances learning with interactive content, global connectivity, and personalized paths. It equips students with 21st-century skills, offers diverse resources, facilitates efficient assessment, and prepares them for the evolving technological landscape. Cost-effective and forward-looking, this approach transforms education, improving academic performance and ensuring students' readiness for the digital age.

II. METHODOLOGY

2.1. Research Design

A quantitative research design was adopted to examine the role of digital tools in improving students' academic performance. The study followed a systematic process involving problem identification, sample determination, ethical approval, informed consent, data collection, and statistical analysis.

2.2. Study Population and Sample

The study was conducted in Zorzor District, Lofa County, Liberia. The target population consisted of Grade 11 and 12 students and teachers from Zorzor Central High School and Zorzor Lutheran Mission High School. The total student population was 635. A sample of 100 participants (90 students and 10 teachers) was selected using purposive sampling.

2.3. Intervention Description

The intervention focused on integrating digital tools such as Learning Management Systems (LMS), collaborative online platforms, gamified learning modules, and AI-supported tutoring systems. These tools were selected to enhance engagement, personalization, and collaborative learning.

2.4. Components of the Intervention and methods:

Learning Management Systems (LMS): Implement cutting-edge Learning Management Systems for personalized learning with interactive content, real-time feedback, and data analytics to customize materials based on individual students' progress and learning styles.

Virtual Reality (VR) and Augmented Reality (AR): Utilizing VR/AR for immersive education, simulations, and virtual labs enhance understanding in science, engineering, and medicine.

Collaborative Online Platforms: Online platforms enhance collaborative learning with forums, project tools, and virtual groups. They promote teamwork and communication, crucial skills for the modern workplace, by facilitating joint assignments and projects.

Gamified Learning Modules: Creating educational games and quizzes to enhance learning, incorporating rewards for motivation, fostering an enjoyable learning environment through gamified modules that reinforce educational goals for students.

Artificial Intelligence (AI) Tutoring Systems :AI Tutoring Systems provide personalized, adaptive tutoring, assessing student progress, offering instant help, and tailoring sessions based on analysis of responses, enhancing learning experiences.

2.5. Expected Outcomes:

The anticipated outcomes include improved academic performance, increased engagement and motivation, and the development of 21st-century skills among students. The intervention plan outlines a comprehensive approach involving innovative teaching methodologies, advanced technologies, and continuous assessment strategies. It aims to enhance the learning experience, promote critical thinking, and prepare students for the challenges of the 21st century.

2.6. Instrumentation:

Primary data were collected using structured questionnaires, interviews, and classroom observations. Questionnaires were selected for their ability to capture quantitative data efficiently from a large sample.

2.7. Research Procedure

The research procedure involves a literature review on new digital technology tools and their impact, followed by the design of a methodology for effective investigation and analysis. Data collection methods, including interviews, surveys, observations, and document analysis, was employed.

2.8. Ethical Considerations

Ethical principles, including informed consent, confidentiality, and voluntary participation, were strictly observed

throughout the study (Laustsen et al., 2021).

2.9. Considerations during Data Collection/ Researcher Bias:

Measures are implemented to prioritize participants' safety and well-being, including informed consent, confidentiality, and ensuring physical and emotional safety during data collection. To mitigate researcher bias, a diverse research team is formed, training on bias recognition and addressing biases is provided, unbiased analytical tools are employed, and transparency and accountability are maintained.

2.10. Data Collection/Analysis:

Primary data were collected using structured questionnaires, interviews, and classroom observations. Questionnaires were selected for their ability to capture quantitative data efficiently from a large sample.

2.11. Validity and Reliability:

To enhance research validity and reliability, a collaborative partnership approach with educational institutions, teachers, and students was employed, ensuring diverse perspectives. Prejudice control measures minimized biases, and standardized methods were used for consistent data collection and analysis.

III. RESULTS

3.1. Descriptive Findings:

This chapter thoroughly analyzes the outcomes of implementing an innovative education with diverse digital tools in the various high schools in Zorzor district. Table 1: Students engagement with digital tools.

Table 1. Students' Academic Performance by Grade and Gender

Grades	1	2	3	Total
11th grade	56%	20%	24%	100%
Female	63%	17%	21%	100%
Male	49%	23%	28%	100%
12th grade	29%	16%	55%	100%
Female	29%	16%	55%	100%
Male	29%	16%	56%	100%
Grand Total	42%	18%	40%	100%

Table 1 illustrates clear grade-level differences in digital tool engagement. Among 11th-grade students, engagement is predominantly low, particularly among females, with 63% classified at Level 1 compared to 48% of males. By contrast, 12th-grade students exhibit substantially higher engagement, as more than half of both females (55%) and males (56%) fall within Level 3. While minor gender differences are observed in 11th grade where males demonstrate slightly higher engagement these differences are minimal in 12th grade, indicating a convergence of digital engagement levels across genders at the higher grade level.

Table 2. Challenges Associated with the Absence of Digital Technology

Grades	1	2	3	Total
11th grade	15%	31%	53%	100%
Female	3%	33%	64%	100%
Male	27%	30%	43%	100%
12th grade	15%	31%	54%	100%
Female	15%	31%	55%	100%
Male	15%	31%	54%	100%
Grand Total	15%	31%	54%	100%

Table 2 indicates that limited access to digital technology presents substantial challenges for students across all groups, with more than half reporting high levels of difficulty. Eleventh-grade students, particularly females, are the most affected: 64% of 11th-grade females report high levels of challenge, compared with 43% of their male counterparts. In contrast, 12th-grade students exhibit relatively consistent patterns across genders, with similar proportions of males and females reporting high levels of difficulty. Overall, the findings suggest that inadequate digital technology significantly hinders learning, with the greatest impact observed among 11th-grade female students.

Table 3. Perceived Impact of Digital Tool Integration on Learning Outcomes

Grades	1	2	3	Total
11th grade	25%	11%	64%	100%
Female	21%	7%	71%	100%
Male	29%	14%	57%	100%
12th grade	23%	21%	56%	100%
Female	25%	25%	50%	100%
Male	21%	18%	62%	100%
Teacher	30%	20%	50%	100%
Female	40%	40%	20%	100%
Male	20%	0%	80%	100%

Grand Total	24%	18%	58%	100%

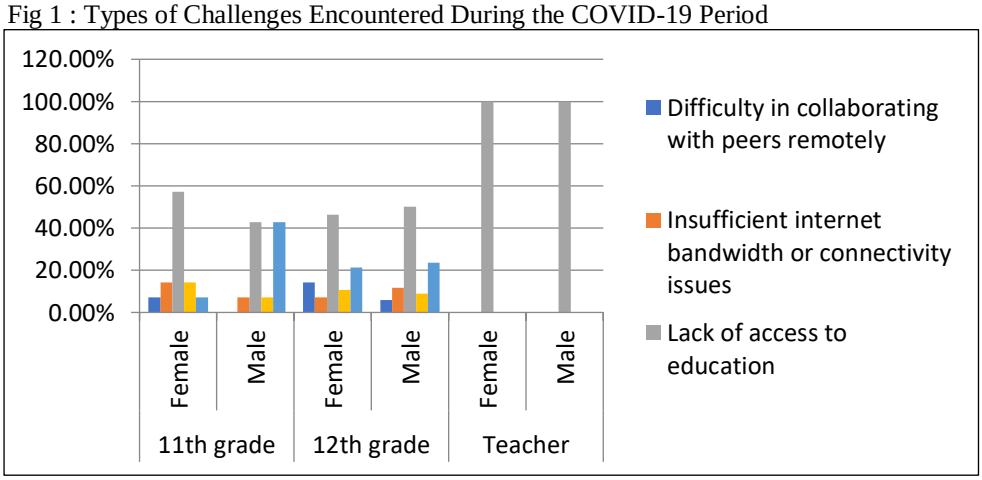
Table 3 indicates that the integration of digital tools is widely perceived as enhancing learning outcomes, with a majority of respondents (58%) reporting a high level of improvement. Both 11th- and 12th-grade students generally rate the impact positively, although 11th-grade students report slightly greater benefits than their 12th-grade counterparts. Gender-based patterns differ by grade level: among 11th graders, females report stronger perceived improvements than males, whereas the opposite pattern is observed among 12th graders. Teachers express more varied perceptions; however, male teachers report the highest level of improvement overall, with 80% selecting the highest response category. Despite these variations, the overall trend suggests that digital tools substantially enhance perceived learning outcomes.

Table 4. Challenges Experienced During COVID-19 Due to Limited Digital Tools

Grade	No	Yes	Total
11th grade	0.00%	100.00%	100.00%
Female	0.00%	100.00%	100.00%
Male	0.00%	100.00%	100.00%
12th grade	1.61%	98.39%	100.00%
Female	0.00%	100.00%	100.00%
Male	2.94%	97.06%	100.00%
Teacher	0.00%	100.00%	100.00%
Female	0.00%	100.00%	100.00%
Male	0.00%	100.00%	100.00%
Grand Total	1.00%	99.00%	100.00%

Table 4 indicates that nearly all respondents, across grades and genders, experienced challenges during the COVID-19 period due to inadequate access to digital tools. All 11th-grade students and all teachers reported facing such difficulties, with no respondents in these groups indicating otherwise. Among 12th-grade students, a very small proportion predominantly male reported not experiencing challenges; however, the vast majority still indicated significant difficulties. Overall, 99% of respondents were negatively affected, underscoring that insufficient digital tools constituted a widespread and near-universal problem during the pandemic.

Fig 1 : Types of Challenges Encountered During the COVID-19 Period



Across all respondent groups, the most significant challenge during the COVID-19 period was limited access to education, affecting more than half of the participants and consistently ranking as the most frequently reported issue among 11th-grade students, 12th-grade students, and teachers. Limited access to online databases and academic journals emerged as the second most common challenge, particularly among male students in both grade levels. Other difficulties including inadequate internet bandwidth, lack of required software or digital tools, and constraints on remote collaboration were reported less frequently; however, female students generally indicated slightly higher prevalence rates than their male counterparts. Notably, teachers identified limited access to education as their sole primary challenge, underscoring the extensive disruption to teaching and learning continuity during the pandemic.

IV. DISCUSSION

This study, conducted at Zorzor Central High School and Zorzor Lutheran Mission High School in Zorzor District, Lofa County, Liberia, examines the influence of digital tools on students' academic performance and engagement. The findings indicate a positive relationship between the use of digital technologies and improved academic outcomes, while also revealing notable gender disparities in digital engagement. The predominance of smartphones and the widespread use of platforms such as Google Classroom highlight the need for targeted interventions that promote equitable access and participation.

Despite the observed benefits, several challenges constrain effective digital integration, including limited access to devices and internet connectivity, high data costs, and insufficient digital skills among some students. These barriers underscore the urgency of investing in technological infrastructure and comprehensive digital literacy programs to foster inclusive learning environments. Teacher involvement emerged as a critical determinant of successful integration, with evidence of gender gaps in digital tool usage among educators. This finding reinforces the importance of sustained professional development and institutional support to enhance teachers' digital competencies and address gender-based disparities.

Overall, the results align with existing literature emphasizing the need to bridge the digital divide, adopt student-centered pedagogical approaches, and address gender inequalities in technology use. The study offers practical insights for navigating digital transformation in secondary education, particularly in resource-constrained contexts. Its recommendations such as the development of mobile-friendly learning materials, the use of diverse assessment strategies, and continuous pedagogical adaptation provide a strategic framework for fostering an inclusive and adaptive digital learning environment. By implementing these measures, schools in Zorzor District can advance toward a more technologically enriched educational experience that better prepares students for the demands of an evolving digital society.

V. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

This study examined academic performance patterns, the role of digital technology in quizzing competitions, the extent of digital integration in high schools, and the challenges experienced during the COVID-19 period. The findings provide a coherent overview of how digital readiness influences both learning outcomes and academic activities.

First, the analysis revealed clear differences in academic performance across grade levels. Eleventh-grade students generally performed above average, whereas twelfth-grade students demonstrated noticeably lower performance. Gender differences were minimal, indicating that academic variation is more strongly associated with grade level than gender. These results suggest the need for targeted instructional support for final-year students to improve academic outcomes.

Second, the study found that the absence of adequate digital technology significantly affected the effectiveness of quizzing competitions. Most respondents across both grade levels reported a high negative impact, with female students indicating slightly greater challenges. This finding highlights the importance of digital tools in supporting competitive academic activities and aligns with prior research emphasizing technology-enabled learning environments.

Third, perceptions of digital technology integration were largely positive. Most respondents reported moderate to high improvements in learning outcomes, with over half indicating a high level of impact. However, variations across demographic groups suggest the need for focused interventions, including teacher training and student support, to ensure equitable benefits from digital integration.

Finally, the study underscores the widespread challenges faced during the COVID-19 pandemic due to limited access to digital tools. Students and teachers alike reported significant barriers to effective teaching and learning, reinforcing the necessity of sustainable digital infrastructure and preparedness strategies for future disruptions.

Overall, the findings emphasize the critical role of digital technology in enhancing academic performance, supporting extracurricular academic activities, and ensuring continuity of education during crises. Clear presentation of results through well-structured tables and figures, alongside consistent APA-style referencing, strengthens the interpretability and academic quality of the study. These insights offer practical implications for policymakers, school administrators, and educators seeking to improve digital integration and educational resilience.

5.2. Recommendations

Enhance Support for 12th-Grade Students**:** Given the documented decline in academic performance among 12th-grade students, the implementation of targeted academic interventions is imperative. Schools should establish structured support systems, such as personalized tutoring, academic counseling, and remedial programs specifically designed to address identified learning gaps. These measures can enhance academic achievement and better prepare students for post-secondary education or workforce entry.

Invest in Digital Technology Infrastructure: The findings underscore the critical importance of digital technology in supporting learning activities, including online assessments, quizzing competitions, and remote instruction, particularly during the COVID-19 pandemic. Educational authorities and school administrators should prioritize strategic investments in reliable internet connectivity, up-to-date hardware and software, and interactive digital learning platforms. Strengthening digital infrastructure can enhance student engagement, promote collaborative learning, and support the continuity of education during periods of disruption.

Strengthening Teacher Professional Development: Variations in teachers' perceptions of digital integration suggest the need for ongoing and sustained professional development. Training programs should focus on improving digital literacy, integrating technology effectively into pedagogy, and using digital tools to support differentiated and inclusive instruction. Strengthening teachers' competencies in educational technology will enhance instructional quality and maximize learning outcomes.

Address Equity in Access to Education: The study highlights persistent inequities in access to education, particularly during emergency situations such as the COVID-19 pandemic. Policymakers and education stakeholders should implement strategies to narrow the digital divide, including device provision, subsidized internet access, and targeted support for students from disadvantaged backgrounds. Ensuring equitable access is essential for fostering inclusive, sustainable, and resilient learning environments.

Promote Collaborative and Multi-Stakeholder Approaches: Addressing academic performance gaps and digital integration challenges requires coordinated and collaborative efforts among educators, policymakers, parents, and community stakeholders. Multi-stakeholder partnerships can facilitate resource sharing, evidence-informed decision-making, and the development of contextually responsive and sustainable educational solutions. Such collective approaches are vital for strengthening educational systems and improving student outcomes in both routine and crisis contexts.

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