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How Are Basic School Teachers in Ghana Improvising ICT Integration? Implications for the Implementation of the Standard-Based Curriculum

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Abstract
The inadequacy of technological resources in Ghanaian basic schools compels teachers to improvise ICT tools and resources to implement the standards-based curriculum. However, how teachers adapt these resources to meet curriculum mandates remains unclear. Therefore, this study adopted a critical realist paradigm and a multi-case study design to examine how basic school teachers improvise ICTs to implement the standards-based curriculum. The narration data were triangulated with classroom observation data and thematically analysed using MAXQDA 2020 software. The findings revealed that most teachers use their personal laptops and smartphones to teach various subjects. Additionally, when original ICT tools are unavailable, teachers often improvise with low-cost materials. Only a few teachers leverage open-source software, online resources, or mobile applications to enhance teaching and learning in the absence of advanced ICT tools. The findings were more prominent in rural schools. The study suggests that more technological resources should be provided to schools. Furthermore, teachers should receive training on innovative improvisation strategies and the effective use of open-source software and online resources to facilitate learning.

Keywords: ICT integration, improvisation, standards-based curriculum, multi-case study design, basic schools

Introduction

A curriculum serves as the foundation of any educational system, outlining the knowledge, skills, values, and behaviors learners must acquire (Gouedard et al., 2020). It provides a structured framework through textbooks, syllabi, and standards, enabling schools to organize education effectively (Mochiah & Adibi, 2023). Curriculum changes occur in response to societal shifts, educational goals, and policy directions, often addressing issues such as low-quality education or outdated content (Cobbold, 2017; Offorma, 2016).

In 2019, Ghana's National Council for Curriculum and Assessment (NaCCA) and the Ghana Education Service (GES) replaced the objective-based curriculum with a standards-based one. This reform expanded basic education to senior high school and emphasized critical thinking, creativity, and 21st-century skills over rote memorization. The curriculum introduces subjects like Our World, Our People, history, and the 4Rs while fostering holistic learner development—intellectually, emotionally, physically, and spiritually (Addai-Mununkum & Setordzi, 2023; Mochiah & Adibi, 2023; Appau, 2021).

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It promotes innovation, learner-centered teaching, formative assessment, teacher development, and diverse pedagogical approaches to support Ghana's socio-economic transformation.

Information and communication technology (ICT) is not only a standalone subject but also supports other curriculum subjects (Olumba, 2013). It plays a key role in realizing the philosophy of the standards-based curriculum by facilitating the acquisition of 21st-century skills such as critical thinking, communication, information literacy, leadership, collaboration, global citizenship, personal development, and digital literacy—skills designated as core competencies in the new curriculum (Ministry of Education, 2019). Therefore, integrating ICT into Ghana's education system is crucial for the successful implementation of the new curriculum and its intended outcomes. The use of technology in the classroom not only enhances education quality but also fosters 21st-century skill development (Ayebi-Arthur et al., 2009). Computing is vital in the standards-based curriculum, necessitating instruction on topics such as introduction to computing, presentation software, spreadsheets, databases, desktop publishing, programming, artificial intelligence, the internet and social media, and ICT-related health and safety issues (Ministry of Education, 2019).

While the curriculum mandates ICT integration and computing instruction in Ghana's basic school classrooms, numerous studies (Asamoah et al., 2022; Enu et al., 2018; Agyei, 2013; Akaadom & Gorni, 2023; Asare et al., 2023; Natia, 2015; Mintah et al., 2023; Abedi, 2024; Soma et al., 2021) reveal significant challenges. These include inadequate technological resources such as computers, internet access, and software, particularly in government-funded basic schools (Ayebi-Arthur et al., 2009). Due to insufficient government funding, many schools struggle to acquire the necessary technologies for effective teaching and learning (Wilson & Somhlab, 2017). The lack of ICT resources in Ghanaian basic schools is well-documented (Buabeng-Andoh, 2012), with public government schools facing even greater challenges (Ayebi-Arthur et al., 2009). Additionally, a digital divide exists between urban and rural schools in terms of ICT infrastructure, electricity access, and skilled personnel.

Despite these constraints, teachers are expected to integrate ICT into their pedagogy to deliver the computing curriculum, often requiring them to improvise resources based on their own experiences (Ministry of Education, 2019). However, it remains unclear how teachers adapt and improvise ICT tools and resources in the face of these limitations to meet the standards-based curriculum's requirements. Previous studies have primarily focused on the challenges of integrating ICT into the Ghanaian basic schools, often overlooking the coping mechanisms and strategies teachers use to teach the curriculum. The study moves beyond just identifying limitations to investigate, empirically and practically, the innovative and flexible methods educators employ to satisfy the requirements of the standards-based curriculum. It aims to address this knowledge gap by examining the state of ICT integration in the standards-based curriculum and how teachers improvise ICT tools and resources for teaching and learning in the absence of original ones. This research is significant as it provides a more profound understanding of ICT integration and improvisation in Ghana's public basic schools, which is essential for informing policy and practice. Therefore, this study explores the following research questions: (a) What is the state of ICT integration in the basic school standards-based curriculum? (b) How are teachers improvising ICT tools and resources for teaching and learning?

Literature Review

ICT integration in education

Rather than being treated as a standalone discipline, ICT is integrated across multiple subjects. Msafiri et al. (2024) found that ICT is widely used in teaching subjects such as science, mathematics, languages, history, music, and business studies. In Ghana, the standards-based curriculum emphasizes ICT integration across all subjects (Ministry of Education, 2019). Educators and policymakers view this approach as essential for aligning the education system with 21st-century demands and national development goals (Msafiri et al., 2023; Herlinawati et al., 2024).

To support innovative teaching practices, a variety of ICT resources are available to educators. Software applications such as GeoGebra, Moodle, WebQuest, and Autograph facilitate teaching and learning. Digital storytelling and digital libraries further enrich instruction (Msafiri et al., 2023). These tools, when effectively integrated into classrooms, enhance student motivation, engagement, and skill development while simplifying the learning process. For example, WebQuest fosters problem-solving, cognitive growth, and creative collaboration (Papadaki et al., 2023). Educators also utilize computers, tablets, and smartphones to create dynamic learning environments. Aliyu and Talib (2023) highlight the use of robotics in chemistry education, while learning management systems (LMS) such as Google Classroom, Edmodo, Moodle, and MOOCs facilitate online learning. Digital STEM classrooms further equip elementary students with 21st-century skills (Zainil et al., 2023). Additionally, platforms like WhatsApp, Zoom, Kahoot, Facebook, Socrative, ClassDojo, and Nearpod enhance classroom engagement (Ramaila & Molwele, 2022). Beyond these digital tools, DeCoito and Estaiteyeh (2022) advocate for the use of short flipped video resources to support instruction. Blackboard fosters collaboration, while YouTube videos and Facebook serve as instructional aids (Acharya, 2015). YouTube, in particular, enhances collaborative learning experiences (Fynn et al., 2021).

ICT tools play a crucial role in developing students' critical thinking, communication, collaboration, and computational skills (Su & Yang, 2023; Msafiri et al., 2024). Haleem et al. (2022) argue that incorporating projectors, computers, and advanced digital tools enhances classroom engagement. A combination of technology-driven instruction, oral presentations, and group activities creates an interactive learning environment. Teachers can utilize laptops, projectors, and projection screens to facilitate instruction (Njenga, 2015). Even in resource-limited settings, educators can employ creative and innovative approaches to enhance learning. Online tools, educational applications, and digital resources offer alternative solutions. PowerPoint presentations, for example, integrate text, graphics, and videos to create engaging lessons while aligning with Robert Gagne’s instructional events (Berger-Estilita & Greif, 2020). Gamified learning platforms such as Kahoot help review classroom material, while websites like EasyBib and spelling training applications provide additional academic support. The integration of ICT in education offers numerous advantages. It enhances learning outcomes, increases student motivation, and fosters skill development. Moreover, ICT broadens access to diverse curriculum materials, enriching both teaching and learning experiences. Personalized learning becomes more feasible, allowing educators to address students' varying needs, abilities, and learning styles (Msafiri et al., 2024).

ICT integration challenges in education

Adequate resources are essential for effective ICT integration in education. However, limited infrastructure and resources often hinder successful implementation. Msafiri et al. (2023, 2024) found that inadequate ICT tools, a lack of software and computers, insufficient support, and limited pedagogical and technological knowledge create significant barriers to ICT adoption in schools. Additionally, inconsistent resource supply and the absence of clear policies further impede progress. Similarly, Ibrahim et al. (2022) identified key challenges, including the scarcity of computer laboratories, a lack of internet-enabled devices, and the compartmentalization of ICT as a separate subject rather than integrating it into core disciplines such as mathematics and social studies. Lomo et al. (2024) examined ICT integration challenges in a district in Ghana’s Greater Accra region, highlighting a lack of electricity, internet facilities, ICT tools, and dedicated classrooms for ICT use. High maintenance costs also prevented teachers from repairing damaged devices, exacerbating the issue. Inadequate teacher training hinders the incorporation of innovative technologies into classroom practices, limiting the adoption of tools such as online learning software. Ferede et al. (2022) noted that many ICT tools remain underutilized by teachers, while Poudevigne et al. (2022) emphasized the importance of selecting appropriate tools to enhance lesson delivery.

Several studies have examined ICT integration in Ghanaian schools. Asamoah et al. (2022) conducted a cross-sectional survey of 112 students and 70 teachers in second-cycle institutions, revealing that while ICT has been incorporated into the education system, power outages and limited internet access remain major challenges. Similarly, Enu et al. (2018) assessed teachers' proficiency in technology integration in Ghanaian basic schools, identifying inadequate ICT resources as a persistent issue. Agyei (2013) explored ICT integration in teacher education in Ghana, emphasizing the influence of government policies on technology adoption. The study highlighted shortages in technological resources and skilled personnel as major obstacles. Akaadom and Gorni (2023) examined the ICT knowledge and skills of basic school teachers, revealing moderate proficiency levels and persistent difficulties in technology integration. Asare et al. (2023) analyzed Ghana's policy framework for ICT integration, highlighting resource limitations as a significant barrier. Natia (2015) explored the potential of ICT to enhance teaching and learning in Ghanaian basic schools, citing inadequate computers, power issues, and a lack of technical expertise as key challenges. Other studies have examined ICT integration in specific subjects. Mintah et al. (2023) investigated technology use in mathematics teaching in senior high schools, finding that available resources were underutilized. Soma et al. (2021) similarly reported insufficient computers and infrastructure in most Ghanaian schools, while Abedi (2024) identified a lack of technological tools and support as significant obstacles to student technology adoption. Finally, Asante (2014) examined ICT integration in early childhood education, revealing limited adoption due to resource constraints.

Improvisation in education

Improvisation is a crucial concept, particularly in the realm of education policy and curriculum reform. However, it is often conceptualized in broad terms, overlooking the uneven distribution of development and technological advancements. At its core, improvisation represents a delicate balance between planned strategies and unforeseen circumstances, enabling individuals to adapt and respond to evolving challenges (Safstrom & Rytzler, 2023). It involves generating innovative ideas, systems, or alternatives when original resources are inaccessible, unusable, or unaffordable, leveraging the creative ingenuity of educators (Okwo, 2019). Moreover, it encompasses the adaptation or invention of new tools, materials, or devices in the absence of conventional resources (Adu & Adu, 2014).

Improvisation unfolds through the expansion of teachers' creative repertoire and their ability to navigate spontaneous, intuitive, and responsive situations, often requiring ingenuity and resourcefulness (Sawyer, 2004; Sullivan, 2010; Shem-Tov, 2011). Whether it involves utilizing available substitutes or creatively repurposing existing materials, improvisation serves as a practical solution to resource constraints, facilitating effective teaching and learning (Holdhus et al., 2016).

In education, improvisation frequently emerges as a necessity, compelling teachers to adopt innovative strategies to meet students' learning needs. Empirical studies, such as Okwo's (2019) investigation into technology improvisation for global e-learning, advocate for strategies like adopting solar-powered devices, leveraging portable internet connectivity, and developing instructional materials for localized distribution. Similarly, Anyakaorah (2021) emphasizes the importance of improvisation in ensuring quality education, suggesting inventive substitutes for computer hardware components when the originals are unavailable. For instance, teachers can repurpose old computer components—such as calculators, laptops, smartphones, and digital cameras—to facilitate instruction, which is preferable to relying solely on blackboard diagrams or paper-based illustrations.

However, research highlights disparities in the extent to which educators embrace improvisation. While studies like Eze et al.'s (2023) exploration of computer education in Enugu North Local Government Junior High Schools indicate a moderate inclination toward improvisation, others, such as Olumba's (2013) investigation into ICT resource availability in Ebonyi State secondary schools, reveal teachers' reluctance or inability to improvise, exacerbating resource deficiencies.

While improvisation offers a pragmatic approach to overcoming resource limitations and enhancing teaching and learning, its effectiveness depends on educators' competencies, creativity, and willingness to adapt to evolving pedagogical demands. As technology rapidly transforms education, fostering a culture of improvisation holds immense potential to empower educators and optimize learning outcomes, particularly in resource-constrained settings such as Sub-Saharan Africa.

Conceptual model

We developed a conceptual model (Fig. 1) based on the research objectives and the Input-Process-Output (IPO) framework. The IPO framework is a powerful tool for understanding how inputs are transformed into outputs in complex systems or organizations through various processes (MacCuspie et al., 2014). By adopting this framework, we illustrate the factors influencing ICT integration and the potential benefits of its implementation in Figure 1.

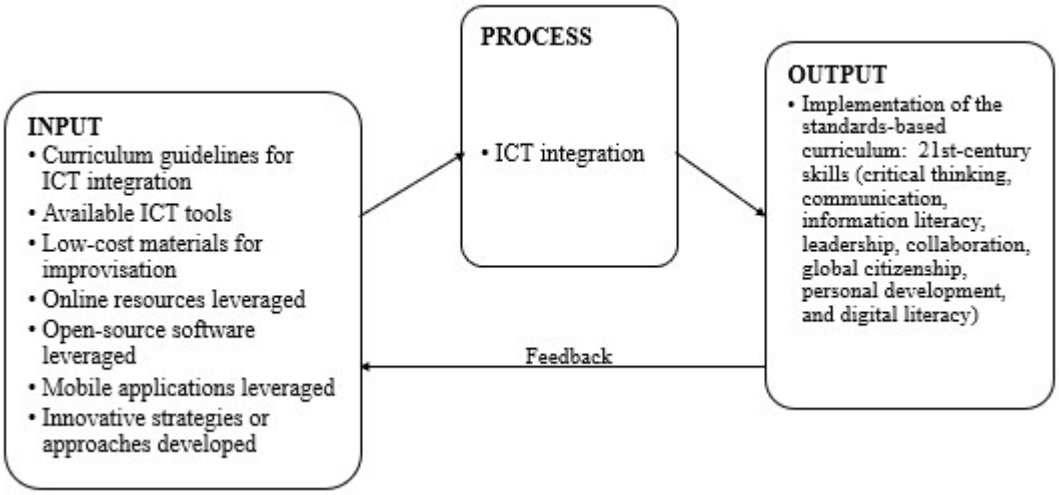

Figure 1. *Adapted IPO model*

Figure 1 illustrates that achieving full ICT integration in basic schools requires several key factors: providing essential ICT tools, training teachers on standards-based curriculum guidelines for ICT integration, utilizing low-cost materials, leveraging open-source software, adopting online resources, and implementing innovative strategies. This comprehensive approach fosters the successful realization of the curriculum's objectives, which emphasize the development of 21st-century skills such as critical thinking, communication, information literacy, leadership, collaboration, global citizenship, personal development, and digital literacy.

Methodology

Procedure

The study was framed within the critical realist paradigm, which asserts that understanding the social world requires examining the perceptions, theories, constructions, and underlying structures that shape it (Archer et al., 2013). Epistemologically, this paradigm holds that knowledge is generated by exploring the structures that give rise to it. In the context of Ghanaian basic schools, where technological resources are often scarce, teachers frequently resort to improvisation to facilitate teaching and learning. Therefore, the critical realist paradigm was chosen to construct a comprehensive and in-depth explanatory account of how teachers integrate improvised ICT tools into the classroom, drawing insights directly from their experiences (Wynn & Williams, 2012). To capture nuanced and comparative perspectives, we employed a multiple-case study design, allowing for an in-depth exploration of

teachers' experiences in both urban and rural basic schools (Yin, 2014). This design aligns well with the critical realist paradigm, as it enables a thorough investigation of each case while providing explanatory depth (Reid, 2019). Additionally, a key strength of this approach is its ability to replicate patterns across cases, enhancing the robustness of the findings. By confirming or disconfirming results across different cases, the study ensures greater reliability and validity in its conclusions.

Participants

Although Ghana's sixteen regions share similar characteristics in terms of urban-rural divides, resource availability, and government funding for education, the Ashanti region was purposefully selected as the study location due to the accessibility and availability of participants within the researchers' reach (Creswell, 2014). The regional education directorate assisted the researchers in identifying key teachers who teach ICT and other subjects in both typical rural and urban schools to participate in the study. These teachers were purposively selected because of their extensive knowledge of ICT and their ability to integrate it into other subjects. Contacting the directorate was necessary because it has supervisory jurisdiction over all the schools in the region, making access to the schools easier. A date was then scheduled for the interviews. The researchers were mindful of the study's objectives and research design, ensuring the selection of representative samples from the two different settings to provide comprehensive insights into the phenomenon under study within the cases. The study identified 12 key participants—6 from rural schools and 6 from urban schools. Teachers were selected based on their experience teaching ICT alongside other subjects and their participation in multiple workshops designed to equip them with the necessary skills and knowledge to implement the standards-based curriculum. Of the 12 participants, 4 were female (33%) and 8 were male (67%), with all teachers holding a bachelor's degree in education. They had been teaching in basic schools for at least five years, demonstrating their substantial experience in the study's context.

Data collection

We employed semi-structured interviews and classroom observations to gather data from participants, aligning with the objectives of the study. Utilizing multiple data sources ensured the convergence of evidence and enhanced the trustworthiness of the study (McMillan, 2004). An interview guide based on the research objectives was developed, incorporating open-ended questions to elicit views and insights from participants. Follow-up questions were posed when clarification was needed. The guide centered on two broad themes: the state of ICT integration in the basic school standards-based curriculum and how teachers improvise ICT tools for teaching and learning in basic schools. The interview guide ensured consistency in the questions posed to respondents. To facilitate the data collection process, we obtained an introductory letter from the regional education directorate and sought permission from headteachers of selected basic schools. Key teachers were identified as participants, and ethical considerations were communicated to them. They were provided with consent forms and an information sheet detailing the study's objectives and ethical conditions. Participants were informed about the recording of interviews and assured that recordings would be destroyed after data analysis. Confidentiality and voluntary participation were emphasized, allowing them to opt out at any stage.

The interviews were conducted between March 2024 and May 2024, with each session lasting between 50 and 60 minutes. Participants were individually interviewed at their respective schools during break periods to avoid classroom disruptions. Additional questions were asked based on participant responses, and field notes were taken during the sessions. Debriefing sessions were held post-interview to ensure clarity of responses, shared understanding, and data convergence.

Classroom observations were conducted a day after each interview to corroborate interview data and ensure triangulation. Lessons delivered by participants were observed and assessed against the questions in the interview guide. Observations provided deeper insights beyond self-reported data.

During the observations, we maintained a non-intrusive presence but engaged teachers to clarify specific issues. We examined how they integrated ICT into their lessons and how they improvised ICT tools to support teaching and learning. Field notes were taken, and each observation session lasted between 40 and 60 minutes, depending on the lesson period. Observations played a crucial role in verifying interview responses, thereby strengthening the reliability of the study (Saunders et al., 2016).

The study involved 12 teachers, six from rural schools and six from urban schools. To ensure anonymity, participants were assigned pseudonyms: rural schools: P1R, P2R, P3R, P4R, P5R, P6R, and urban schools: P1U, P2U, P3U, P4U, P5U, P6U. Interviews were conducted holistically, with probing to achieve data saturation. Saturation was reached early due to the homogeneity of participants and the specificity of the research phenomenon (Guest et al., 2006; Morse, 2000; Hagaman & Wutich, 2017). However, all identified participants were interviewed to ensure comprehensive data collection. In conclusion, our approach ensured a rigorous and ethically sound data collection process, strengthening the validity and reliability of the findings.

Data analysis

The collected interview data were transcribed verbatim with online artificial intelligence software. We listened to the audio recording several times to ensure that the recordings were well transcribed. The transcribed data was also sent to the interviewees to validate the data in terms of the accuracy of what they said (Lincoln & Guba, 1985; Creswell, 2014). The data were read multiple times to make meaning of them. The raw data was analyzed on a case-by-case basis using an inductive thematic approach. The steps used in the analysis were sorting and arranging the transcribed data, reading through the data to determine the sense it entails, coding the data by categorizing and labeling the data into segments, generating descriptions from the coded segments, presenting the descriptions in a narration, and finally, interpreting or making meaning of the data (Creswell, 2014). The coding of the data was done utilizing MAXQDA 2020 software. We used the software because we aimed to provide code metrics or frequencies and also visualize the data as illustrated in Figs. 2, 4, 6, and 8. The software supports mixed methods data analysis. Themes and patterns were identified, and open codes matched with their themes and sub-themes within the software. A collaborative approach was used to review and discuss the data segments, and as a result, consensus was consistently reached. We agreed on the meaning of the texts before coding to ensure that the correct segments were coded under the appropriate sub-themes and themes. In total, ten sub-themes and two broad themes were generated from the interview responses. This systematic and collaborative approach ensured the reliability of the coding process and that the themes accurately reflected the perspectives of the participants (Nowell et al., 2017; Lincoln & Guba, 1985). The two broad themes were ICT integration, with 5 sub-themes, and ICT improvisation, with 5 sub-themes, as shown in Table 1.

The theme, ICT integration, comprises the sub-themes: (a) curriculum familiarity, (b) available ICT resources, (c) subject areas of ICT integration, (d) ICT integration challenges, and (e) benefits of ICT integration. These sub-themes have codes or labels associated with them. These sub-themes enable us to evaluate teachers' familiarity with the curriculum guideline and their integration of ICT into the lessons. In addition, the second theme, ICT improvisation, encompasses the sub-themes (a) low-cost objects, (b) online resource leverage, (c) innovative strategies, (d) reasons for improvisation, and (e) benefits of improvisation. These sub-themes on ICT improvisation comprise labels that reflect the experiences of the participants of the study in terms of low-cost materials and innovative strategies they adopt to integrate ICT into their lessons.

Table 1.
Main themes and sub-themes for data analysis

N	Themes	Sub-Themes
1	ICT integration	Curriculum guidelines familiarity
		Available ICT Resource
		Subject areas of ICT integration
		Benefits of ICT integration
		ICT integration challenges
2	ICT Improvisation	Low-cost objects for improvisation
		Online resources leveraged for improvisation
		Innovative strategies for improvisation
		Reasons for improvisation
		Benefits of improvisation

Findings

We structured the results according to the themes and sub-themes in Table 1. The presentation of the results was supported with models. The models, Figs. 2, 4, 6, and 8, were generated with the MAXQDA software. The software produced the code metrics, which are the frequencies of the codes that were then keyed into Microsoft Excel to generate the bar graphs, Figs. 3, 5, 7, and 9.

The state of ICT integration in public basic schools

This section answers question number 1: "What is the state of ICT integration in the basic school standards-based curriculum?"

The state of ICT integration in rural schools

The analysis of the data on ICT integration in rural schools is presented in Figs. 2 and 3. Regarding (a) familiarity with the standards-based curriculum guideline for integrating ICT into teaching, there were a total of four mentions of becoming familiar through training workshops in rural areas and three mentions of getting familiar with the curriculum through curriculum materials. For (b) available ICT resources in schools for teaching and learning, there were four mentions of personal laptops, five mentions of personal smartphones, and one mention of desktop computers. Regarding (c) subjects of ICT integration, there were six mentions of computing, four mentions of science, two mentions of mathematics, and one mention of English. As for (d) benefits of effective ICT integration, there were four mentions of understanding concepts, two mentions of acquisition of digital skills, and one mention of making learning easy. Regarding (e) ICT integration challenges, there were three mentions of internet connectivity challenges, three mentions of few devices, one mention of frequent lights-out, and one mention of a lack of computers.

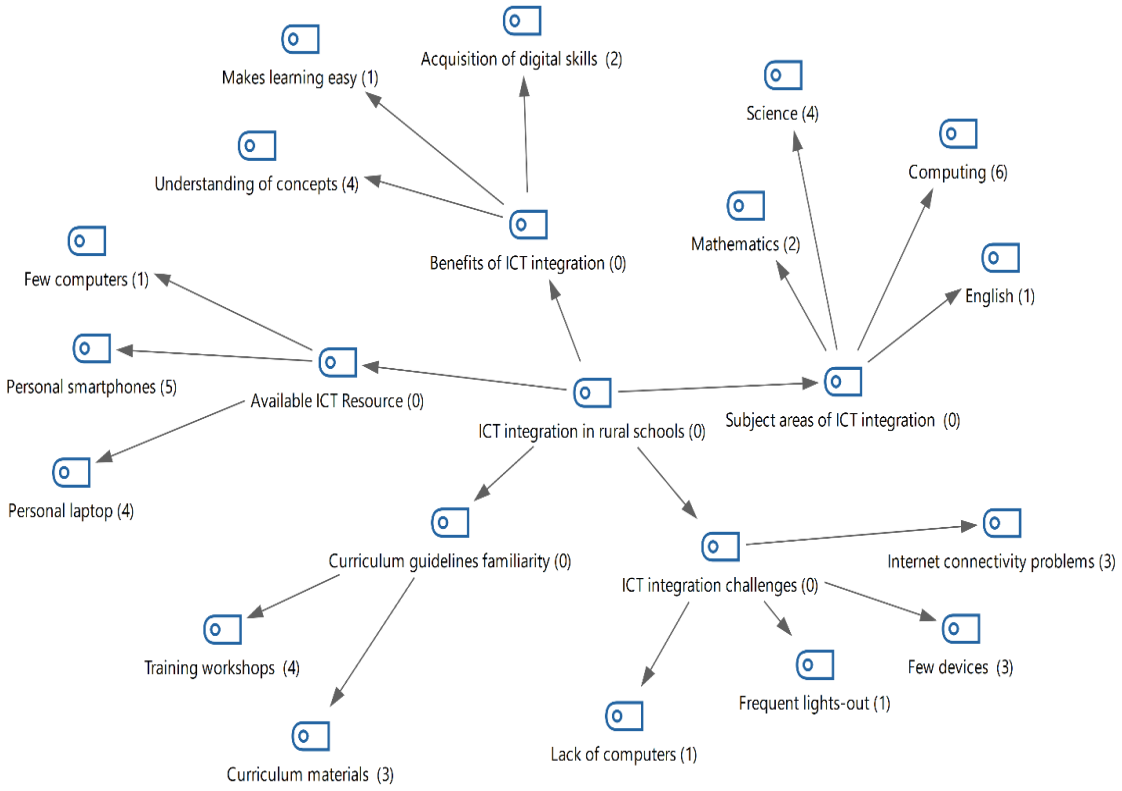

Figure 2. *Model of ICT integration in rural schools*

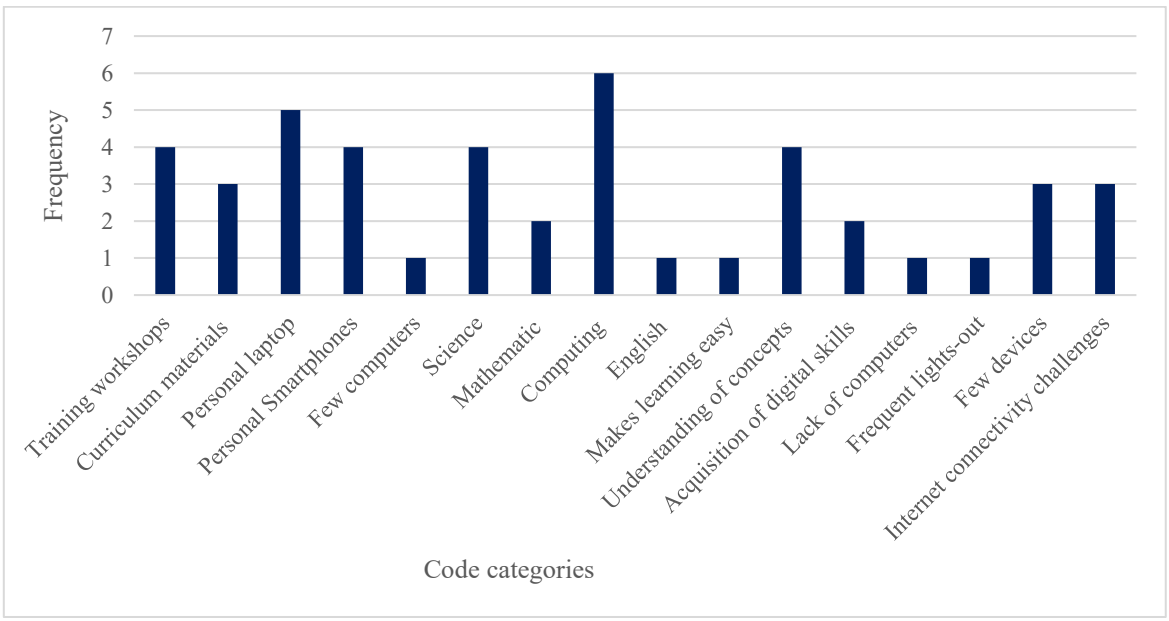

Figure 3. *Distribution of frequencies by categories*

ICT integration in urban schools

The analysis of the data on ICT integration in urban schools is presented in Figs. 4 and 5. Regarding (a) familiarity with the standards-based curriculum guidelines, there were four mentions of having gotten familiar with the guidelines through curriculum material use for teaching and two mentions of training

workshops. For (b) available ICT resources in schools, there were four mentions of personal smartphones, three mentions of personal laptops, two mentions of computer labs, two mentions of projectors, and one mention of modems. As for (c) subjects of ICT integration, there were six mentions of computing, three mentions of science, two mentions of mathematics, one mention of social studies, and one mention of our world, our people. Regarding (d) effective ICT integration, there were three mentions of understanding concepts, one mention of concrete teaching, one mention of increased interactivity, one mention of making learning easy, and one mention of learning being fun. Concerning (e) ICT integration challenges in urban schools, there were four mentions of internet connectivity problems, four mentions of frequent lights-out, and two mentions of few devices.

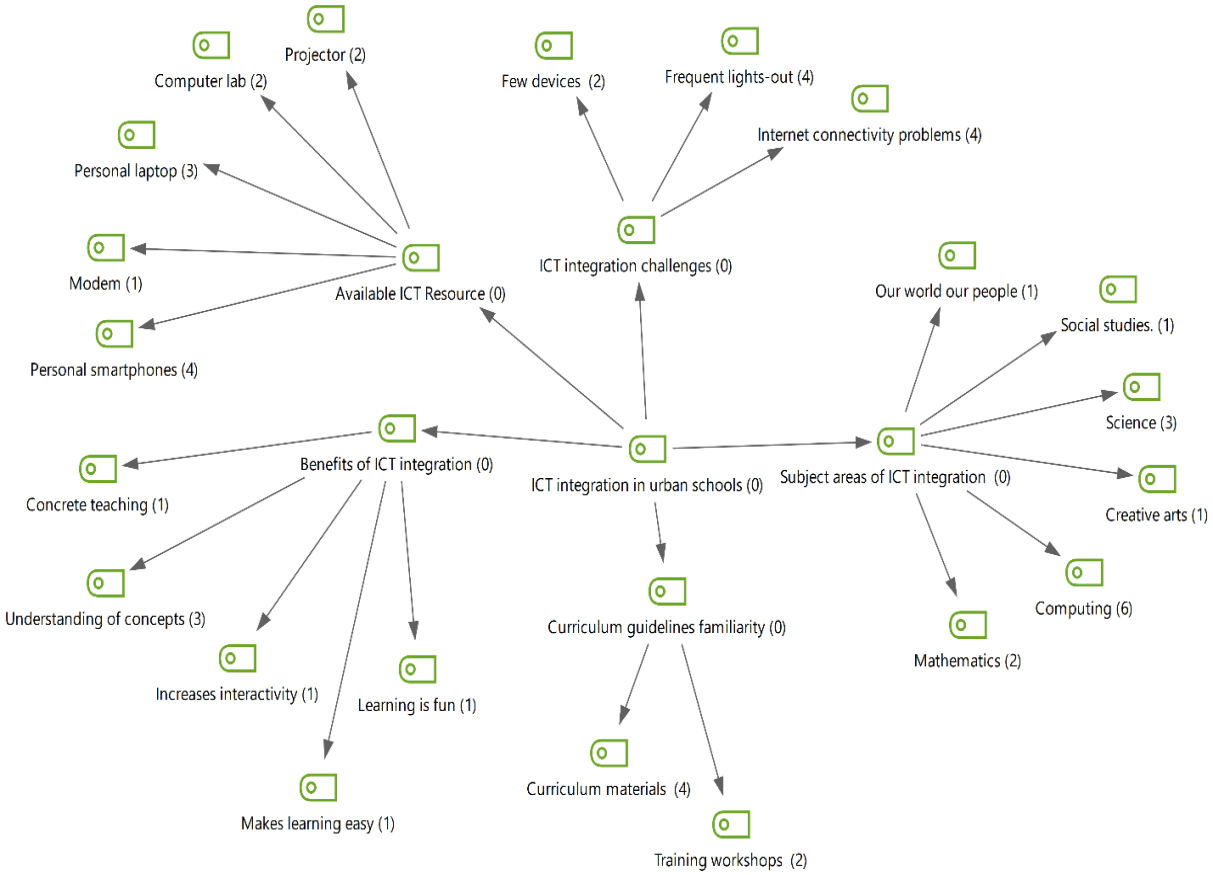

Figure 4: *Model of ICT integration in urban schools*

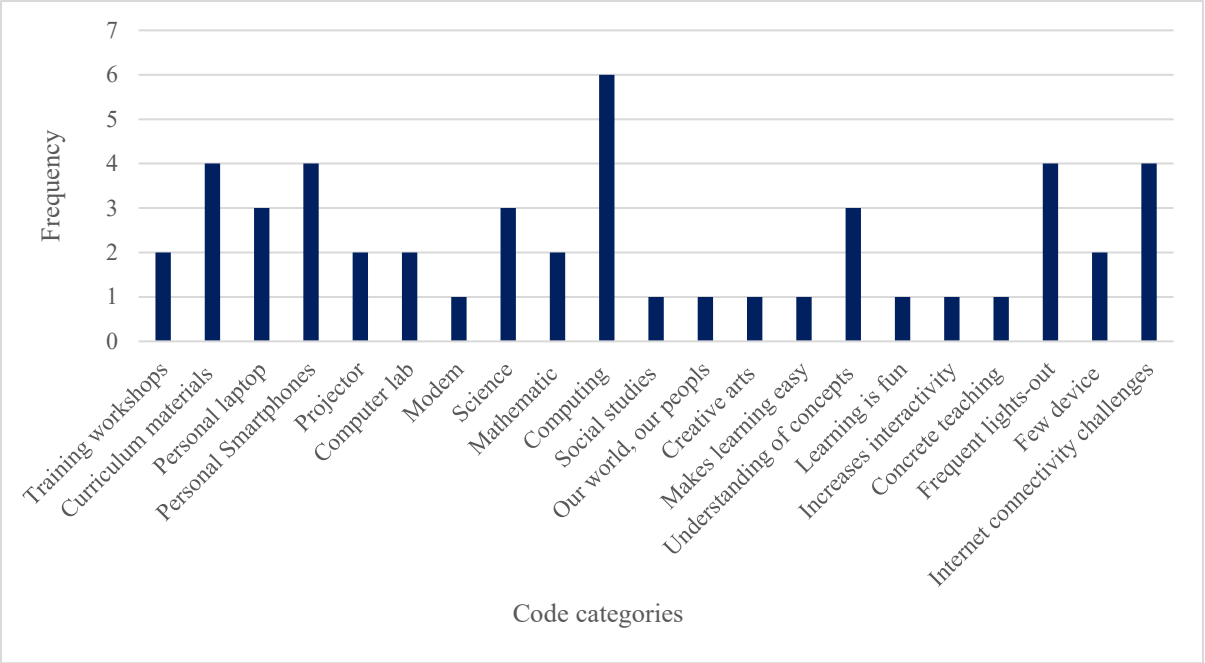

Figure 5. *Distribution of frequencies by categories*

ICT Improvisation

This section answers the research question number 2: "How are teachers improvising ICTs for teaching and learning in public basic schools?"

ICT Improvisation in rural schools

The analysis of data on ICT improvisation in rural schools is presented in Figs. 6 and 7. Regarding (a) low-cost materials for improvisation, there were two mentions of cardboard, one mention of empty boxes, one mention of an old non-functional device, one mention of printed pictures of devices, and one mention of a mirror. For (b) online resources leveraged for improvisation, there were two mentions of learning materials on websites and one mention of online videos. As for (c) innovative strategies for improvisation, there were three mentions of drawing ICT tools on boards, one mention of a field trip, and one mention of showing students printed pictures. Regarding (b) reasons for improvisation, there were three mentions of inadequate resources and two mentions of unavailability of resources. Relating to (e) benefits of improvisation on students' engagement, there were three mentions of concept understanding, two mentions of sustained interest in learning, one mention of concrete teaching, and one mention of increased interactivity.

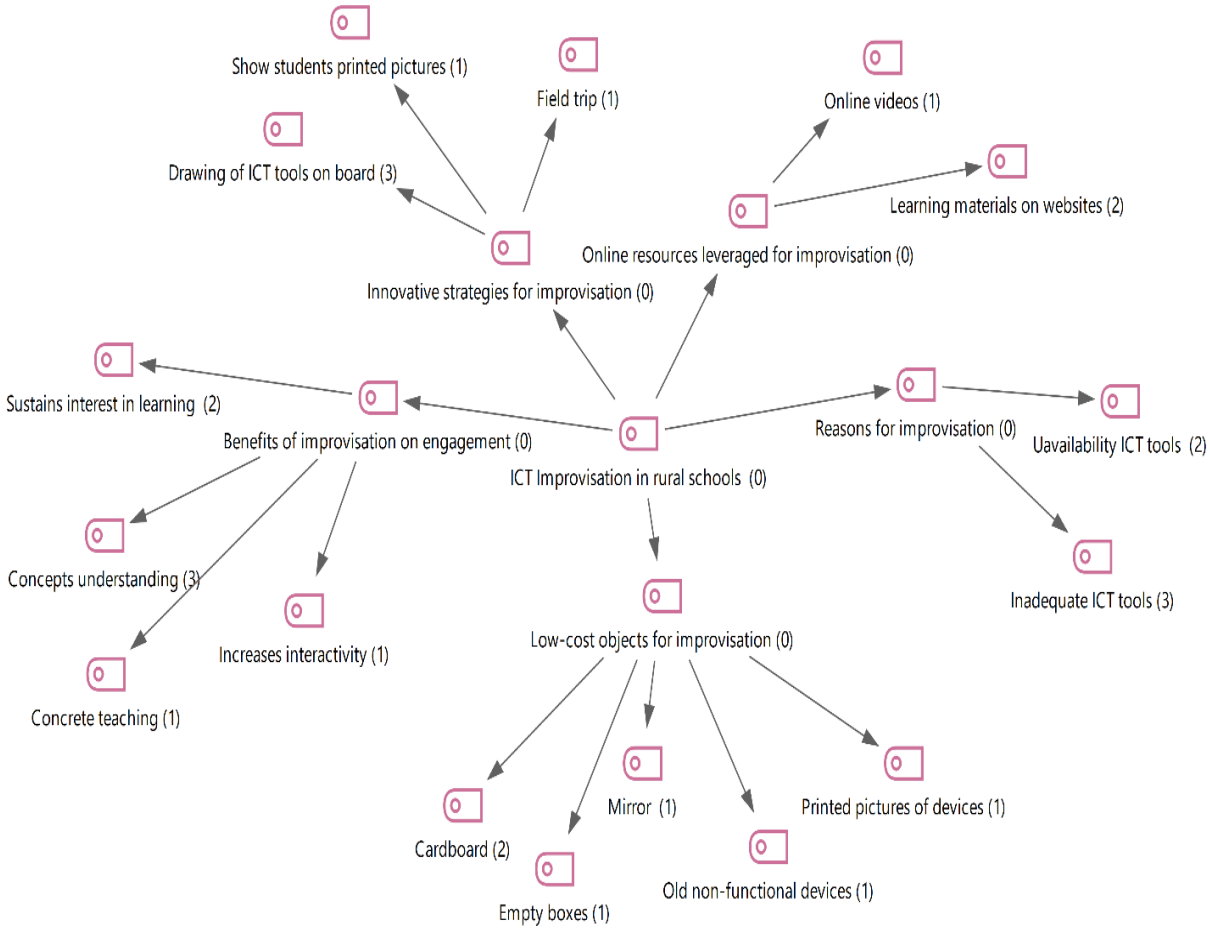

Figure 6. *Model of ICT improvisation in rural schools*

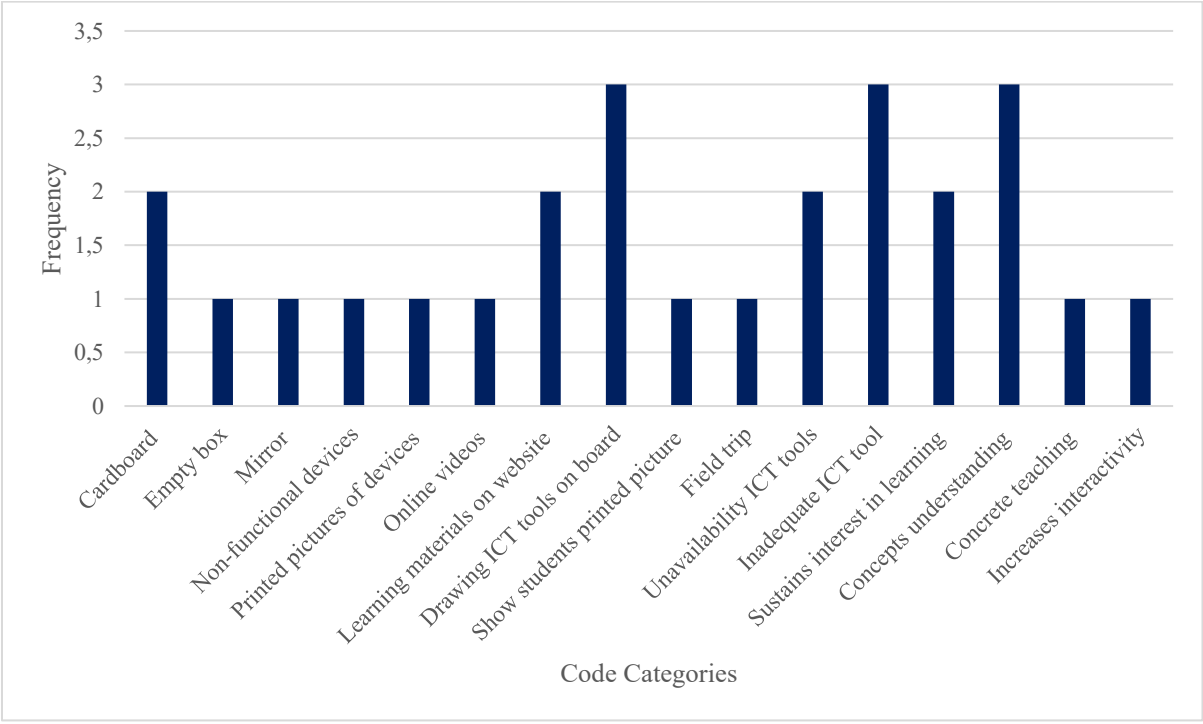

Figure 7: *Distribution of frequencies by categories*

ICT Improvisation in urban schools

The results of the analysis of the data on ICT improvisation in urban schools are presented in Figs. 8 and 9. Regarding (a) low-cost materials for improvisation, there were four mentions of cardboard and two mentions of non-functional devices. Concerning (b) online resources leveraged for improvisation, there were two mentions of learning materials on websites, two mentions of online learning apps, and one mention of online videos. As for (c) innovative strategies for improvisation, there was one mention of showing students printed pictures, one mention of doing it yourself, one mention of using internet images, one mention of showing videos to students, and one mention of using cardboard to develop ICT tools. Regarding (d) reasons for improvisation, there were two mentions of unavailability of ICT tools and one mention of inadequate ICT tools. For (e) benefits of improvisation on students' engagement, there were three mentions of sustained interest in learning, two mentions of concept understanding, and one mention of interactivity.

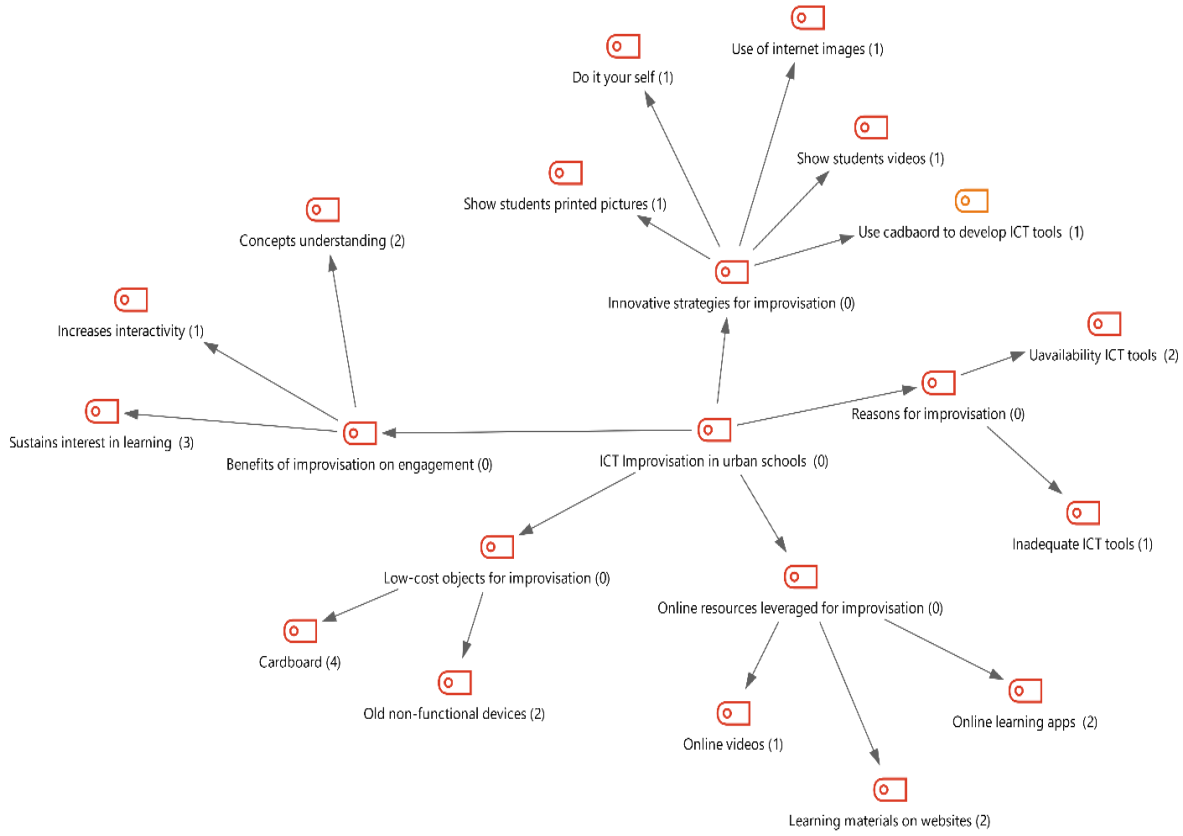

Figure 8. *Model of ICT improvisation in urban schools*

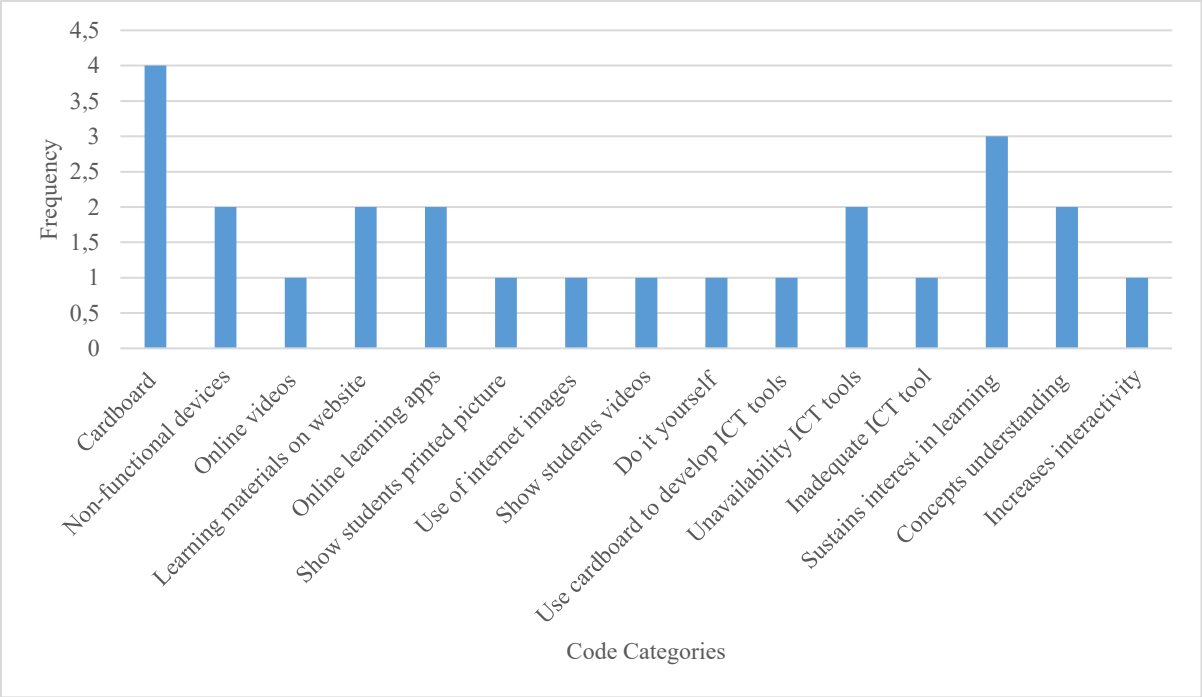

Figure 9. *Distribution of frequencies by categories*

Discussion

The findings indicate that teachers in both rural and urban schools are familiar with the standards-based curriculum guidelines for ICT integration in teaching. However, their sources of familiarity differ. According to Fig. 3, most rural teachers gain awareness through training, whereas urban teachers (Fig. 5) primarily learn from curriculum materials. In Ghana, pre-service teachers use curriculum documents, while in-service teachers receive periodic training and access to specific materials for their classes. Professional learning communities (PLCs) also contribute to teachers' familiarity, aligning with studies (Quainoo, 2024; Tran & O'Connor, 2024) that highlight the role of workshops and PLCs in curriculum discussions. This supports Msafiri et al. (2023), who assert that curriculum familiarity enhances teachers' ability to select appropriate ICT tools.

Teachers in both settings predominantly use personal laptops and mobile phones for instruction. However, comparative analysis of Fig. 3 and Fig. 5 reveals that urban schools have additional resources such as computer labs, modems, and projectors, whereas rural schools struggle with limited ICT infrastructure. Although both settings report insufficient ICT devices, rural schools face more severe challenges. Literature (Ramaila & Molwele, 2022; Halleem et al., 2022) highlight the use of advanced ICT tools in technologically advanced countries, yet the basic schools in this study lack such resources. Unlike this study, Msafiri et al. (2023) reported the use of various educational software. Other studies (Papadaki et al., 2023; Aliyu & Talib, 2023) highlight digital tools such as Google Classroom, Edmodo, MOOCs, Zoom, Kahoot, and ClassDojo—resources largely absent in the schools examined.

Teachers in both rural and urban schools integrate ICT across subjects, including science, mathematics, computing, English, social studies, creative arts, and "Our World, Our People," as mandated by Ghana's standards-based curriculum (Ministry of Education, 2019). This supports Msafiri et al. (2024), who argue that ICT should not be standalone but integrated across subjects. However, Ibrahim et al. (2022) contrast this view, noting that ICT integration into mathematics and social studies remains minimal due to perceptions of ICT as a separate subject.

All teachers acknowledged several benefits of ICT integration, including making learning engaging, enhancing concept understanding, promoting digital skills, increasing interactivity, and

enabling personalized learning. These align with Msafiri et al. (2024), who emphasize that ICT enhances learning by providing access to extensive materials and improving teaching processes.

Despite its benefits, ICT integration faces several challenges. Figs. 3 and 5 highlight issues such as inadequate computers, poor internet connectivity, power outages, and limited access to interactive boards. These challenges align with previous studies (Enu et al., 2018; Natia, 2015; Soma et al., 2021; Agyei, 2013), which report similar barriers. The challenges are more pronounced in rural schools, where ICT resources are scarce, and teachers heavily rely on personal devices. Comparative analysis of Fig. 3 and Fig. 5 suggests that urban schools, though facing difficulties, have relatively better ICT infrastructure. Mustafa et al. (2024) further emphasize that rural teachers have limited access to computers and labs, reinforcing the urban-rural disparity.

Due to limited ICT resources, teachers in both settings improvise teaching materials. As illustrated in Fig. 7 and Fig. 9, common improvised materials include cardboard models, empty boxes, mirrors, non-functional devices, and printed images of ICT tools. Rural schools rely more on low-cost improvisation than urban schools. This disparity arises because rural schools have fewer original ICT resources. These findings align with Anyakaorah (2021) and Okwo (2019), who highlight teachers in resource-constrained settings using old computers, boxes, and printed images to enhance instruction. Unlike studies by Aliyu and Talib (2023) and Zainil et al. (2023), which emphasize online resources like Google Classroom, MOOCs, and virtual labs, teachers in this study primarily used online videos, website-based learning materials, and mobile apps. This suggests that basic school teachers struggle to fully leverage diverse technological tools.

Teachers also employ innovative strategies to enhance ICT instruction, including drawing ICT tools on boards, displaying printed images, organizing field trips, using online images and videos, and engaging students in DIY projects. A comparative analysis of Fig. 7 and Fig. 9 indicates that urban teachers use online resources more frequently than rural teachers, who rely more on improvisation. Urban teachers also develop more creative strategies to enrich learning, consistent with Mustafa et al. (2024), who advocate for alternative ICT platforms to support teaching.

Educators must explore ways to develop local materials as substitutes, ensuring interactive and engaging learning experiences (Obodo et al., 2020). Teachers in both settings report that improvisation sustains student interest, enhances conceptual understanding, provides concrete teaching aids, increases interactivity, and improves learning outcomes. These findings align with Obodo et al. (2020), whose study found that improvisation positively impacts academic performance by connecting classroom activities to real-life situations.

Implications and Recommendations

The standards-based curriculum for Ghana's basic schools emphasizes ICT integration and 21st-century skills like critical thinking, creativity, and digital literacy. However, inadequate technological resources and limited teacher capacity pose significant challenges to its implementation, particularly in rural areas. Teachers struggle to leverage open-source software, online resources, and mobile applications, widening the gap between rural and urban schools and exacerbating educational inequalities.

To address these challenges, clear ICT integration guidelines should be institutionalized, and teachers should receive periodic training through workshops and conferences. Readily available curriculum materials, including textbooks and syllabi, are essential for effective implementation. Policymakers must ensure that schools have the necessary ICT tools, aligning available technological resources with curriculum requirements.

Teachers, particularly in rural schools, should be trained in adopting, adapting, and innovating with diverse ICT resources. Programs like OpenAI's training course for teachers and Harvard's Improvisation for Educators can enhance their digital literacy and improvisation skills. Schools should

also encourage teachers to maximize existing resources, integrating ICT tools into lessons to boost student engagement and skill development. School administrators should monitor ICT usage in classrooms and implement quality assurance measures to enhance instructional effectiveness.

The successful integration of technology in education depends on several factors, one of which is teachers' familiarity with curriculum guidelines. Training and active participation in curriculum development deepen teachers' understanding of the curriculum, enabling them to incorporate ICT effectively into their lessons. Workshops provide opportunities for educators to engage with curriculum materials and discuss educational policies (Quainoo, 2024). Furthermore, teachers can explore curriculum materials independently or collaborate with colleagues in professional learning communities (Tran & O'Connor, 2024). A strong grasp of ICT-related curriculum guidelines allows educators to select appropriate tools, implement innovative teaching strategies, and maximize available resources.

Beyond traditional ICT training, teacher education should emphasize improvisation, equipping educators to integrate ICT creatively despite resource limitations. Improvisation is a pragmatic approach to addressing infrastructure gaps, requiring teachers to develop adaptability and innovative pedagogical techniques. Collaboration with NGOs, government programs, and community leaders can help schools secure low-cost technological solutions. Initiatives like Bring Your Own Device (BYOD) can further bridge ICT access gaps, ensuring both teachers and students benefit from digital learning tools. As technology continues to evolve, fostering a culture of improvisation is crucial for optimizing learning outcomes, particularly in resource-constrained environments.

Conclusion

Teachers in both rural and urban schools are familiar with ICT curriculum guidelines, but they acquire this knowledge differently. Urban teachers primarily rely on textbooks and the syllabus, while rural teachers learn through workshops and conferences. Both groups use personal laptops and mobile phones for ICT integration, but urban schools have more resources. Rural schools face severe ICT shortages, limiting access and utilization despite government laptop distribution. Urgent interventions, such as computer laboratories, are needed in rural areas. Due to resource constraints, teachers, especially in rural areas, improvise with low-cost materials like old computer parts, pictures, and drawings. However, they struggle to utilize online and open-source resources, unlike urban teachers, who integrate them more effectively. Intensive training is essential for teachers in both settings to maximize ICT benefits. Training should focus on using online resources, open-source software, and mobile applications for teaching. Teachers recognize the importance of ICT integration and improvisation, emphasizing that both approaches enhance lesson interactivity, engagement, and student understanding. To bridge the ICT gap, the Ghana Education Service, NGOs, school management, and parent-teacher associations must actively support schools with the necessary resources. The findings of this study offer insightful information to guide future ICT planning, teacher preparation, and educational policy in Ghana's basic education sector.

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