

Teachers' familiarity with improvisation techniques in science education: Insights from the Zabzugu District, Ghana

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ABSTRACT

This study examines primary school teachers' proficiency in utilising improvisation techniques for science education in the Zabzugu District of Ghana. In resource-constrained environments, improvisation is a crucial strategy to enhance the quality of science education. This research is grounded in two fundamental theoretical frameworks: Constructivist Learning Theory and Pedagogical Content Knowledge (PCK). Using a descriptive survey design, with a target population of 298, data were collected from 196 primary school teachers across seven circuits in the Zabzugu District through stratified sampling. We analysed the data using SPSS version 25, employing descriptive and inferential statistical techniques to address the study's objectives. The study found that teachers generally demonstrate high familiarity with and enthusiasm for improvisation techniques. However, challenges persist, including limited access to training workshops and resources on improvisation. A positive correlation ($r = .376$, $p < .001$, $N = 196$) was found between teachers' familiarity with improvisation techniques and the challenges they face during implementation, suggesting that as teachers become more knowledgeable, they also become more aware of the complexities involved. The findings highlight the potential of improvisation to bridge resource gaps in science education and underscore the need for enhanced teacher training and support in this area. This research contributes to understanding how improvisation techniques can be leveraged to improve science education in resource-limited settings, with implications for educational policy and practice in Ghana and similar contexts globally. This study concludes that the teachers have proficiency and enthusiasm for improvisation in science education. However, enduring challenges require continuous professional development, enhanced access to resources, and focused support from policymakers to elevate teaching quality in resource-limited settings. Recommendations include practical training, collaborative learning, curriculum integration, and gender equity in resource allocation.

Keywords: Improvisation Techniques, Primary Schools, Resource-Constrained Environments, Science Education, Zabzugu District of Ghana

I. INTRODUCTION

As a foundation for technological progress and economic expansion, science education is essential for Ghana's national development. The Ghanaian government has recently acknowledged the significance of science, technology, engineering, and mathematics (STEM) education, enacting multiple efforts to improve its quality and accessibility (Aina & Keith, 2015). The provision of effective science education encounters considerable obstacles, especially in rural regions where resources are frequently limited (Arkorful et al., 2020). In this scenario, teachers play a crucial role in addressing these challenges through improvisation in teaching. Improvisation entails the inventive utilisation of locally accessible materials and novel pedagogical techniques to address resource constraints (Okori & Jerry, 2017). This methodology is especially pertinent in contexts like the Zabzugu District in northern Ghana, where educational institutions often need essential laboratory apparatus and instructional materials (Graham, 2022). The Zabzugu District in Ghana's Northern Region illustrates the resource limitations encountered by numerous rural educational environments nationwide. Primary schools in this district frequently function with inadequate infrastructure and restricted access to traditional science instructional resources (Quansah et al., 2019). These circumstances require inventive strategies from teachers to guarantee that students obtain quality science education despite the absence of institutional resources.

This study examines primary school teachers' awareness in the Zabzugu District regarding improvisation strategies in scientific education. This study investigates teachers' knowledge, attitudes, and practices concerning

improvisation to elucidate its potential to mitigate resource disparities and improve the quality of science education in rural Ghana (Eshun et al., 2018). Comprehending teachers' improvisation skills is essential for formulating specific interventions and support systems to enhance scientific instruction in resource-limited settings (Akyeampong & Rolleston, 2013). The Zabzugu District in the Northern Region of Ghana illustrates the difficulties encountered by numerous rural educational environments in developing nations. The district's primary schools are characterised by inadequate infrastructure and minimal resources, typically under considerable restraints (Graham, 2022). The region is primarily rural, with numerous schools needing more fundamental infrastructure and instructional resources vital for efficient science education. This situation requires teachers to play a vital role in guaranteeing that students obtain quality science education despite the scarcity of traditional resources (Quansah et al., 2019). Improvisation is essential in science education, especially in resource-limited settings such as Zabzugu District. It entails inventing locally sourced materials and novel pedagogical techniques to address deficiencies in conventional laboratory apparatus and instructional resources (Okori & Jerry, 2017). In science education, improvisation allows teachers to deliver experiential learning opportunities, rendering abstract topics more concrete and comprehensible for students. This method not only fulfils the urgent requirement for educational materials but also cultivates creativity and problem-solving abilities in teachers and students (Eshun et al., 2018).

1.1 Statement of the Problem

The significance of science education in Ghana's national development is well recognized, as it plays a critical role in fostering technological advancement and economic growth (Aina & Keith, 2015). However, primary school teachers in rural regions, such as the Zabzugu District, face substantial challenges in delivering effective science instruction. These challenges are primarily rooted in resource limitations, which hinder students' quality of education. Research indicates that inadequate access to teaching materials, insufficient infrastructure, and a lack of training opportunities severely impact teachers' ability to provide comprehensive science education (Quansah et al., 2019; Graham, 2022).

In this context, improvisation techniques emerge as a beacon of hope, a vital strategy for overcoming these obstacles. Improvisation allows teachers to utilise locally available resources creatively, thus enhancing the teaching and learning experience despite the scarcity of traditional materials. However, the extent to which primary school teachers in the Zabzugu District are familiar with and capable of employing these improvisation techniques remains inadequately explored (Eshun et al., 2018). Understanding teachers' competencies in this area is crucial, as their ability to effectively implement improvisation can significantly influence students' engagement and comprehension of scientific concepts.

This study aims to address this critical knowledge gap by investigating the proficiency of primary school teachers in the Zabzugu District in utilising improvisation techniques for science education. By examining their familiarity with these strategies, the research will shed light on both the potential benefits and barriers teachers face in resource-constrained settings (Nii Akai Nettey et al., 2024). The findings of this study are not just informative, but they are crucial for the future of science education in rural Ghana.

The findings of this study are expected to provide valuable insights that will inform the development of targeted interventions and support systems essential for enhancing science instruction in the region. Such interventions could include professional development programs focused on improvisation techniques, resource allocation strategies, and collaborative networks among teachers. Addressing these needs is not just important, it is urgent for improving the quality of science education in rural Ghana and ensuring that students receive a robust educational foundation that equips them for future challenges (Akyeampong & Rolleston, 2013; Darling-Hammond, 2010).

1.2 Research Questions

- i. What is the extent of teachers' familiarity with the procedures for utilising improvisational skills to teach?
- ii. What challenges do teachers face when implementing the procedures involved in improvisation skills when teaching Science?
- iii. What is the relationship between teachers' familiarity with the procedures involved and the challenges they face during implementation?

II. LITERATURE REVIEW

2.1 Theoretical Framework

This research is grounded in two fundamental theoretical frameworks: Constructivist Learning Theory and Pedagogical Content Knowledge (PCK). These frameworks provide essential insights into the dynamics of teaching and learning, particularly in resource-constrained environments like the Zabzugu District of Ghana.

Constructivist Learning Theory emphasizes the active role of learners in constructing their understanding and knowledge of the world through experiences. Influential theorists such as Piaget (2013) and Vygotsky (1978) contributed significantly to this theory. Piaget posited that learners progress through stages of cognitive development, indicating that education should be tailored to the student's developmental stage. Vygotsky introduced the concept of the Zone of Proximal Development (ZPD), highlighting the importance of social interaction and cultural context in learning. This framework supports the idea that improvisation in teaching can help bridge gaps in understanding, allowing teachers to utilize locally available resources to create meaningful learning experiences. By fostering an environment where students actively engage and collaborate, teachers can enhance their students' comprehension of scientific concepts, making abstract ideas more concrete.

Pedagogical Content Knowledge (PCK), developed by Shulman (1987), integrates subject matter knowledge with pedagogical skills. PCK underscores the importance of effectively teaching specific content, which is crucial for teachers in resource-limited settings. It emphasizes that teachers must not only understand the science they teach but also how to convey that knowledge in ways that are accessible and engaging for students. This framework is particularly relevant in improvisation, as it equips teachers with the strategies necessary to adapt their teaching methods to overcome challenges posed by limited resources. For instance, teachers proficient in PCK can creatively incorporate improvisational techniques to teach complex scientific concepts using everyday materials, thus enhancing students' learning experiences.

Together, these frameworks not only shed light on the critical role of improvisation in science education, especially in settings where traditional resources are scarce, but also provide practical guidance. They underscore the need for teachers to be versatile and innovative as they navigate the complexities of teaching science in such environments. By understanding and applying these theoretical perspectives, teachers can develop more effective strategies to engage students, promote experiential learning, and ultimately improve educational outcomes.

2.1.1 Alignment with the Study

The study's emphasis on improvisation strategies in science teaching strongly corresponds with the theoretical frameworks of Constructivist Learning Theory and Pedagogical Content Knowledge (PCK), underscoring the importance of its findings to the field of education. Assessing teachers' knowledge and applying improvisation techniques, which involve adapting teaching methods on the spot to address specific learning needs, demonstrates constructivist principles of active, experiential learning, emphasising that students construct their understanding through hands-on experiences (Eshun et al., 2018). This aligns with the notion that effective learning occurs when students engage actively with content, particularly in resource-constrained environments where traditional resources may be lacking.

Examining obstacles teachers encounter in applying improvisation strategies pertains to pedagogical content knowledge, as it encompasses the practical utilisation of subject expertise within limited instructional contexts (Akyeampong, 2017). This framework highlights the necessity for teachers to understand the science they teach and adapt their teaching methods to convey that knowledge in an effective and accessible way. In our study, this adaptability is critical, as teachers must navigate the complexities of improvisation while also addressing the specific needs of their students.

Furthermore, the positive correlation between teachers' familiarity with improvisation and their challenges is consistent with both theories. This indicates that as teachers enhance their pedagogical content knowledge (PCK), they engage with more intricate applications of constructivist learning principles (Frykholm & Glasson, 2005; Hofstein & Mamlok-Naaman, 2007). The finding suggests that increased familiarity improves teaching efficacy and highlights the complexities teachers must navigate in their practice. As teachers become more adept at improvisation, they may also become more aware of the challenges inherent in implementing these techniques effectively.

The study also recommends professional development and resource accessibility to boost teachers' capacity to establish constructivist learning environments by improving pedagogical content knowledge (PCK) (Abakah et al., 2022). By focusing on these areas, the research aligns with the theoretical underpinnings of both frameworks, advocating for a holistic approach to teacher training that integrates improvisation techniques. This approach is essential for enhancing the overall quality of science education in resource-constrained settings.

2.2 Empirical Review

2.2.1 The Extent of Teachers' Familiarity with Improvisation Techniques and Their Application in Teaching Science

A literature review underscores the widespread recognition of improvisation as a potent strategy in science education within resource-limited settings globally. For instance, Adeoye (2019) discovered that improvisation significantly boosted pupils' engagement and comprehension of scientific concepts in rural schools in Nigeria. This finding not only highlights the potential of improvisation to create more engaging learning environments but also

inspires teachers to enhance student understanding. In the Ghanaian context, Abakah et al. (2022) stressed the indispensability of improvisation in science education, particularly for rural schools. Their study revealed that teachers' ability to improvise could significantly enhance the quality of science instruction in resource-poor settings, indicating a strong familiarity among teachers with improvisational strategies. Furthermore, Yeboah et al. (2019) explored interactive instructional resources in Ghanaian primary schools, finding that locally sourced, improvised materials could make science education more practical and engaging. These studies collectively demonstrate that teachers' familiarity with improvisation techniques is present and effectively applied to improve science education outcomes.

2.2.2 The Challenges Teachers Face When Implementing Improvisation Techniques in Science Education

Despite the advantages of improvisation, implementing these techniques is fraught with challenges. Boakye and Ampiah (2017) identified several obstacles faced by science teachers in Ghana, including a lack of training, time constraints, and limited support from school administration. These challenges underscore the need for a comprehensive understanding of teachers' proficiency in utilising improvisation techniques, particularly in districts like Zabzugu, where the need for such approaches is most acute. Teachers often struggle to integrate improvisation into their lessons due to insufficient professional development opportunities that could enhance their skills. This lack of training can hinder their confidence and effectiveness in applying improvisational strategies, ultimately impacting student learning. Additionally, logistical challenges, such as inadequate access to materials and resources, further complicate the implementation process. It is essential to address these barriers to fully harness the potential of improvisation in science education.

2.2.3 The Relationship between Teachers' Familiarity with Improvisation Techniques and the Challenges They Encounter During Implementation

The relationship between teachers' familiarity with improvisation techniques and their challenges during implementation is an area of critical investigation. The studies by Amponsah et al. (2024a, 2024b) reveal that emotional intelligence, learning styles, and self-efficacy significantly influence academic performance and teaching effectiveness. As teachers become more familiar with improvisational techniques, they may also become more aware of the complexities involved in their application. The positive correlation between familiarity and the identification of challenges is a significant finding that underscores the importance of research in understanding the dynamics of educational quality. This dynamic reflects the intricate interactions of factors influencing educational quality and underscores the urgent need for context-specific measures in Ghana's education system. By understanding these relationships, stakeholders can develop targeted interventions that improve teachers' improvisation skills and provide the necessary support to navigate the challenges that arise in resource-limited environments.

III. METHODOLOGY

3.1 Research Design and Approach

This study employed a descriptive survey research design, which is handy for collecting data on attitudes, experiences, and behaviours from a large population (Cohen et al., 2018). This approach was deemed appropriate for investigating teachers' proficiency in utilising improvisation techniques, as it allowed for gathering quantifiable data and insights into specific challenges within the Zabzugu District's educational framework.

3.2 Sampling Strategy

The study population comprised 298 science teachers from seven circuits within the Zabzugu District, encompassing primary schools (Graham, 2022). The study employed Krejcie and Morgan's (1970) sample size determination table to ensure a representative sample, resulting in a calculated sample of 196 teachers. Considering the number of schools, this sample was distributed across the seven circuits in the district. We utilised a simple random sampling method, ensuring every teacher within the circuits had an equal chance of being selected, thus maintaining a high level of fairness and minimising bias (Creswell, 2014). The final sample comprised 196 teachers, including 167 males (85.2%) and 29 females (14.8%). The sample spanned various age groups, with 38.8% aged 30 years or below, 34.2% between 31-40 years, and 27.0% between 41-50 years.

3.3 Data collection

We collected data through a self-administered questionnaire, a method chosen for its efficiency in collecting large amounts of data within a short period (Cohen et al., 2018). We structured the questionnaire into sections covering demographics, familiarity with improvisation, implementation challenges, and perceptions of effectiveness. It utilised a Likert scale, allowing respondents to indicate their agreement or disagreement with specific statements. To ensure

the validity and reliability of the research instrument, the questionnaire underwent a rigorous development process. Content validity was established through review by subject experts in science education, who provided feedback on the appropriateness and clarity of the items, ensuring that the questionnaire accurately measures the intended constructs. Furthermore, the questionnaire was pretested with 20 teachers from a neighbouring district, allowing modifications to improve clarity and ensure effective data capture (Creswell, 2014).

3.4 Data Analysis

We assessed the instrument's reliability using Cronbach's alpha, yielding a coefficient of 0.78, which is considered acceptable for social science research (Tavakol & Dennick, 2011). This high reliability coefficient indicates that the instrument had a consistent internal structure and would produce stable results if used repeatedly under similar conditions, thereby enhancing the trustworthiness of the study's findings. We analysed the data using SPSS version 25, employing descriptive and inferential statistical techniques to address the study's objectives. These included descriptive statistics to quantify familiarity and challenges and Pearson correlation to assess relationships.

3.5 Ethical Considerations.

Ethical concerns were of the utmost importance during the research process. Participants were informed about the study's purpose and assured that their identities and personal information would be kept confidential. Before collecting data, the researchers obtained informed consent from the teachers, ensuring that they were not forced to participate in the study. The study adhered to ethical guidelines to ensure that the rights and well-being of all participants were protected.

IV. FINDINGS & DISCUSSION

4.1 Findings

The study's findings provide valuable insights into primary school teachers' familiarity with and utilisation of improvisation techniques in science education within the Zabzugu District, a region known for its unique challenges and opportunities in science education. The results are presented in alignment with the research objectives, focusing on teachers' familiarity with improvisation, their challenges in implementation, and areas of concern. We tackled this familiarity in the three research questions composed for the study.

4.1.1 The Extent of Teachers' Familiarity with Improvisation Techniques and their Application in Teaching Science

This sought to analyse the extent of teachers' familiarity with the procedures for utilising improvisational skills to teach Science in the Zabzugu District. In essence, it looked at the level of awareness, enthusiasm, and practical application of improvisation techniques among primary school teachers. In answering this question, we asked teachers in the Zabzugu District to respond to statements regarding their knowledge, attitudes, and practices related to improvisation in science teaching. Responses ranged from 1- Strongly Disagree, 2-Disagree, 3-Undecided, 4- Agree, 5- Strongly Agree. We interpreted the mean scores as follows: 4.51-5.00 (Strongly Agree), 3.51-4.50 (Agree), 2.51-3.50 (Undecided), 1.51-2.50 (Disagree), and 1.0-1.50 (Strongly Disagree).

Table 1

Teachers' Familiarity with the Procedures for Utilising Improvisational Skills to Teach

S/N	Statement	Mean	SD	Descriptor
1.	I am enthusiastic about improvisation skills.	4.17	.685	4
2.	I often use improvisation skills to teach science subjects.	3.98	.997	4
3.	I have taught several science topics using improved materials.	3.91	1.122	4
4.	The improvisation of primary materials can be an alternative to teaching and learning science.	4.55	.529	5
5.	I encourage students to improvise	4.33	.543	4
6.	I'm aware of the quality of improvisation skills to be used for teaching and learning science	4.29	.632	4
7.	I have attended several improvisation skills workshops since I started my teaching career.	2.96	1.458	3
8.	I have access to several books on improvisation skills.	3.26	1.284	3

Average Mean: 3.932

Average Mean of Standard Deviation: 0.5704

Table 1 presents the results of teachers' responses regarding their familiarity with improvisation skills in teaching science. The overall mean score of 3.932 (SD = 0.5704) indicates that teachers in the Zabzugu District generally have a high familiarity with improvisation techniques. Teachers reported the highest level of awareness that improvisation of primary materials can be used as an alternative for teaching and learning science (M = 4.55, SD = 0.529). This suggests that teachers recognise the potential of improvisation as a pedagogical strategy and are inspired by its innovative approach, which aligns with findings from Eshun et al. (2018) on the importance of improvisation in resource-constrained educational settings. Encouragingly, teachers also reported high enthusiasm about improvisation skills (M = 4.17, SD = 0.685) and frequently encouraged students to improvise (M = 4.33, SD = 0.543). This positive attitude towards improvisation is crucial for its effective classroom implementation, as Ogunniyi (2013) noted in his study on science education in Africa.

However, the data reveal some areas of concern. Teachers reported lower scores for attending improvisation skills workshops (M = 2.96, SD = 1.458) and accessing sources of books on improvisation skills (M = 3.26, SD = 1.284). These findings suggest a gap in professional development opportunities and resource availability, which could hinder teachers' ability to utilise improvisation techniques fully. This aligns with Akyeampong and Rolleston's (2013) observations on the challenges of teacher preparation in Ghana. The relatively high standard deviations for these items also indicate a wide variation in teachers' experiences with training and resources. This disparity could lead to inconsistent application of improvisation techniques across different classrooms and schools in the district.

Despite these challenges, teachers reported frequently using improvisation skills to teach science subjects (M = 3.98, SD = 0.997) and teaching several science topics with improvised materials (M = 3.91, SD = 1.122). This suggests that teachers incorporate improvisation into their teaching practice, even with limited formal training and resources. However, it also underscores the clear need for more structured professional development and improved access to resources. Addressing these gaps could significantly enhance teachers' proficiency in utilising improvisation techniques, potentially leading to improved science education outcomes in the district.

4.1.2 The Challenges Teachers Face when Implementing Improvisation Techniques in Science Education

This study was conducted to identify and analyse the challenges faced by teachers in the Zabzugu District when implementing improvisation techniques in science education. The understanding of these challenges is not only crucial but also the first step towards developing effective strategies to support teachers in improvisation. Teachers were asked to rate various potential challenges on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree) to address this question. We interpreted the mean scores as follows: 4.51-5.00 (Strongly Agree), 3.51-4.50 (Agree), 2.51-3.50 (Undecided), 1.51-2.50 (Disagree), and 1.0-1.50 (Strongly Disagree).

Table 2

Challenges Teachers Face when Implementing the Procedures involved in Improvisation Skills when Teaching Science

S/N	Statement	Mean	SD	Descriptor
1.	We have limited time planning for practical projects.	4.43	.648	4
2.	Lack of proper funding for teaching materials.	4.54	.733	5
3.	Issues of a large class	4.34	.702	4
4.	Insufficient teaching materials.	4.34	.906	4
5.	Students' reluctance in adopting improvisation skills.	3.64	1.116	4
6.	Poor academic performance of students while using improvisation skills.	3.07	1.411	3
7.	Students' inability to understand improvisation skills.	3.49	1.222	3

Average Mean: 3.979

Average Mean of Standard Deviation: 0.5610

Table 2 presents the outcomes of teachers' feedback on the hurdles they face in incorporating improvisation skills into science instruction. The average score of 3.979 (SD = 0.5610) indicates that teachers often grapple with significant issues when applying improvisation methods. The most pressing concern, as identified by teachers, is the dire need for sufficient funds for instructional materials (M = 4.54, SD = 0.733), a 'Very High' Categorisation. This finding aligns with previous research by Eshun et al. (2018), which highlighted resource constraints as a major barrier to effective science education in rural Ghana. The limited time for planning practical projects emerged as the second most critical challenge (M = 4.43, SD = 0.648), also classified as 'Very High.' This underscores the urgency for teachers to receive support in managing the time-consuming nature of improvisation alongside their regular teaching responsibilities, a challenge underscored by Ayot (2013) in his research on instructional techniques in East Africa.

Challenges related to large class sizes (M = 4.34, SD = 0.702) and insufficient instructional resources (M = 4.34, SD = 0.906) were rated as 'High.' These findings underscore the significant infrastructure and resource limitations faced by schools in the Zabzugu District, as highlighted by Akyeampong and Rolleston (2013) in their study on educational access and quality in Ghana. Notably, student engagement and performance issues received

lower ratings than resource and preparation challenges. Students' reluctance to acquire improvisation skills ($M = 3.64$, $SD = 1.116$) was classified as a 'High' challenge, but poor academic performance ($M = 3.07$, $SD = 1.411$) and students' struggle to grasp improvisation skills ($M = 3.49$, $SD = 1.222$) were categorized as 'Moderate' problems. The high standard deviations for these items indicate a wide range of experiences among instructors when dealing with student-related issues, underscoring the urgent need to address these resource constraints for improved student performance.

The data suggests that the primary challenges teachers face in implementing improvisation methods are institutional and resource-based, rather than pedagogical or student-centered. To address these issues, it is crucial that interventions at the governmental and administrative levels are implemented. These interventions are likely to be necessary to enhance funding, resource allocation, and time management for scientific education in the Zabzugu District. These findings provide significant insights for educational policymakers and administrators who are committed to improving the effectiveness of science instruction through improvisational strategies in resource-limited environments. Their role in implementing these interventions is crucial and cannot be overstated.

4.1.3 The Relationship between Teachers' Familiarity with Improvisation Techniques and the Challenges they Encounter during Implementation

This study investigated the potential connection between teachers' familiarity with improvisation techniques and the challenges they face when implementing them in science education. Understanding this relationship is crucial for developing targeted interventions and support strategies for teachers. To address this question, a Pearson correlation analysis was conducted between the variables of familiarity and challenges. Table 3 presents the results of the Pearson correlation analysis between teachers' familiarity with improvisation procedures and the challenges they face during implementation. The analysis reveals a statistically significant positive correlation between familiarity and challenges ($r = .376$, $p < .001$, $N = 196$), highlighting the practical implications of these findings for science education and teacher training.

Table 3

Pearson's Correlation between Familiarity and Challenges

Variable	Analysis	Familiarity	Challenges
Familiarity	Pearson Correlation	1	.376
	Sig. (2-tailed)		.000
	N	196	196
Challenges	Pearson Correlation	.376	1
	Sig. (2-tailed)	.000	
	N	196	196
	N	230	

This moderate positive correlation suggests that as teachers' familiarity with improvisation techniques increases, they also report more challenges. This finding aligns with research by Eshiet (2014), who found that teachers with excellent knowledge of improvisation techniques were more likely to identify and report challenges in their implementation. However, this contrasts with Olagunju and Babajide's (2011) study, which suggested that increased familiarity led to fewer perceived challenges. The positive correlation between familiarity and challenges can be interpreted through several lenses. Hofstein and Mamlok-Naaman (2007) noted that increased familiarity often leads to greater awareness of potential challenges in science teaching. As teachers become more adept at improvisation, they may attempt more complex applications, encountering a more comprehensive range of challenges, as Frykholm and Glasson (2005) observed. Akyeampong (2017) highlighted how contextual factors, such as resource constraints, become more apparent as teachers implement their knowledge of improvisation techniques. Furthermore, Loughran (2010) described how more familiar teachers critically reflect on their practice, potentially leading to a higher recognition of challenges. These perspectives collectively suggest that the relationship between familiarity and perceived challenges is multifaceted, reflecting increased competence and a more nuanced understanding of the complexities of implementing improvisation techniques in science education. This emphasis on the multifaceted nature of the relationship should intrigue teachers, researchers, and policymakers about the complexity of the issue.

The strength of the correlation ($r = .376$) indicates a moderate relationship, suggesting that while familiarity and challenges are related, other factors also play significant roles in determining the challenges teachers face. This is consistent with the multifaceted nature of educational challenges described by Darling-Hammond (2010) in her work on educational equity. These findings have important implications for teacher training and support programmes. They suggest that more than simply increasing teachers' familiarity with improvisation techniques may be required to reduce the challenges they face, a conclusion also reached by Adu-Gyamfi et al. (2016) in their study on improvisation in Ghanaian science education. Instead, a more comprehensive approach may be needed, addressing both knowledge

of improvisation and strategies for overcoming implementation challenges. In conclusion, the positive correlation between familiarity and challenges highlights the complex nature of implementing improvisation techniques in science education. It underscores the need for ongoing support and professional development that not only enhances teachers' knowledge of improvisation but also equips them with strategies to navigate the challenges they are likely to encounter as they apply these techniques in their classrooms. This emphasis on ongoing support should reassure teachers, researchers, and policymakers about the potential solutions to the challenges, a recommendation echoed by Okebukola and Jegede (2016) in their research on improvisation in Ghanaian schools.

4.2 Discussion

The findings of this study offer significant insights into the state of improvisation in science education within the Zabzugu District, revealing both encouraging trends and areas requiring attention.

The findings reveal a high level of familiarity and enthusiasm amongst teachers regarding improvisation techniques in the Zabzugu District. With an overall mean familiarity score of 3.932 out of 5, teachers demonstrate a strong awareness of improvisation as a viable teaching strategy. This aligns with Eshun et al.'s (2018) findings on teachers' adaptability in deprived areas of Ghana, where they found similar levels of familiarity and enthusiasm. Similarly, Okebukola and Jegede (2016) found that teachers in resource-constrained environments often display a high awareness of improvisation as a necessary skill, a finding that resonates with our research. The exceptionally high score (4.55) for recognising improvisation as an alternative for teaching science suggests teachers are cognisant of its potential to bridge resource gaps. This recognition aligns with Asano et al. (2021) assertion that improvisation is crucial for effective science education in rural Ghanaian schools. Teacher enthusiasm (mean score 4.17) is especially promising, indicating a positive attitude towards innovative teaching methods. As Akyeampong (2017) notes, teacher motivation is key in adopting new pedagogical approaches. This enthusiasm contrasts with findings by Adewara and Lawal (2015), who reported lower enthusiasm levels among teachers in some Nigerian schools, possibly due to contextual differences. The high frequency of using improvisation (mean 3.98) further suggests teachers are actively applying their knowledge in the classroom, consistent with Asano et al. (2021) and Yeboah et al.'s (2019) observations in other Ghanaian primary and junior high schools.

Despite high familiarity and enthusiasm, there is a notable gap between teachers' awareness and access to training and resources. Lower scores for attending workshops (2.96) and access to resources on improvisation (3.26) highlight significant challenges in implementation. This echoes Boakye and Ampiah's (2017) findings, identifying lack of training and resources as significant obstacles for science teachers in Ghana. Similarly, Obodo et al. (2020) found that adequate professional development opportunities could have improved effective improvisation in Nigerian schools. The gap suggests that while teachers recognize improvisation's value, they may need more practical skills and materials for effective implementation. This disparity between theoretical knowledge and practical application could limit improvisation's impact on science education in the district. This challenge is expected in Ghana; Kambuga (2024) reported similar issues in Tanzania, where teachers struggled to translate their awareness into effective classroom practices due to resource constraints. However, these findings contrast with Moomaw's (2024) study in Uganda, which found that teachers could overcome resource limitations more effectively, possibly due to differences in local support systems or cultural factors.

A Pearson correlation analysis revealed a statistically significant positive correlation between familiarity and challenges ($r = .376$, $p < .001$, $N = 196$), suggesting that as teachers become more familiar with improvisation techniques, they also report more challenges. This enlightening finding aligns with Eshiet's (2014) observation that more expert teachers are likelier to identify a broader range of implementation challenges. Similarly, Githui et al. (2022) found that experienced teachers in Kenya reported more nuanced challenges in improvisation, indicating a deeper understanding of the complexities involved. However, it contrasts with Olagunju and Babajide's (2011) argument that familiarity should reduce perceived challenges. This discrepancy might be explained by contextual differences or variations in how challenges are defined and measured across studies. The positive correlation can be interpreted through various perspectives: Hofstein and Mamlok-Naaman (2007) suggest increased familiarity brings heightened awareness of potential difficulties; Frykholm and Glasson (2005) note that more familiar teachers attempt more complex techniques; and Akyeampong (2017) argue that contextual factors become more apparent with deeper engagement. Additionally, Mushimiyimana et al. (2022) found that teachers with higher familiarity levels in Rwanda tended to innovate more, potentially encountering new challenges in the process. This supports our finding that increased familiarity correlates with more reported challenges. The moderate strength of the correlation indicates that whilst familiarity and challenges are linked, other factors also play significant roles in shaping teachers' difficulties. This multi-faceted nature of challenges in improvisation is consistent with Darling-Hammond's (2010) broader observations on the complexity of educational innovations in resource-constrained environments.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study on primary school teachers' proficiency in utilising improvisation tactics for scientific instruction in the Zabzugu District has revealed important findings regarding the current state of science education in resource-constrained environments in Ghana. Teachers demonstrate considerable expertise and enthusiasm for improvisation techniques, particularly recognising improvisation as an effective approach for teaching science. Significant challenges in implementation persist, especially with workshop attendance and resource availability, highlighting a gap between theoretical comprehension and practical application. This study demonstrates a substantial correlation between teachers' proficiency in improvisation techniques and the challenges faced during implementation. This signifies that as teachers deepen their comprehension of improvisation, they concurrently become cognisant of the complexities involved in its execution. This relationship underscores the imperative for ongoing assistance and professional development, a duty to which policymakers should be dedicated, enhancing teachers' comprehension of improvisation and equipping them with resources to tackle anticipated challenges. These findings highlight the significant potential of improvisation to enhance science teaching, particularly in resource-constrained environments. To leverage this potential, educational policymakers and administrators advocate for the enhancement of professional development, improved resource accessibility, promotion of collaborative learning, integration of improvisation into curricula, allocation of targeted funding, and execution of regular effectiveness evaluations. Despite persistent challenges, the substantial expertise and enthusiasm of teachers create a strong basis for the effective integration of improvisation in science instruction. This should ensure policymakers and administrators that, with appropriate support, the quality of scientific education in resource-constrained environments can be significantly enhanced, perhaps creating a model for similar situations across Ghana and beyond.

5.2 Recommendations

To maximise the potential of improvisation in science education, policymakers and administrators should enhance professional development programmes focused on practical improvisation skills, improve access to resources and materials, foster collaborative learning environments amongst teachers, and integrate improvisation into science curricula and teacher education programmes. Additionally, allocating targeted funding for improvisation materials and training, conducting regular assessments to evaluate effectiveness, and promoting gender equity in access to training and resources are crucial. These strategies aim to address identified gaps and leverage teachers' enthusiasm, potentially improving science education quality in resource-constrained environments.

Disclosure statement

The researchers affirm that there was no conflict of interest throughout the study.

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