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Exploring mathematics teachers' integration of technology in the standards-based curriculum in the North Gonja District

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ABSTRACT

This study investigates the integration of technology by Mathematics teachers in the implementation of the Standard-Based Curriculum (SBC) in the North Gonja district of the Savannah Region of Ghana. It explores the mixed-method approach, and data were collected from 56 teachers through structured questionnaires and seven (7) educational stakeholders via semi-structured interviews. The study seeks to assess the extent of technology integration, explore teachers' experience, and identify key barriers in a resource-constrained rural context. Findings revealed that while most teachers have received general training in technology use, there is a significant gap in Mathematics-specific digital pedagogy. Teachers demonstrated moderate confidence and awareness of TPACK principles but face challenges such as inadequate infrastructure, limited access to subject-specific tools, poor internet connectivity, and insufficient institutional support. Self-efficacy played a critical role in influencing how teachers adopted or resisted technology in their classrooms. The study concludes that with targeted professional development, better infrastructure, and conceptualized support systems, technology integration in Mathematics education can be significantly improved in rural settings. Recommendations include expanding teacher training programmes, developing ICT infrastructure, and increasing stakeholder engagement to support technology-enhanced learning.

Keywords: Technology, Integration, Standards-Based Curriculum, Mathematics education

1. INTRODUCTION

The rapid advancement of technology has significantly transformed the educational landscape, providing new opportunities for enhancing teaching and learning. Globally, education systems are increasingly integrating digital tools to improve instructional practices and student engagement. In Ghana, the introduction of the Standard-Based Curriculum (SBC) aims to equip learners with critical thinking, problem-solving, and digital literacy skills necessary for the 21st-century goals (NaCCA, 2019). A key component of this curriculum is the effective implementation of technology to facilitate interactive and learner-centered education.

Teachers play a fundamental role in the successful implementation of the SBC, as they are responsible for integrating technological tools into classroom instruction. However, the effectiveness of this integration is influenced by various factors, including teachers' experiences, attitudes, and access to resources. While research highlights the benefits of technology in education, teachers in resource-constrained environments, such as the North Gonja district, often face significant challenges in adopting and utilizing digital tools (Johnson et al., 2016). These challenges may hinder full realization of the curriculum's goals.

1.1. Background to the Study

The integration of technology into education has gained significant traction in recent years, with numerous countries adopting technology-enhanced learning to improve student outcomes and instructional efficiency (Schmidt et al., 2009). In Ghana, the implementation of the Standards-Based Curriculum (SBC) is part of broader educational reforms aimed at fostering competency-based learning and equipping students with 21st-century skills (NaCCA, 2020). The success of this curriculum, however, depends heavily on the ability of teachers to effectively integrate technology into their teaching practices.

Teachers play a vital role in the implementation of the standards-based curriculum, and their experiences and challenges in integrating technology can influence the overall effectiveness of the curriculum (Apau, 2021). While technology has the potential to enhance teaching and learning, its integration in classrooms-particularly in resource-constrained environments such as the North Gonja District is most likely to face factors such as inadequate infrastructure, lack of professional development, and resistance to change (Kohnke, 2021). Understanding teachers' experiences in integrating technology within this curriculum framework is necessary for informing policy decisions and designing appropriate interventions to support educators.

According to Cobbold (2017), the process of translating curriculum intentions into practice, that is to say moving from page to playground, is acknowledged by curriculum experts as the most challenging phase of the educational change process. It is often fraught with challenges and constraints which, if not handled promptly, can lead to implementation failure. Although literature abounds in the challenges involved in the implementation of the Standard-Based Curriculum in Ghana. It is interesting to note that there is currently no such study recorded in the North Gonja District in the Savannah Region of Ghana, a region characterized by rural and semi-urban educational settings where access to digital tools and internet connectivity is limited. Examining Mathematics teachers' perspectives on the use of technology in delivering the Standard-Based Curriculum in the region would provide valuable insights into the realities of implementing technology-driven educational reforms in a developing context.

1.2. Statement of the problem

Technological Pedagogical Content Knowledge (TPACK) has emerged as a very useful framework for describing and understanding the goals for technology in pre-service teacher education (Schmidt et al., 2009). Despite the recognized benefits of technology integration in education, many teachers in Ghana, particularly in rural regions like Savannah, face numerous challenges in incorporating digital tools into their teaching practices (Agyei & Voogt, 2015). Though the Ghana Education Service has recognized and emphasized the need for technology integration in the Standard-Based Curriculum by providing teachers with the TM1 laptop, the level of preparedness and support for teachers to effectively use technology remains a concern (NaCCA, 2020).

Research on the introduction of educational technology, especially in developing societies, shows that it is important to ask the questions: Is the country including the society in the educational system? Is there adequate infrastructure in the society to equip schools for the integration? Are the human resources (teachers and stakeholders) well trained for the implementation? (Arshad-ayaz et al., 2022). To successfully teach in a technologically advanced environment, the teacher requires knowledge in three primary areas: Pedagogical Knowledge (PK), Content Knowledge (CK), and Technological Knowledge (TK), with the overlapping areas being critical (Mbatia et al., 2023).

The standard-based curriculum was introduced, focusing on the development of critical thinking and problem-solving rather than rote learning, which was associated with the previous curriculum (NaCCA, 2020). The curriculum also emphasizes the integration of ICT in order to meet international standards. Although studies such as (Gaxhiqi, 2021) and (Okoye & Martin, 2020) recognize the effectiveness and role of technology in lesson delivery, others, such as (Amuko, 2015), also identified several challenges associated with the implementation of technology in lesson delivery in resource-constrained environments.

According to (NaCCA, 2019), a key component of this curriculum is the effective use of technology to facilitate interactive and learner-centered education. However, previous studies have highlighted the barriers to technology integration in education, including inadequate training, limited access to digital resources, and infrastructural challenges (Ertmer & Ottenbreit-leftwich, 2010). Additionally, there is limited empirical research that specifically explores the experiences and challenges of teachers implementing the Standard-Based Curriculum (SBC) in Ghana. Without a clear understanding of these experiences, educational policymakers may struggle to develop targeted interventions that address teachers' needs and enhance the successful integration of technology in instruction. Therefore, this study seeks to fill the gap by looking into the challenges and experiences faced by Mathematics teachers in integrating technology into the Standard-Based Curriculum in the North Gonja District of the Savannah Region. The findings would contribute to the existing literature and provide recommendations in rural educational contexts.

1.3. Objectives of the study

The study would be guided by the following objectives:

1. To assess the extent to which mathematics teachers integrate technology in their instructional practices within the Standard-Based Curriculum
2. To analyze the key challenges that affect the effectiveness of technology integration among mathematics teachers
3. To examine mathematics teachers' experience in integrating technology in the implementation of the Standard-Based Curriculum

1.4. Research Questions

The study will be guided by the following research questions:

1. To what extent do mathematics teachers integrate technology into their instructional practices within the Standard-Based Curriculum?
2. What are the major challenges that influence the frequency and effectiveness of technology integration among mathematics teachers?
3. What are the experiences of mathematics teachers in integrating technology into the Standard-Based Curriculum?

1.5. Significance of the study

This study is significant for several reasons:

1. **Policy Development:** The findings will provide valuable insights to policymakers and education stakeholders on the realities of technology integration in rural settings, informing policies that support teachers in the standard-based curriculum implementation.
2. **Teacher Professional Development:** The study will highlight the challenges teachers face, guiding the design of targeted professional development programs to equip educators with the necessary skills to integrate technology effectively.
3. **Resource Allocation:** Understanding the availability and accessibility of technological resources will help in advocating for better resource distribution and infrastructure development in rural schools.
4. **Improved Teaching and Learning:** By identifying effective strategies for technology integration, the study can contribute to improved instructional practices and student engagement.
5. **Contribution to Literature:** The research will add to the existing body of knowledge on technology integration in education, particularly in developing contexts like Ghana.

2. LITERATURE REVIEW

2.1. Theoretical Framework

The study is guided by the Technological Pedagogical Content Knowledge (TPACK) framework developed by researchers (Schmidt et al., 2009). TPACK highlights the intersection of technology, pedagogy, and content knowledge required for effective technology integration in teaching. This framework is essential in understanding how teachers incorporate digital tools in the Standards-Based Curriculum while balancing instructional methods and subject content. Additionally, the study considers the Diffusion of Innovations Theory (Rogers & Everett, 1973) to explore how teachers adopt and implement technology in their teaching practices.

2.2. Global Perspectives on Technology Integration in Education

Technology integration has been widely embraced worldwide, with countries implementing digital learning strategies to enhance teaching and learning. Studies by Voogt and Knezek (n.d.) revealed that technology can improve students' engagement, facilitate personalized learning, and enhance pedagogical practices when effectively integrated. However, disparities exist in technology access, with rural and under-resourced schools facing greater challenges (Tondeur, 2019). Research in sub-Saharan Africa suggests that while technology adoption is growing, inadequate infrastructure, limited teacher training, and high costs remain significant barriers (Fu, 2013).

2.3. Technology Integration in the Ghanaian Education Context

Ghana's educational reforms have emphasized the role of technology in fostering competency- based learning under the Standard-Based Curriculum (NaCCA, 2019). However, Agyei and Voogt (2015) highlight that many Ghanaian teachers lack adequate digital literacy and access to technological resources, particularly in the rural regions. Research by (Buabeng-Andoh, 2012) suggests that although teachers recognize the benefits of technology, their ability to implement it effectively is hindered by infrastructure and pedagogical limitations.

2.4. Challenges of Technology Integration

Teachers in the North Gonja District in the Savanna region encounter multiple barriers in integrating technology into their instructional practices. Studies indicate that key challenges include:

1. **Infrastructure limitations:** limited access to electricity, internet connectivity, and digital devices (Ertmer & Ottenbreit-leftwich, 2010).
2. **Lack of Teacher Training:** inadequate professional development programs on ICT usage in the classroom (Agyei & Voogt, 2015).
3. **Resistance to Change:** Some teachers are reluctant to adopt new technological tools due to a lack of familiarity or confidence in their effectiveness (Tondeur, 2019)
4. **Limited Government Support:** Insufficient funding and policy implementation gaps affecting technology provision and maintenance (NaCCA, 2019).

2.5. Strategies for Enhancing Technology Integration in Rural Schools

Several strategies have been proposed to address the challenges faced by teachers in integrating technology into the Standard-Based Curriculum:

1. **Capacity Building:** Providing targeted training and workshops to enhance teachers' digital skills (Schmidt et al., 2009).
2. **Infrastructure Development:** Expanding access to electricity, internet connectivity, and digital devices in rural schools (Agyei & Voogt, 2015)
3. **Policy Support and Funding:** Strengthening government initiatives to allocate sufficient resources for ICT implementation (Buabeng-Andoh, 2012)
4. **Peer Support Networks:** Encouraging teacher collaboration and knowledge-sharing on best practices for technology use in the classroom (Alharbi, 2019).

2.6. The Self-Efficacy Theory

Self-efficacy is rooted in Albert Bandura's (Bandura, 1977) social cognitive theory, positing that individuals believe in their capabilities to organize and execute courses of action directly influencing their motivation, persistence, and resilience in achieving goals. In educational settings, teachers' self-efficacy refers to educators' confidence in their ability to perform specific tasks, such as integrating technology into pedagogy, managing classroom dynamics, or aligning instruction with curriculum standards. Self-efficacy is shaped by four primary sources:

1. Mastery experiences (prior success or failure)
2. Vicarious experiences (observing peers' success)
3. Social persuasion (encouragement or feedback from others)
4. Physiological/emotional states (stress or excitement during task execution)

For technology integration, self-efficacy determines whether teachers adopt, adapt, or resist digital tools, particularly when navigating the demands of a standards-based curriculum (Tschannen-Moran & William, 2019). According to (2021), teacher efficacy takes a key role in improving quality education in every nation. To them, efficacious teachers are more likely to stay in the teaching profession, spending more time teaching and making greater efforts in classroom management.

2.7. Self-Efficacy and Technology Integration

Teachers' self-efficacy in technology (often termed as technology integration self-efficacy) is critical for overcoming challenges such as

1. **Technical Complexity**: Fear of malfunctioning tools or inadequate troubleshooting skills.
2. **Pedagogical alignment**: Uncertainty about how to use technology to meet curriculum standards.
3. **Time constraints**: Balancing technology preparation with curriculum coverage.

Research shows that teachers with high self-efficacy are more likely to experiment with innovative tools, persist through setbacks, and align technology use with learning objectives (Scherer & Teo, 2020). Conversely, low self-efficacy correlates with avoidance of technology or superficial use (e.g., substituting analog tools without pedagogical transformation) (Ertmer & Ottenbreit-leftwich, 2010).

2.8. Linking Self-Efficacy to Standard-Based Curriculum

Standard-based curricula emphasize measurable outcomes, requiring teachers to design instruction that aligns with predefined competencies. Integrating technology into this framework demands:

1. **Content-Technology Synergy**: Selecting tools that enhance mastery of the curriculum standards (e.g., simulations for science concepts).
2. **Differentiated Instruction:** Using adaptive software to meet diverse student needs within standardized goals.
3. **Assessment Alignment:** Leveraging technology for formative/summative evaluations tied to curriculum benchmarks.

Self-efficacy influences teachers' confidence in navigating these demands. For example: Teachers with high self-efficacy are more likely to modify technology creatively to address specific standards (using coding platforms to teach mathematical reasoning). Those with low self-efficacy may default to rigid tool use (relying solely on pre-packaged digital worksheets), limiting curricular innovation (Gonzalez et al., 2016).

2.9. Empirical Evidence and Current Debates

Recent studies highlight the interplay between self-efficacy, technology, and curriculum implementation:

Quantitative Findings: A meta-analysis by (Scherer & Teo, 2020) found that self-efficacy explains 34% of the variance in teachers' technology adoption intentions. Teachers in high-stakes standards-based systems (U. S. Common Core) report lower self-efficacy when pressured to use technology for standard test preparation (Gonzalez et al., 2016).

Qualitative Insights: Interviews reveal that teachers with strong self-efficacy view technology as a bridge to student-centered pedagogy while those with weaker efficacy perceive it as a compliance burden (Mckechnie & Wilson, 2020). Collaborative professional development (PD) programs that model technology-curriculum alignment boost efficacy through vicarious learning (Hughes et al., 2021).

2.10. Key Gaps in Literature

1. Most studies focus on K-12 contexts; higher education and vocational training are underrepresented.
2. Few examine how systemic factors (e.g., inequitable resource access) moderate self-efficacy's impact.
3. Limited research connects self-efficacy to equity-driven technology integration (e.g., tools for marginalized learners).

2.11. Theoretical Implication for the study

For a study exploring teachers' experiences and challenges, self-efficacy theory provides a lens to:

1. **Diagnose Barriers**: Identify how low confidence in using specific tools (AI-Driven analytics) hinders alignment with curriculum standards.
2. **Informed Interventions**: Design PD programmes emphasizing mastery experiences (hands-on workshops for curriculum-aligned tech tools)
3. **Contextualize Motivation**: Explore how teachers' efficacy and beliefs intersect with institutional pressures (standardized testing mandates).

3. RESEARCH METHOD

3.1. Research Paradigm

This study is grounded in the pragmatic paradigm**,** which allows for the integration of both quantitative and qualitative methods to gain a comprehensive understanding of teachers' experiences and challenges in integrating technology within the Standards-Based Curriculum.

3.2. Research Approach

It employed the explanatory sequential mixed-method design, where quantitative data was collected and analysed. It was followed by qualitative data collection to explain and confirm the quantitative findings (Creswell & Creswell, 2018).

3.3. Research Design

This study adopted a mixed-methods research design, combining both quantitative and qualitative approaches to gain a comprehensive understanding of Mathematics teachers' experiences and challenges in integrating technology into the Standard-Based Curriculum (SBC) in the North Gonja district of the Savannah Region. The mixed-methods approach allows for a deeper exploration of teachers' perspectives while also providing measurable data to support the findings (Creswell & Creswell, 2018).

3.4. Research Population

The targeted population for this study consisted of all primary school and JHS Mathematics teachers in the North Gonja district in the Savannah Region who are involved in the implementation of the Standard-Based Curriculum. School administrators and educational officers were also included to provide additional perspectives on institutional and policy-related challenges in technology integration.

3.5. Sampling Technique and Sample Size

A stratified random sampling technique was used to select 56 teachers for the quantitative phase, ensuring representation from different schools within the Daboya and Lingbinsi strata of schools. For the qualitative phase, a purposive sampling technique was employed to select participants who have relevant experience in implementing the standards-based curriculum using technology. The sample includes:

- 31 primary and JHS teachers from the Daboya cluster of schools.
- 25 teachers from the Lingbinsi cluster of schools.
- For the qualitative phase, 7 participants, including 3 teachers, 3 headteachers, and a SISO, were interviewed.

3.6. Data Collection Methods

Quantitative Data Collection

A structured questionnaire was administered to the sampled teachers. The questionnaire included Likert-scale and multiple-choice questions focusing on teachers' demographic features such as gender, experience, high qualifications, and technology integration. Data were collected using questionnaires and interviews.

Qualitative Data Collection
Semi-structured interviews were conducted with selected teachers to explore their personal experiences, attitudes, and challenges in greater depth.

3.7. Data Collection Instruments
The study utilized multiple data collection methods to ensure comprehensive findings:
1. **A structured questionnaire** was adopted from (Schmidt et al., 2009) and administered to the sampled teachers. The questionnaire included Likert-scale and multiple-choice questions focused on teachers' experiences, access to technology, frequency of use, and perceived barriers.
2. **Semi-Structured Interviews:** One-on-one interviews were conducted with teachers, school administrators, and education officers to gather detailed information about their experiences and challenges in integrating technology.

3.8. Trustworthiness of the Instruments
In a mixed-methods study, ensuring the trustworthiness of both quantitative and qualitative instruments is crucial for obtaining valid and reliable findings. This section outlines the strategies employed to establish the credibility, reliability, validity, dependability, and conformability of the research instruments used in the study.

3.8.1. Validity and Reliability
The questionnaire was pre-tested with a small sample of teachers to ensure clarity and reliability. The Cronbach's Alpha coefficient was computed to measure the internal consistency of the questionnaire items. A reliability coefficient of 0.7 or higher was considered acceptable.

3.8.2. Credibility, Dependability and Conformability
Triangulation was used by comparing questionnaire data with interviews to enhance the validity of findings. Some of the participants were selected at random to review their transcribed responses to confirm that their views were accurately captured.

3.9. Data Analysis Approach
Quantitative data from the questionnaires were analyzed using descriptive and inferential statistics in SPSS. Frequency distributions, mean scores, and Standard deviation were computed to identify trends and relationships.

Qualitative data from interviews were analyzed using thematic analysis (Clarke & Braun, 2013), where key themes related to technology integration experiences, challenges, and strategies were identified and interpreted. The data were transcribed, coded, and categorized into themes that reflect the key issues identified in the study.

3.10. Ethical Considerations
To ensure ethical compliance, the study adhered to the following principles:

- **Informed consent:** Participants were briefed on the purpose of the study and were provided with written consent before participation.
- **Confidentiality:** Personal information and responses were kept confidential and used solely for research purposes.
- **Voluntary Participation:** Participants were informed of their rights to withdraw from the study at any stage without any consequences.
- **Approval:** Ethical clearance was sought from relevant institutional review boards before commencing data collection.

4. DATA ANALYSIS
4.1. Demographic Information of Teachers
Descriptive statistics were computed using means and standard deviations. The mean value for gender was 1.3393, with a standard deviation of 0.47775. This distribution indicates a predominance of male participants within the sample. The relatively low standard deviation suggests limited variability, implying that the group was fairly homogeneous with respect to gender, with males constituting the majority.

Regarding participants' highest educational qualifications, the mean value was 1.7143, falling between the categories of Diploma Certificate and Bachelor's Degree. This finding indicates that most teachers possess a Diploma Certificate, while a substantial proportion hold Bachelor's Degrees. The low standard deviation further suggests minimal dispersion in educational attainment, with the majority of participants concentrated within the first two qualification categories.

Further analysis examined whether teachers had received training in technology and data integration. The mean value of 1.3929 indicates that most respondents had undergone such training. However, the proximity of the mean to 1.4, together with a standard deviation close to 0.5, suggests that a notable proportion of participants had not received this training.

In terms of teaching experience (Mufidah et al., 2021a), the mean value was 1.75, indicating that most teachers had between zero and ten years of experience. The comparatively higher standard deviation of 1.03133 reflects greater variability in this variable, suggesting that participants ranged widely in experience levels, from early career teachers to more experienced professionals.

Table 1: Descriptive Statistics on Research Questions 1 and 2

Statement	N	Minimum	Maximum	Mean	Std. Deviation
Have you received any training on technology integration in teaching?	56	1.00	2.00	1.3929	0.49281
Limited access to technological devices hinders my ability to integrate technology.	56	1.00	5.00	4.2321	1.11177
Poor internet connectivity affects my use of digital resources in teaching.	56	1.00	5.00	3.9821	1.21343
I lack adequate training on how to integrate technology into Mathematics lessons.	56	1.00	5.00	3.2500	1.39153
The school administration does not provide sufficient support for technology integration.	56	1.00	5.00	3.6250	1.34249
I face difficulty in aligning technology use with Standard-Based Curriculum.	56	1.00	5.00	3.2679	1.22832
Students lack the necessary digital skills to engage effectively with technology-enhanced lessons.	56	1.00	5.00	3.5179	1.48925
Time constraints make it difficult to incorporate technology into lesson planning.	56	1.00	5.00	3.4821	1.26478
Valid N	56				

Source: Researcher's Field Data, 2025

The data presented in Table 1 were analyzed to address Research Questions 1 and 2, with particular emphasis on the extent to which Mathematics teachers in the North Gonja District integrate technology into their instructional practices within the Standard-Based Curriculum.

4.2. Teachers' Proficiency in Using Digital Tools

The analysis of teachers' exposure to training in technology integration yielded a mean score of 1.3929 and a standard deviation of 0.4928. This result indicates that the majority of respondents had received training, while the relatively low standard deviation reflects a high level of consistency in responses. This suggests a clear trend toward participation in professional development related to technology integration(Mawusi et al., 2026).

To assess the relevance of such training to teachers' proficiency in the use of digital tools(Abantas-Emji et al., 2025) for Mathematics instruction, the findings produced a mean score of 3.3393 and a standard deviation of 1.36551. The mean value indicates moderate agreement, suggesting that teachers generally perceive themselves as somewhat proficient in the use of digital tools. However, the relatively high standard deviation points to considerable variability in proficiency levels, with some teachers demonstrating high confidence and others indicating limited competence.

4.3. Frequency of Technology Use to Enhance Lesson Delivery

The frequency with which teachers use technology to enhance lesson delivery yielded a mean score slightly above 3.0, indicating that technology is used occasionally or somewhat frequently in Mathematics instruction. The standard deviation of 1.15193 reflects moderate variability, suggesting differences in the extent of technology use among teachers.

4.4. Comfort in Troubleshooting Basic Technical Issues

The mean score of 2.8750 suggests that many teachers lack confidence in troubleshooting basic technical issues, despite having received training in technology integration. This finding indicates a potential barrier to effective technology use in the classroom. The variability in responses further highlights differences in teachers' technical confidence.

In contrast, teachers reported a mean score of 3.6429 regarding their ability to adjust instructional strategies to incorporate technology. The lower standard deviation of 0.92301 indicates relatively consistent responses, suggesting that most teachers feel confident in adapting their teaching approaches to include technological tools.

4.5. Design of Student-Centered Technology Activities

The ability to design student-centered technology-based activities recorded a mean score of 3.9643 and a standard deviation of 0.93350. This represents the highest rated item, indicating strong agreement that teachers actively engage students through technology-driven, student-centered approaches. The relatively low standard deviation suggests that this practice is widely adopted among respondents.

Similarly, the use of technology to differentiate instruction yielded a mean score of 3.5536 and a standard deviation of 1.12686. These results indicate moderate to high levels of technology use for addressing diverse learning needs, although the slightly higher standard deviation suggests some inconsistency across teachers.

Teachers' understanding of the mathematics curriculum and the role of technology in enhancing learning produced a mean score of 3.7857 and a standard deviation of 1.10724. The relatively high mean reflects general confidence, while the variability indicates differences in the depth of understanding among respondents.

4.6. Use of Technology to Demonstrate Complex Concepts

The use of technology to explain complex mathematical concepts yielded a mean score of 3.3214 and a standard deviation of 1.14586. This indicates a moderate level of agreement, suggesting that teachers feel somewhat capable of using technology for this purpose (Liu, 2013), although levels of confidence vary.

4.7. Selection of Appropriate Technologies Based on Teaching Strategies

The selection of appropriate technological tools in relation to instructional strategies produced a mean score of 3.8393 and a standard deviation of 0.96816. The relatively high mean indicates that most teachers feel confident in aligning technology with their pedagogical approaches. The moderate to low standard deviation reflects a reasonable level of consensus among respondents.

4.8. Use of Subject-Specific Software in Mathematics

The use of subject-specific technological (Bright et al., 2024) tools, such as graphing software and interactive applications, recorded a mean score of 2.8393 and a standard deviation of 1.18746. This relatively low mean suggests limited or inconsistent use of such tools. The higher standard deviation indicates substantial variation, with some teachers using these tools frequently while others rarely or never do so.

4.9. Integration of Technology Aligned with Mathematical Content

Teachers' perceptions of the alignment between technology use and mathematical content yielded a mean score of 3.6607 and a standard deviation of 1.13260. The findings suggest general agreement that technology is meaningfully integrated with subject content, although the variability indicates that some teachers experience challenges in achieving this alignment.

4.10. Effective Combination of Technology, Pedagogy, and Content

The analysis of teachers' ability to integrate technology, pedagogy, and content knowledge in line with the Technological Pedagogical Content Knowledge framework produced a mean score of 3.7500. This indicates that many teachers believe they are effectively combining these elements to support student learning. The relatively low standard deviation suggests broad agreement among respondents.

4.11. Balanced Integration in Lesson Planning

The highest mean score of 4.0357, accompanied by a standard deviation of 0.93350, was recorded for the extent to which lesson plans reflect a balanced integration of teaching methods, technological tools, and mathematical content. This finding indicates a high level of confidence among teachers in their ability to design well-integrated instructional plans, with strong consistency across the sample.

4.12. Relationship Between Training and Use of Subject-Specific Tools

The analysis revealed notable variability in teachers' exposure to technology training, as indicated by the relatively high standard deviation. Furthermore, the low frequency in the use of subject-specific technological tools was attributed to the lack of specialized training within the district. It was therefore established that insufficient subject-specific professional development limits teachers' capacity to effectively utilize discipline-specific tools for technology integration in Mathematics instruction.

Table 2: Summary table

Variable	Mean	Interpretation	Consistency (Std. Dev.)
Tech training received	1.39	Most have received training	High
Selecting tech based on strategy	3.84	Strong Ability	Consistent
Use of subject-specific tools	2.84	Less Frequent use	Highly Varied
Aligning tech with content	3.66	Generally Effective	Moderate Variability
Combining tech, pedagogy & content	3.75	Strong Application of TPACK	Consistent
Balanced lesson plan integration	4.04	Strongest Area	Consistent

Source: *Researcher's Field Data, 2025*

From the analysis above, there was a high standard deviation in having received tech training. The less frequency in the use of subject-specific (Jobri Jovevski, 2023)tools was a result of a lack of subject-specific training in the district. It was therefore established that the lack of subject-specific training hindered their ability to use subject-specific tools to integrate technology (Mawusi et al., 2026) effectively.

4.13. Insights and Interpretation

Strengths

First, teachers generally demonstrate confidence in integrating technology into lesson planning and instructional delivery. Second, there is evidence of a strong understanding and application of technological pedagogical content knowledge principles. Third, most teachers appear to make deliberate and appropriate selections of technological tools, aligning them with instructional strategies and curriculum requirements.

Areas for Development

Despite these strengths, several areas require further attention. The use of subject-specific technological tools remains comparatively low and inconsistent, which may reflect limited familiarity, inadequate access, or insufficient training in mathematics-specific technologies such as simulations, graphing applications, and dynamic geometry software. In addition, while general technology integration is well established, the depth and sophistication of application, particularly in relation to content-specific tools, varies among teachers.

The third research question sought to identify specific challenges influencing the frequency and effectiveness of technology integration among mathematics teachers as stated below:

What are the major challenges that influence the frequency and effectiveness of technology integration among mathematics teachers?

4.14. Barriers to Technology Integration

An analysis of training in relation to barriers to technology integration indicates that, although a majority of respondents reported having received training, a notable proportion had not. The mean score, which is closer to 1, suggests that more than half of the respondents indicated participation in such training.

The findings further identified several significant barriers (McCarty, 2024), such as limited access to technological devices (Johnson et al., 2016), which recorded a high mean score of 4.23, indicating that it constitutes a major obstacle. Poor internet connectivity followed closely with a mean of 3.98, highlighting it as a substantial challenge. Other factors, including lack of training in mathematics-specific technology integration, insufficient administrative support, difficulty aligning technology with the curriculum, students' limited digital skills, and time constraints (Boon & Thompson, 2022), also recorded relatively high mean scores ranging from 3.5 to 4.2. These results suggest that multiple interconnected factors constrain the effective integration of technology in mathematics instruction (Saal et al., 2020).

4.15. Overall Observations

The findings indicate that the most critical barriers to technology integration are limited access to devices and inadequate internet connectivity (McCarty, 2024), both of which were highly rated by respondents. There is also a clear need for more targeted and subject-specific professional development (Mufidah et al., 2021b), particularly in the area of Mathematics instruction. In addition, factors such as administrative support, curriculum alignment, and students' digital readiness present challenges, although perceptions of their impact vary among teachers. Time constraints (Tank et al., 2016)emerge as a common practical concern, likely due to competing instructional demands and tightly structured curricula.

4.16. Qualitative Analysis

The fourth research question sought to examine Mathematics teachers' experiences (Abantas-Emji et al., 2025) in integrating technology into the standards-based curriculum (Antwi, 2025). The qualitative data were collected to complement and validate the quantitative findings, providing deeper insight (Ugwu & Val, 2023)into teachers' perspectives and contextual realities. These experiences were intended to corroborate the statistical results and to further explain patterns observed in the quantitative analysis.

What are the experiences of Mathematics teachers in integrating technology into the Standard-Based Curriculum in the North Gonjga District?

Table 3: Demographic Information

Teachers	Participants	Percentage
Gender		
Male	7	100%
Female	0	0
Years of Experience		
1-5 years	1	14.3%
6-10 years	1	14.3%
11-15 years	3	42.8%
16 years and above	2	28.5%
Highest Qualification		
Diploma	0	0
Bachelor's Degree	0	0
Master's Degree	6	86%
PhD	1	14.3%
	0	0
Area of Study		
Mathematics		
ICT	0	0
Others	3	42.8%
	4	57.1%

Source: *Researcher's field Data, 2025*

The table above presents the demographic characteristics of the participants. A total of seven teachers were interviewed, all of whom were male. This group included three headteachers, one School Improvement Support Officer (SISO), and three (3) JHS teachers. The teaching experience of the participants ranged from three to twenty years, with more than seventy percent (70%) of them having over ten years of teaching experience.

In terms of academic qualifications, eighty-six (86%) percent (86%) of the participants held Bachelor of Education degrees, which qualify them as professional teachers in Ghana. All participants had taught at more than one grade level, indicating a breadth of instructional experience (Mufidah et al., 2021b). With the exception of the headteachers and the school improvement support officer, all participants had implemented the standards-based curriculum for more than one academic year(Antwi, 2025). This suggests that they had acquired sufficient familiarity with the curriculum content and its instructional requirements.

All participants had prior experience teaching both mathematics and information and communication technology, though they were not professionally trained as mathematics teachers (Bonyah & Clark, 2022), which implies a degree of exposure to technological tools (Bright et al., 2024). The School Improvement Support Officer was also a member of the District Teacher Support Team and served as a trainer in the mathematics curriculum. In addition, he facilitated discovery learning programs for learners with special educational needs within the district. Despite these roles, several participants indicated that they had not received formal training as mathematics teachers (Mufidah et al., 2021b)and were assigned to teach the subject due to a shortage of qualified mathematics specialists in the district.

4.17. Technology Integration

The follow-up interview question sought to identify the types of technological tools (Dahal et al., 2022) regularly used by participants in their classrooms. The findings indicate that the primary tools used were personal mobile phones and calculators. Some participants reported occasional use of computers and online platforms such as YouTube. Participants explained that they integrated technology into their lessons by directing learners to online video resources, assigning internet-based tasks, and occasionally using school computers when access was available. However, the extent of integration was largely dependent on the availability of internet data and technological resources(Dahal et al., 2022).

When asked about the factors influencing their choice of technology, participants emphasized accessibility and practicality. For example, some selected YouTube due to the availability of instructional videos, while others relied solely on traditional tools such as the whiteboard due to the absence of computers. The use of personal mobile phones was frequently cited as a necessity resulting from limited institutional resources. Some responses given by respondents in the interview were recorded and transcribed as stated below:

DPPS*: I use a calculator, my phone, and the TM 1 in my teaching.*

DSPS: *When I was in the classroom, I used a calculator and computer to teach before.*

LSPJHS*: I use YouTube.* As the participants stated the types of devices they used, the follow-up question sought to establish how they typically integrate technology into their mathematics lessons.

LSPJHS: *I do integrate technology in my teaching. I guide my learners to go to YouTube to watch video and sometimes too I give them assignments to search for the answers on you tube.*

DPS: *I sometimes use my phone to guide the learner. In my own efforts, when I have data, we use the school's pc to log into net to learn.*
The following question sought to identify the factors that influence their choice of technology.
LSPJHS: *I choose YouTube because there will be a teacher who can give live teachings for the learners to see, unlike Google.*
LPJHS: *Because we don't have computers, I only use the white board.*
LPPS*:* *I use my phone because I don't have a PC.*
The question that followed asked how technology helps address specific learning standards, and the responses of the teachers were recorded as below:
LSPJHS: *Learners can get more understanding and examples to understand. Because I don't integrate technology, I know it addresses it, but I don't have the experience.*
DAJHS*: There will be a greater achievement with integration because the SBC is a practical program.*

A further question was asked: How do they ensure alignment between technology use and curriculum goals? The teachers suggested establishing computer labs to support them in their technology integration. Example: **DSP:** *The district should establish a very good computer lab where they can train teachers on how to use technology tools.* **DPPS:** *Our school is acquiring computers to establish a computer lab. When everything is put in place, we will need a projector to be able to teach and integrate technology.* The respondents recognized the need for subject-specific training that will train them on how to use technology tools to teach learners to align with curriculum intent for effective implementation.

The officer in the interview emphases this curriculum intends by stating the emphasis made in the new curriculum; **SISO:** *The new curriculum has made a lot of provisions for technology integration, but because we don't have the resources, we are not able to utilize the goals well. We need an ICT laboratory where the teachers will be given proper training on how to integrate technology in their teaching.* One of the respondents suggested that provision of technology tools in the schools, as he stated at **LSPJHS:** *Ensuring integration of technology to align curriculum goals depends on the availability of the technology tool. Since the resources are not there, some of us are trying with our phones, which is not easy. If we have at least a projector, it would be easy to align curriculum goals (Antwi, 2025).*

4.18. Challenges and Problem-Solving

The study also inquired about the challenges the teachers faced when integrating technology. In an environment where teachers resorted to using their personal phones to teach, it was obvious that they were faced with some challenges that hindered their use of technology tools. Example, **DDAJHS**: *We lack technology tools in the district, only the TM 1 that some teachers manage.* **SISO**: *The whole district has no ICT lab. Even with the TM 1 laptops they gave to teachers, some can't use them. They are not into technology, so they can't use them.* The responses showed that many of the problems faced by the district is not merely about resource availability but training and usage. **DSPS:** *Some of us were born before computers (illiterates in ICT), so we cannot use technology to teach. Also, the TM 1, some of them are not good.* This confirms the assertion by (Mufidah et al., 2021b)that there is an effect of teacher training on their performance.

The study also wished to find out about the attitudes of parent/learners that affected technology use in the district. Though the findings revealed that the learners get more interested in studying with technology, as stated, **DPPS**: *No, learners are always eager to interact with technology tools, so when you start the lesson, the participation is very active.* Another participant revealed that some parents and their wards remain adamant when technology is used. **DSPS**: *Some of the learners have not interacted with technology tools, and some of their parents don't have them, so even if you give them any work to do using the internet, they won't mind you.* One headmaster revealed how he suggested to parents to purchase tablets for their wards, and the response he had as: **DDAJHS:** *I suggested to parents to buy kids tablets for their wards, and they refused; they said they would spoil their wards. I even explained that those ones do not have SIM cards, but they refused.* Even though some sections of the learners enjoy technology use, the responses revealed that some parents and their wards remain skeptical about it.

Finally, the study sought to know how technology occasionally hindered their ability to meet the curriculum. Teachers admitted that they face some challenges during integration in their lesson delivery.
DMJS: L*ack of technology has hindered the ability to meet the curriculum because most aspect of this curriculum demands technology usage, and since there is no proper integration, our learners lag behind.*
LSPJHS: *Daboya has no stable lighting; there are times we don't have light for so long that I can't even use my phone.*

The responses recorded from the interview above revealed that the problem with technology integration in the district can be classified under training deficits, inadequate technological resources, and attitudes towards technology. Although the purpose of education has changed over time (Gregorious Genelza, 2022), some parents still remain skeptical about technology for fear of exposing their children to foreign behavior that will be difficult to manage.

4.19. Institutional Support and Training

All participants reported having received general training in Information and Communication Technology organized by the Ghana Education Service. However, this training was not subject-specific, though it focused on the integration of technology. Mathematics teachers could not use subject-specific tools because of the limited training. Consequently, no further probing was conducted on this issue.

4.20. Impact on Students' Outcomes

The study also examined the impact of technology integration on learners. Participants indicated that technology generally enhances learner engagement and understanding (Bright et al., 2024). However, some unintended effects (Vázquez-Cano et al., 2022) were noted, such as learners becoming distracted by videos or focusing on the technological tools rather than the instructional content. These effects were considered minimal when proper guidance was provided by the teacher.

4.21. Conclusion

The findings indicate that the North Gonja District faces significant challenges related to both infrastructural limitations and the shortage of qualified Mathematics teachers. None of the teachers interviewed had formal training in Mathematics education, and they were assigned to teach the subject due to the absence of specialists.

Although some teachers demonstrated the ability to integrate technology into their instruction, this was largely dependent on individual initiative and prior exposure to Information and Communication Technology. The lack of subject-specific training limits the development of Technological Pedagogical Content Knowledge required for effective integration. Though studies revealed that there is no perfect method in the classroom when it comes to education (Vidal, 2022), a universal subject-specific training in the district could motivate integration, encourage participation, and improve implementation to meet the 21st-century goals.

Also, though the respondents agreed that technology integration enhances understanding and promotes active classroom participation (Bright et al., 2024), the study revealed that some parents and learners had negative attitudes towards technology and its usage.

The study further highlights the critical role of infrastructure, including access to computers, reliable internet, and stable electricity, in supporting technology integration. Without these resources, even well-designed curricula that emphasize technological competencies cannot be effectively implemented.

5. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

5.1. Findings

First, the extent of technology integration among teachers is moderate. While most teachers have received general Information and Communication Technology training, it does not address subject-specific applications in mathematics. Teachers demonstrate moderate to high levels of integration in lesson planning and delivery, but the use of subject-specific tools remains limited.

Second, teachers generally report confidence in designing learner-centered activities and aligning technology with curriculum objectives. However, their technical proficiency varies, particularly in relation to troubleshooting technical issues.

Third, several barriers hinder effective technology integration. These include limited access to devices, poor internet connectivity, time constraints, and the lack of subject-specific training. Qualitative findings further highlight the absence of information and communication technology laboratories, unreliable electricity supply, and reliance on personal devices.

Fourth, teacher self-efficacy influences the extent of technology integration. Teachers with prior information and communication technology experience demonstrate greater adaptability and innovation, whereas those with lower confidence are less likely to integrate technology.

Fifth, institutional and community support is limited. Training provided by the Ghana Education Service is general rather than subject-specific, and some parents are reluctant to support the use of digital tools.

Finally, technology integration has a positive impact on learners' engagement and understanding. However, inconsistent use limits the full realization of the learner-centered objectives of the standard-based curriculum.

6. CONTRIBUTION OF THE STUDY

6.1. Contribution to Literature

The study contributes empirical evidence on technology integration within a largely underrepresented educational context in a rural district in the Savannah Region of Ghana. While existing scholarship on technology integration in Ghanaian education has predominantly focused on urban and peri-urban settings, this study provides primary data specific to the North Gonja District, thereby filling a notable geographical and contextual gap in the literature.

6.2. Contribution to Methodology

The application of an explanatory sequential mixed-method design offers a methodological contribution by demonstrating how quantitative findings on technology integration patterns can be systematically complemented and enriched by qualitative insights into teachers' lived experiences. This approach affords a more nuanced and triangulated understanding of the barriers and enablers of technology integration than single-method studies permit.

6.3. Contribution to Educational Practice

The study identifies a specific and actionable finding: the absence of Mathematics-specific digital pedagogy training, rather than general ICT exposure, is the primary determinant of low subject-specific technology use. This contribution directs professional development designers and curriculum authorities toward precision-targeted interventions rather than broad-based ICT training programs.

6.4. Contribution to Policy Development

By systematically documenting the infrastructural, institutional, and attitudinal barriers faced by Mathematics teachers in the North Gonja District, the study furnishes policymakers with evidence-based recommendations. These include the prioritization of ICT laboratory development, the expansion of subject-specific teacher training programs, and the strengthening of community engagement strategies for all calibrated to the realities of resource-constrained rural educational settings.

6.5. Contribution to the Advancement of 21st-Century Education in Ghana

The study contributes to the broader national agenda of equipping learners with 21st-century competencies as envisioned by the Standard-Based Curriculum. By identifying and addressing the conditions that constrain effective technology integration, the research supports the realization of digital equity in education and the development of critical thinking, problem-solving, and digital literacy among learners in underserved communities.

7. IMPLICATIONS OF THE STUDY

7.1. Theoretical Implications

The study reinforces the applicability of the Technological Pedagogical Content Knowledge (TPACK) framework in resource-constrained rural educational contexts. The findings demonstrate that TPACK deficiencies, particularly the absence of subject-specific technological knowledge, constitute a structural impediment to meaningful technology integration in Mathematics instruction. Furthermore, the study substantiates Bandura's (1977) Self-Efficacy Theory by confirming that teachers' confidence in their technological competencies directly mediates the frequency and quality of technology adoption within standards-based instructional environments. These findings extend existing theoretical discourse by situating TPACK and self-efficacy within the specific realities of sub-Saharan African educational reform.

7.2. Practical Implications

The study carries significant implications for instructional practice. Mathematics teachers in rural districts must be supported through targeted, discipline-specific professional development that moves beyond general ICT literacy to encompass pedagogically aligned digital tool usage. The evidence that teachers default to personal mobile devices and informal platforms (e.g., YouTube) in the absence of institutional resources underscores the need for structured, curriculum-aligned alternatives. Teachers' moderate-to-high confidence in lesson planning integration contrasted with their limited proficiency in subject-specific tools, which suggests that practical and contextualized training interventions would yield measurable improvements in instructional quality.

7.3. Policy Implications

The findings reveal a systemic misalignment between the aspirations of the Standard-Based Curriculum and the material conditions within which it is implemented. Policymakers must acknowledge that curriculum mandates requiring technology integration cannot be fulfilled in the absence of adequate infrastructure, including reliable electricity, functional ICT laboratories, and consistent internet access. The distribution of TM1 laptops without accompanying subject-specific training exemplifies the insufficiency of hardware-only interventions. Policy frameworks must therefore integrate infrastructure provision with structured capacity-building initiatives and sustained institutional support mechanisms.

7.4. Social and Community Implications

The study highlights that parental attitudes constitute a non-trivial barrier to technology-enhanced learning. Community-level resistance to digital tools rooted in unfamiliarity and cultural skepticism limits students' engagement with technology beyond the classroom. This finding implies the necessity of targeted community sensitization programs designed to promote digital literacy awareness and align parental perspectives with the goals of the Standard-Based Curriculum.

8. CONCLUSION

The study concludes that mathematics teachers in the North Gonja District exhibit a strong willingness to integrate technology into their instructional practices under the standard-based curriculum. However, systemic challenges, including inadequate infrastructure, limited subject-specific training, and insufficient stakeholder support, significantly constrain effective implementation.

Teacher self-efficacy plays a critical role in determining the extent of technology integration, influencing whether teachers adapt available tools or refrain from their use. Although some level of integration occurs through the use of personal devices and online resources, there remains a substantial gap in structured and curriculum-aligned technology use. Addressing these challenges is essential for improving educational quality, promoting equity, and fostering the development of twenty-first-century skills among learners.

8.1. Recommendations

It is recommended that subject-specific professional development programs be expanded to focus on the integration of technology into mathematics instruction. Schools should be equipped with adequate infrastructure, including reliable electricity, internet access, and functional information and communication technology laboratories.

Efforts should also be made to enhance teacher self-efficacy through mentorship programs, collaborative learning communities, and demonstration lessons. The development of accessible digital resource banks aligned with the standard-based curriculum would further support teachers in resource-constrained settings.

In addition, initiatives to engage parents and communities should be implemented to promote awareness of the educational value of technology. Policymakers and educational authorities should provide stronger institutional support through monitoring, funding, and incentives for effective technology integration.

Finally, partnerships with non-governmental organizations and technology providers should be strengthened to improve access to digital tools, connectivity, and training opportunities in underserved districts.

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