Teachers' Competence to Teach Science and Technology Subject in Bunda and Musoma Districts, Tanzania

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Abstract
This study investigated teachers' competence to teach the Science and Technology subject in Bunda and Musoma Districts, Tanzania. The study was guided by Pedagogical Content Knowledge theory, developed by Lee Shulman in 1986. A mixed-methods approach with a convergent design was employed. The target population comprised 1,833 teachers and 223 head teachers from 223 public primary schools, making a total of 2,056 participants from the two districts. The sample included 205 participants, comprising 183 teachers and 22 head teachers from 22 public primary schools. Both probability and non-probability sampling methods were used to draw the sample from the target population. A proportionate stratified random sampling technique was used to select teachers, while total population sampling was applied to head teachers. The validity of both qualitative and quantitative instruments was ensured through the involvement of three experts from MWECAU, while the reliability of quantitative instruments was ensured using Cronbach's alpha. Quantitative data were analysed using descriptive statistics with the aid of SPSS version 22, while qualitative data were analysed thematically. The findings revealed that teachers demonstrated high competence in various teaching approaches, but lower competence in practical activities, particularly in encouraging active participation where reliable internet access was limited. The study concludes that public primary schools in Bunda and Musoma districts were not adequately prepared to teach the Science and Technology subject, and recommends that head teachers prioritise and organise in-service training, seminars and workshops within schools and districts.

Keywords: Science and Technology Subject;Teacher Competence; Teaching,Public primary schools,Tanzania

1. Introduction

Global Context

Science and Technology education is globally recognised as a key driver of innovation, critical thinking, digital literacy, and sustainable social-economic development (Rusmin et al., 2024). International organisations such as UNESCO advocate its integration into basic education to support the achievement of Sustainable Development Goal 4 (SDG 4) (Abera, 2023). However, many countries continue to experience challenges related to inadequate instructional resources, ICT facilities, science equipment, and declining science achievement (Qian et al., 2020; OECD, 2023; Von Davier et al., 2024).

Africa Context

Across Africa, countries such as Kenya, Rwanda, and South Africa have implemented curriculum reforms that emphasise inquiry-based science learning, practical instruction, and digital competencies (DBE, 2011). Despite these reforms, many education systems continue to face challenges associated with teacher preparedness, adapting teaching practices, and limited institutional support (Karua & Kara, 2025). These constraints reduce teachers' effectiveness in implementing Science and Technology education.

Tanzania Context

In Tanzania, the Education and Training Policy (2014, revised 2023) promotes competency-based Science and Technology education to strengthen innovation and national development (URT, 2023). Although the government has supported implementation through teacher training, instructional materials, and science kits, many public primary schools continue to experience shortages of qualified teachers, inadequate facilities, overcrowded classrooms, and limited ICT infrastructure (Loisulie & Kondo, 2025; Tarmo, 2022). Furthermore, low science performance in Mara Region, particularly in Bunda and Musoma Districts, highlights the need to examine school preparedness and teacher competence in implementation of Science and Technology curriculum (Kassile, 2024; NECTA, 2024).

2. Statement of the Problem

The Teaching of the Science and Technology subject in Bunda and Musoma Districts' public primary schools is a problem, as it relies on traditional methods, causing poor knowledge, understanding, poor skills, and low performance of pupils in national examinations. Evidence from the National Examinations Council, as observed by URT 2022 – 2024 , indicates the low pass rate for the science and technology subject. Parents and teachers have expressed growing concerns that pupils complete primary school education lacking essential skills, creativity, problem-solving abilities, and scientific knowledge (Kinyota, 2023; Shen et al., 2026; World Bank, 2021–2024

3. Theoretical Framework

Pedagogical Content Knowledge, developed by Lee Shulman (1986), emphasises that effective teaching goes beyond simply mastering subject content; it involves understanding how to present that content in ways that support meaningful pupil learning by bridging the gap between what teachers know and how they teach it. Pedagogical Content Knowledge includes knowledge of instructional strategies, curriculum design, assessment methods, and the ability to recognise and address students' misconceptions (Sarkar et al., 2024), enabling teachers to connect subject knowledge with learners' diverse needs and make lessons both practical and engaging. While Pedagogical Content Knowledge clearly explains the relevance and application of the framework, it does not fully show how this study contributes to the theory or generates new insights within the context of Science and Technology teaching in Tanzanian primary schools. Instead, Pedagogical Content Knowledge is mainly treated as an

analytical framework rather than a theory to be extended, refined, or tested in a new context, which limits the study's claim of theoretical originality. To strengthen its contribution, the study explores how teachers adapt their pedagogical content knowledge when teaching Science and Technology and how factors such as resources, classroom conditions, and teaching experience influence its application, providing a more context-specific understanding of Pedagogical Content Knowledge.

Pedagogical Content Knowledge provides a strong theoretical framework for assessing teachers' perceived competence in teaching Science and Technology because it emphasises integrating subject-matter knowledge with effective pedagogical strategies to enhance learners' understanding. The framework highlights teachers' ability to adapt instruction to learners' diverse needs, misconceptions, and contexts while promoting reflective practice for continuous improvement in teaching effectiveness. However, Pedagogical Content Knowledge has limitations, as it gives limited attention to the availability of teaching and learning resources and does not provide specific instructional guidelines or address broader contextual factors that may influence teachers' competence. These limitations hinder a comprehensive understanding of all the factors that affect effective Science and Technology teaching. Nevertheless, despite these weaknesses, PCK remains a relevant and valuable framework because it focuses on the essential relationship between content knowledge and pedagogy, enabling the study to examine how teachers perceive and apply their knowledge and instructional skills to facilitate meaningful learning in Science and Technology.

4. Review of Empirical Studies

In this section, the researcher reviews empirical studies related to the extent to which public primary school teachers are competent to teach the Science and Technology subject.

Teachers' competence in teaching the Science and Technology subject is crucial for improving the quality of education. Several studies have explored how teachers perceive their own competence with regard to teaching the subject. This sub-theme focuses on studies conducted on this aspect, and the gaps in each study have been identified.

Ali (2022) examined how teachers at different school levels were judged in terms of their teaching competencies in the Multan district of Pakistan. The study employed a quantitative survey approach to assess the competence of teachers working in public schools. A stratified sampling method was used to select 1,009 teachers representing gender and school location. A questionnaire was used for data collection, and both descriptive and inferential statistics (t-test and ANOVA) were applied in data analysis. The study found that teachers perceived themselves to be competent in lesson planning, instructional delivery, lesson closure, student evaluation, and classroom management. The study contributes important information showing that teachers were competent in delivering lessons. However, the study collected data only from teachers, without obtaining the views of head teachers as school leaders or supervisors who together enforce the teaching of Science and Technology. To address this gap, the current study collected data from both teachers and head teachers to assess teachers' competence in teaching Science and Technology in public primary schools in Bunda and Musoma districts. The involvement of head teachers, as the immediate supervisors of teachers, enhanced the validity and reliability of the findings by providing an external perspective on teachers' competence.

Hawa et al. (2021) evaluated the skills of opening and closing lessons as demonstrated by teachers. The study focused on two Indonesian teachers and applied the UCLA summative evaluation method to assess their competence. A mixed-methods design was used, whereby a questionnaire, an interview guide, and an observation checklist were used to collect data. The findings showed that both teachers performed the skills to open lessons well, although several

components were not done well; the teachers also carried out the skills to end lessons well, but in the aspect of reviewing, there was no opportunity for students to make a summary, and the provision of psychological and social encouragement did not always motivate learners towards higher achievement. However, the study was conducted with only two teachers, which limits the generalisability of the findings. To address this gap, the current study sampled 183 teachers from 22 schools to obtain more representative data. Furthermore, the study examined components of teaching competence, including lesson planning, evaluation, and classroom management, to provide a comprehensive assessment of teachers' perceived competence in teaching Science and Technology in Bunda and Musoma districts.

Alasmari and Althaqafi (2024) conducted a study to identify teachers' use of proactive and reactive classroom management strategies in Saudi Arabia. The study adopted a mixed-methods approach, using both a questionnaire and semi-structured interviews with 80 teachers. The findings revealed that teachers were competent in classroom management and that they considered proactive strategies to be more effective than reactive ones. However, the study collected information from teachers only, without triangulating the data with other sources. This lack of triangulation may have affected the validity of the findings, as teachers might have provided socially desirable responses. To fill this gap, the current study involved both teachers and head teachers to gain a fuller understanding of the perceived competence of public primary school teachers in managing classrooms while teaching Science and Technology. The inclusion of head teachers, as supervisors of teachers, provided an external perspective for data triangulation and hence enhanced the validity and trustworthiness of the findings.

Xinh and Hong (2021) analysed the teaching skills of Science and Technology teachers in primary schools in Vietnam. A survey research design was employed, whereby data were collected using questionnaires from 600 primary school teachers selected from 26 schools. The study found that some teachers did not have a clear understanding of the teaching of Science and Technology in primary schools. However, the views of other stakeholders, such as head teachers, were not sought. Therefore, the current study assessed the perceived competence of primary school teachers in teaching Science and Technology by also considering head teachers' views through interviews, so that they could contribute to identifying interventions to support the effective teaching of the subject.

Hailu (2021) analysed the competence of primary school science teachers in teaching science in Ethiopia. The study focused on teachers' competence in terms of subject matter mastery, methods of teaching, laboratory utilisation, lesson planning, and investigating pupils' progress. Data were collected using questionnaires, focus group discussions, classroom observation, and interviews. The study found that teachers of the science subject in Ethiopia were less competent in almost all the areas investigated. Although the study adds substantial knowledge to the current study, the findings cannot be generalised to the Tanzanian context due to contextual differences between Ethiopia and Tanzania in terms of education policies and environmental conditions. Therefore, there was a need for a study to be conducted in the Tanzanian context to investigate teachers' competence in teaching Science and Technology in public primary schools.

Prosper and Nderego (2024) conducted a study on the use of tablets in teaching, examining competencies, challenges, and opportunities among public primary school teachers in Tanzania. In this study, a questionnaire survey was deployed to collect data from 130 teachers in 10 randomly selected schools. It was found that primary school teachers had a moderate level of competence in using tablets for teaching ($M = 3.78$, $SD = .462$). The findings also revealed moderate challenges in incorporating tablets into teaching methods. The study provided a notable contribution, showing that teachers had a moderate level of competence in

using technological tools to teach the subject. However, the study employed only a questionnaire to gather data, without considering triangulation through other instruments. Thus, the current study filled this gap by collecting data using a questionnaire, an interview guide, and an observation guide, which enabled triangulation of the information and hence validated the findings.

Previous studies have shown that teachers generally perceive themselves as competent in lesson planning, instructional delivery, classroom management, lesson closure, and technology integration. However, many studies assessed only selected dimensions of teaching competence rather than providing a comprehensive assessment of teachers' competence in teaching Science and Technology. Therefore, there is limited evidence on the overall competence of teachers in implementing the Science and Technology curriculum.

Most existing evidence was generated from countries such as Pakistan, Indonesia, Vietnam, Saudi Arabia, and Ethiopia, whose educational policies, curricula, and school environments differ considerably from those of Tanzania. Even within Tanzania, limited empirical evidence exists on teachers' competence to teach Science and Technology in public primary schools, particularly in Bunda and Musoma Districts, creating the need for context-specific evidence.

Most previous studies relied predominantly on teachers' self-reported questionnaire data without incorporating the perspectives of head teachers, limiting data triangulation and increasing the likelihood of response bias. In addition, some studies used relatively small samples, reducing the generalisability of their findings. To address these limitations, the current study employed a mixed-methods approach involving questionnaires, interviews, and observations, and collected data from both teachers and head teachers to enhance the validity and comprehensiveness of the findings.

5. Methodology

This study was guided by the pragmatist paradigm and adopted a convergent mixed-methods research design to examine the extent to which public primary school teachers are competent to teach the Science and Technology subject in Bunda and Musoma Districts, Tanzania. The pragmatist approach was considered appropriate because it focuses on practical solutions to real-world problems and allows the use of both quantitative and qualitative methods to gain a deeper understanding of the research issue. Through the convergent design, quantitative and qualitative data were collected concurrently, analysed separately, and then integrated during the interpretation stage to provide a comprehensive picture of teachers' competence.

The study involved a target population of 2,056 participants, comprising 223 head teachers and 1,833 teachers from 223 public primary schools in the two districts. Following the recommendation of Creswell and Plano Clark (2018) that a sample of 10% is adequate for representing a heterogeneous population, a sample of 205 participants was selected. This sample included 22 public primary schools, 22 head teachers, and 183 teachers. Proportionate stratified random sampling was used to select schools and teachers to ensure fair representation from both districts, while all head teachers from the selected schools were included through total population sampling.

Data were collected using questionnaires, interviews, and classroom observation guides. To ensure the quality of the research instruments, expert reviews and pilot testing were conducted before the main study. The reliability of the teachers' questionnaire was assessed using Cronbach's alpha, which produced a coefficient of 0.875. Since this value exceeded the acceptable threshold of 0.70, the instrument was considered highly reliable for data collection (Okendo et al., 2020). The credibility of qualitative findings was strengthened through triangulation, peer review, and the use of multiple sources of data and participant groups.

Quantitative data were analysed using descriptive statistics, including frequencies, percentages, and mean scores, with the support of SPSS version 22. Qualitative data were transcribed verbatim and analysed thematically to identify recurring patterns and themes. Throughout the study, ethical standards were strictly observed by obtaining the necessary research permits, securing informed consent from participants, ensuring voluntary participation, maintaining confidentiality, and avoiding plagiarism and other forms of research misconduct.

6. Results and Discussion

The study focused on the extent to which public primary school teachers were competent in teaching the Science and Technology subject in Bunda and Musoma districts. Teacher competence is vital for the successful delivery of Science and Technology because teachers' knowledge, pedagogical skills, and instructional abilities determine how well subject content is conveyed to pupils. In the Science and Technology subject, teachers' competence is linked to school preparedness, as capable teachers are better able to design meaningful learning activities, facilitate practical experiences, and help pupils develop scientific and technological skills. Teachers' responses on different aspects of competence were summarised as shown in Table 1.

Table 1

Teachers' Response on the Extent to which Public Primary School Teachers are Competent to Teach the Science and Technology Subject

Statement	Very low extent		Low extent		Moderate		High extent		Very high extent		Mean
	f	%	f	%	f	%	f	%	f	%	
i. I can prepare detailed lesson plans specific to Science and Technology topics.	16	10	14	8	8	5	100	60	29	17	3.67
ii. I can relate science and technology topics to real-life applications or future issues.	11	7	30	18	20	12	75	45	31	19	3.51
iii. I am skilled at designing and delivering engaging lessons for science and technology subject.	5	3	19	11	32	19	88	53	23	14	3.63
iv. I am aware of the latest developments in the field of science and technology, which can assist me in providing modern instruction.	6	4	42	25	30	18	71	43	18	11	3.32
v. I can employ appropriate teaching methods to meet the various needs of pupils in the subject of science.	4	2	27	16	33	20	82	49	21	13	3.53
vi. I can evaluate pupils' work in the subject of science and technology.	4	2	17	10	19	11	74	44	53	32	3.93
vii. I can integrate technology and practical activities into their science and technology lessons.	16	10	36	22	21	12	70	42	24	14	3.30
viii. I can manage time efficiently to balance theory and practical activities.	8	5	23	14	28	17	74	44	34	20	3.62

ix. I can use teaching materials that increase pupils' understanding of science and technology concepts.	8	5	28	17	25	15	74	44	32	19	3.56
x. I may collaborate with colleagues to improve teaching methods in the subject of science and technology.	12	7	33	20	16	10	75	45	31	19	3.48
Grand Mean											**3.56**

Source: Field data (2024). f = frequency; % = percentage; n = number of respondents = 167.a mean score of 4.30–5.00 , very high level, 3.50–4.2, high level . mean score of 2.70–3.49 moderate level, 1.90–2.69, low level and 1.00–1.89 very low level

Table 1 indicates a mean score of 3.67, showing that teachers are competent in meeting basic lesson-planning requirements, including creating lesson plans that are logically structured and aligned with the syllabus. This mean score shows the high extent to which teachers possess the essential professional skills needed for lesson planning in Science and Technology teaching. This result suggests that teachers in Bunda and Musoma districts demonstrated a high extent of preparedness in organising their lessons and following the formal requirements of lesson preparation. It should be noted that proper lesson planning is a fundamental component of effective teaching because it enables teachers to structure instructional activities, define learning objectives, and sequence content in ways that support pupils' understanding of subject concepts (Shulman, 1986). Therefore, the relatively high mean score indicates that teachers are capable of preparing lesson plans that meet basic professional expectations.

Interviews with head teachers suggest that although teachers were generally preparing lesson plans in accordance with the syllabus, the quality of instructional design within these plans may not sufficiently support learner-centred and inquiry-based teaching approaches, which are essential for effective Science and Technology teaching. For instance, Head Teacher 4 explained:

"Teachers of the Science and Technology subject generally plan their lessons well by following the syllabus and incorporating key scientific concepts. They meet the basic requirements, although some prepare lesson plans that restrict pupils' participation in various science-related activities" (Head Teacher 4, interview, 21st May 2024).

Similarly, Head Teacher 12 pointed out that while teachers were complying with formal lesson-planning requirements, the instructional activities included in some lesson plans did not necessarily promote meaningful learning outcomes:

"*Most teachers prepare their lesson plans with great attention, following the required formats for each lesson. But some lesson plans have activities that do not lead to the attainment of the stated objectives, such as problem-solving"* (Head Teacher 12, interview, 29th May 2024).

Another head teacher also noted that teachers often relied heavily on textbooks when preparing their lesson plans:

> My teachers are required to plan for every lesson, including the Science and Technology subject. At my school, the teachers' lesson-planning skills are generally adequate. However, the teachers rely mostly on textbooks as the main source of material, without making much use of prepared teaching aids (Teacher 1, interview, 17th May 2024).

The information suggests that although teachers demonstrated competence in preparing Science and Technology lesson plans that aligned with syllabus requirements, they faced challenges in designing and implementing instructional activities that promoted active

learning, inquiry, and practical engagement. Lesson plans generally reflected compliance with formal planning requirements; however, they often lacked activities that could effectively stimulate pupils' curiosity, critical thinking, and problem-solving skills.

Classroom observations revealed a noticeable gap between lesson planning and instructional practice. Despite the inclusion of learner-centred activities in lesson plans, classroom teaching was predominantly teacher-centred. Teachers mainly explained concepts verbally while pupils listened, copied notes, and answered a limited number of closed-ended questions. Teaching relied heavily on textbooks and teacher explanations, with minimal use of teaching aids, experiments, demonstrations, or other practical activities that could enhance pupils' understanding through active participation. Consequently, pupils had few opportunities to explore ideas, conduct investigations, or develop inquiry-based learning skills essential to the Science and Technology subject.

These findings indicate that while teachers possessed basic procedural skills in lesson preparation, they might lack the advanced pedagogical competencies required to translate planned learner-centred activities into effective classroom practice. This challenge may be partly attributed to limited training in the integrated Science and Technology subject, as many teachers were initially trained in other subject areas and later assigned to teach Science and Technology, which requires specialised content knowledge and pedagogical approaches.

These findings are consistent with the study by Suwarma and Apriyani (2022), which reported that teachers' lesson-planning skills were generally at an intermediate level, although not all lesson plans reflected activities of similar quality. This suggests that many teachers can prepare lesson plans adequately but encounter difficulties in designing and implementing learning activities that foster higher-order thinking and deeper conceptual understanding. Research in science education similarly emphasises that effective teaching requires the integration of content knowledge with appropriate pedagogical strategies to support meaningful learning experiences.

The quantitative and qualitative findings complement each other by demonstrating that, although teachers in Bunda and Musoma districts were generally competent in lesson preparation, significant challenges remained in implementing effective learner-centred teaching approaches. Furthermore, inadequate ICT facilities, unreliable internet connectivity, and limited access to digital learning resources may have constrained the use of participatory, interactive, and practical teaching methods. As a result, lesson plans that appeared well designed on paper were not always effectively enacted in classroom instruction.

Table 1 indicates that teachers' responses had a mean score of 3.93, indicating that they were able to evaluate pupils' work in the Science and Technology subject effectively. According to the interpretation scale adopted in this study, this score reflects a high level of competence among teachers in assessing pupils' understanding of the subject. The findings reveal that teachers in Bunda and Musoma districts possessed the basic professional skills required to evaluate pupils' academic performance in Science and Technology through classroom assessments.

Teacher competence in evaluation is essential because it enables teachers to monitor pupils' learning progress, identify misconceptions, and provide appropriate instructional support. Effective assessment practices also help teachers determine whether instructional objectives have been achieved and guide necessary adjustments in teaching strategies. Furthermore, assessment provides feedback that can improve both teaching and learning processes (Bakker et al., 2022). Therefore, the relatively high mean score implies that teachers generally had confidence in their ability to effectively assess pupils' understanding of the subject.

However, further analysis of qualitative data reveals important limitations in the assessment practices used in Science and Technology classrooms. During an interview, Head Teacher 17 explained:

"Most teachers evaluate pupils' understanding regularly, and they provide assessment tasks for each lesson. Probably due to the large number of pupils, they do not always provide feedback on time to address their mistakes" (Head Teacher 17, interview, 4th May 2024).

Another head teacher added:

> I have observed the teachers of the Science and Technology subject assessing their pupils. They usually use tests and examinations as required. However, teachers rarely use different forms of assessment, such as projects, experiments, or practical work, to effectively assess the acquisition of scientific and technological skills (Head Teacher 7, interview, 23rd May 2024).

Responses from head teachers indicated that teachers were competent in assessing pupils' understanding of Science and Technology concepts. However, they raised concerns about the lack of timely feedback given to pupils after assessment activities. Similarly, the head teachers noted that assessment methods remained largely traditional, focusing mainly on testing pupils' ability to recall facts, definitions, and formulas through written questions rather than assessing practical application and problem-solving skills. Nevertheless, although teachers were regularly assessing pupils, the process was often affected by circumstantial challenges such as large class sizes and insufficient resources, which reduced the effectiveness of assessment practices in the Science and Technology subject.

Observations conducted across all sampled schools revealed that teachers were frequently assessing pupils through tests, written exercises, and oral questioning, reflecting the predominance of traditional assessment methods in classroom practice. Pupils were mainly required to answer short questions drawn from textbooks or notes, with limited opportunities for practical investigations or hands-on tasks. As a result, most assessment activities focused on learners' ability to recall factual information, definitions, and formulas rather than on inquiry, experimentation, creativity, or problem-solving skills.

These findings suggest that, although teachers demonstrated competence in assessing pupils' theoretical knowledge through written tests and examinations, limited attention was given to evaluating practical scientific skills and inquiry abilities, which are essential components of the Science and Technology subject. These findings align with Rubeba and Kitula (2024), who reported that teachers tended to rely heavily on traditional written assessments and often had limited competence in implementing alternative assessment approaches that captured pupils' practical and inquiry-based learning in science subjects. Overall, the results indicate that while teachers possessed the basic competence required to assess pupils' knowledge in Science and Technology, there was a need to strengthen their capacity to use varied, learner-centred assessment strategies that foster scientific inquiry skills and deeper conceptual understanding.

Table 1 further shows that teachers reported a mean score of 3.53 for their ability to use suitable teaching methods to address the diverse learning needs of pupils in the Science and Technology subject. This mean score falls within the high-extent category, indicating that teachers regarded themselves as capable of applying different instructional strategies in teaching the subject. The responses from teachers suggest that they were trying to incorporate creativity, flexibility, and innovation into their teaching practices to accommodate different learning abilities among pupils. In this regard, Head Teacher 3 explained during an interview:

> My teachers employ different techniques to ensure their pupils understand the intended concepts. They use lectures, group discussions, pictures, and sometimes

> personal phones or tablets to ensure pupils have attained the intended goal of the lesson. Where there is a shortage of teaching materials, teachers use their smartphones or laptops (Head Teacher 3, interview, 20th May 2024).

Another head teacher added:
"*Although teachers know the appropriate teaching methods, the lack of sufficient teaching materials means that most lessons rely on lectures, question-and-answer methods, and group discussions"* (Head Teacher 14, interview, 31st May 2024).
On the same issue, Head Teacher 15 further added:

> *"Teachers sometimes use drawings and charts to explain some concepts in the Science and Technology subject."* (Head Teacher 15, interview, 31st May 2024).

The information from teachers were diversifying their instructional approaches despite limited teaching and learning resources. Classroom observations showed that teachers were using a variety of strategies, including verbal explanations, questioning techniques, chalkboard drawings, charts, and, in a few cases, digital devices such as smartphones or tablets to support instruction. These practices demonstrated teachers' adaptability in responding to resource constraints.
However, the limited availability of instructional materials often restricted opportunities for practical and inquiry-based learning. For example, when teaching topics such as evaporation, magnetism, electricity, and ICT-related content, teachers frequently relied on textbook explanations, chalkboard illustrations, and charts rather than allowing pupils to interact with real materials or conduct experiments. In schools where computers and other technological devices were unavailable, teachers drew diagrams of computer accessories and smartphone components on the chalkboard to illustrate concepts. Similarly, charts were used to explain procedures such as operating a television and introducing basic ICT skills, while a few teachers used smartphones to demonstrate internet-related applications.

Although these strategies enabled teachers to deliver lessons under challenging conditions, pupils had limited opportunities to participate in hands-on activities and investigative learning experiences that were essential for developing practical scientific skills and deeper conceptual understanding. These findings are consistent with Shulman's (1986) Pedagogical Content Knowledge theory, which emphasises that effective teaching requires the integration of subject-matter knowledge with appropriate pedagogical strategies. The teachers' ability to adapt instructional methods reflects an important aspect of pedagogical competence; however, the shortage of instructional resources constrained the implementation of more effective learner-centred and practical approaches.
Table 1 also indicates that teachers reported a mean score of 3.62 for their competence in managing time and classroom activities effectively when teaching the Science and Technology subject. This score reflects a high extent of competence, suggesting that teachers generally possess the classroom management skills necessary to organise lessons and maintain productive teaching environments. Effective classroom management is critical for successful teaching because it enables teachers to maintain order, facilitate participation, and ensure that instructional time is used efficiently (Seufert et al., 2022). Well-managed classrooms also support pupils' engagement and create conditions conducive to effective learning. However, interview responses from head teachers revealed that certain challenges remained in ensuring active participation among all pupils. For example, Head Teacher 9 explained:

> Teachers manage time and resources effectively, balancing theoretical and practical activities. There are instances where not all pupils participate actively, particularly

> during hands-on experiments, where some may become passive observers. Sometimes, teachers also use much of the lesson time writing on the blackboard, leaving the pupils talking to each other (Head Teacher 9, interview, 27th May 2024).

Similarly, Head Teacher 5 pointed out that:

> Classroom management is a strength among teachers, as they maintain control during lessons. Yet, during practical experiments, particularly in larger classes, managing the classroom and ensuring that every pupil remains engaged can be a challenge. This is not a challenge for the Science and Technology subject only, but it is common to almost every teacher (Head Teacher 5, interview, 22nd May 2024).

The head teachers' responses indicate that teachers were adequately prepared to manage different aspects of classroom instruction, including lesson planning, lesson presentation, lesson closure, evaluation, and general classroom management. Classroom observations conducted in the sampled schools supported the head teachers' responses. During classroom visits, the researcher observed that teachers introduced Science and Technology lessons clearly, guided pupils through learning activities, and summarised key points at the end of the lesson. Teachers also managed classroom routines effectively by giving instructions, monitoring pupils' behaviour, and maintaining order throughout the lesson. In most classrooms, pupils remained disciplined and followed the teacher's directions.

However, the observations also revealed that pupils became passive during certain parts of the lesson, particularly when teaching activities involved prolonged writing or copying notes from the chalkboard. During these moments, classroom interaction decreased, and many pupils focused mainly on note-taking rather than actively participating in discussions or practical activities. In some lessons, only a few pupils responded to questions, while the majority remained quiet and less engaged. This suggests that although teachers demonstrated good classroom management skills, some teaching approaches limited active pupil participation during Science and Technology lessons.

The combination of statistical data and classroom observations indicates that teachers in public primary schools possess a reasonable level of preparedness to teach Science and Technology. Quantitative data showed that teachers were generally competent and met the professional qualifications required for primary school teaching, as reflected in the grand mean score of 3.56. However, qualitative evidence provided deeper insights, revealing that classroom practices often remain teacher-centred, with limited emphasis on inquiry-based learning, experimentation, and active pupil engagement. Head teachers' experiences and classroom observations further highlighted gaps in teachers' practical and experimental teaching skills. These findings suggest that while a strong foundation exists, there is a need for continuous professional development and capacity-building programmes to strengthen teachers' practical competencies and enhance the effective teaching of Science and Technology.

7. Summary of the Major Findings

The study examined the extent to which public primary school teachers are competent to teach the Science and Technology subject in Bunda and Musoma districts. The findings showed that teachers demonstrated a high extent of competence in key teaching areas, including lesson preparation, classroom management, time management, and pupil assessment. However, qualitative findings revealed weaknesses in actual classroom practice. Teaching was largely teacher-centred, with limited use of practical, investigative, and learner-centred activities. Assessment methods relied mainly on written tests rather than practical or project-based tasks that could better evaluate scientific and technological skills. Although

teachers generally managed classrooms effectively and followed the syllabus, observations showed limited use of teaching materials and interactive approaches, leading some pupils to become passive during lessons. Despite resource shortages, some teachers demonstrated creativity by using drawings, charts, mobile phones, and tablets to support instruction. Overall, the findings suggest that teachers were highly competent in the formal aspects of teaching, but had limited competence in promoting active participation and practical learning activities.

8. Conclusions

The study concludes that although teachers possessed basic professional competence in lesson preparation and classroom management, they were insufficiently equipped to effectively deliver learner-centred and practical Science and Technology instruction. Limited professional preparation and inadequate specialised training have constrained teachers' ability to integrate innovative, experimental, and activity-based teaching approaches into classroom practice. Consequently, the intended goals of the Science and Technology subject cannot be fully achieved without strengthening teachers' pedagogical and practical competencies through continuous professional development.

9. Recommendations for Action

Head teachers should prioritise and organise the strengthening of professional development opportunities for teachers by organising in-service training, seminars and workshops within schools and districts. There is also a need to build on the positive perceptions teachers already hold towards support, mentoring, pedagogical guidance, and incentives to motivate teachers to improve their classroom practices.

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