



From Awareness to Adoption: Exploring ICT Integration among Secondary School Computer Science Teachers in Sabon Gari Area of Kaduna State, Nigeria

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Abstract

This study examined information and communications technology (ICT) integration among secondary school computer science teachers in Sabon Gari Local Government area, Kaduna State, Nigeria, focusing on the transition from awareness to actual adoption of ICT in instructional practices. Guided by three research questions, the study examined teachers' experiences of ICT resource availability and utilization, their perceptions of ICT competence, and the contextual factors influencing ICT adoption. A qualitative phenomenological research design to gain an in-depth understanding of teachers' lived experience of ICT integration in the classroom research design was employed, using purposive sampling to select eight computer science teachers from secondary schools within the study area. Data were collected through semi-structured interviews and analyzed using thematic analysis. Findings revealed significant disparities in the availability of ICT resources, with some schools having access to functional ICT facilities while others faced severe shortages. Teachers in better-equipped schools reported greater opportunities for integrating technology, whereas those in under-resourced schools experienced limitations that hindered effective ICT use. ICT competence is developed through continuous professional learning, self-directed practice, and sustained engagement with digital tools. In addition, ICT adoption was also influenced by institutional support, infrastructural availability, and professional development opportunities. Despite these challenges, teachers demonstrated positive attitudes toward ICT and recognized its value in enhancing student engagement and learning outcomes. The study recommends that government and school administrators strengthen ICT infrastructure and provide continuous professional development to support effective ICT integration in secondary schools.

Keywords: ICT integration, secondary education, ICT infrastructure, technology acceptance model, qualitative research method

1 Introduction

The emergence and widespread adoption of information and communication technology (ICT) have significantly influenced educational systems across the globe. In recent years, technological innovations have reshaped conventional teaching and learning processes, making education more dynamic, interactive, and accessible (Msafiri et al., 2023). The integration of digital technologies into educational environments has enabled institutions to enhance instructional delivery, increase student participation, and equip learners with the competencies needed to function effectively in an increasingly digital and knowledge-driven society (Bond et al., 2020; Nkomo et al., 2021). As technology continues to permeate various aspects of education, the role of teachers in facilitating technology-supported learning has become increasingly important. The effective use of ICT in the classroom requires educators to possess a combination of technological knowledge, pedagogical expertise, and positive attitudes toward digital innovation. According to Falloon (2020), teacher digital competence encompasses the skills, knowledge, and dispositions necessary for the meaningful application of technology in educational contexts. Likewise, Tondeur et al. (2021) argued that teachers' readiness and capacity to adapt to emerging technologies are critical determinants of successful ICT integration in schools. The incorporation of ICT into educational practice has been associated with numerous benefits, including enhanced learner engagement, improved communication, increased collaboration, and the promotion of active participation in the learning process (Bond et al., 2020; Nkomo et al., 2021). Through digital technologies, learners can access a wide range of educational resources, engage in self-directed learning, and receive more personalized instructional support. These potential benefits have encouraged governments, policymakers,

and educational stakeholders to invest in technological infrastructure and initiatives aimed at strengthening teachers' digital competencies (Falloon, 2020; Woldemariam et al., 2025).

Despite the growing recognition of ICT as a valuable educational resource, its implementation remains inconsistent across many educational settings, particularly in developing countries (Tondeur et al., 2021). Although teachers may be familiar with various digital tools and understand their educational relevance, such awareness does not always translate into actual classroom utilization. The movement from awareness to adoption is influenced by several interconnected factors, including teachers' technological competence, perceptions of technology, availability of digital resources, institutional support mechanisms, and access to professional development programmes (Tondeur et al., 2021; Woldemariam et al., 2025). Consequently, disparities often exist between teachers' understanding of ICT and their ability to integrate it effectively into instructional activities. ICT awareness generally refers to an individual's knowledge of technological tools and their potential applications within educational settings, whereas ICT adoption involves the deliberate acceptance and practical use of such technologies for teaching and learning purposes. Studies suggest that teachers who possess higher levels of digital competence and receive adequate organizational support are more likely to adopt and utilize technology in their instructional practices than those who lack these enabling conditions (Falloon, 2020; Tondeur et al., 2021). Furthermore, continuous professional training has been identified as a crucial factor in improving teachers' confidence, competence, and willingness to incorporate digital technologies into classroom instruction (Bond et al., 2020; Woldemariam et al., 2025).

Within the Nigerian educational system, ICT integration has become an important strategy for enhancing educational quality and developing learners' digital capabilities (Olowonefa, 2022). Nevertheless, several barriers continue to limit the effective implementation of technology in schools. Challenges such as inadequate technological facilities, restricted access to digital resources, insufficient training opportunities, and other contextual constraints often impede teachers' efforts to utilize ICT effectively. These limitations may prevent educators from progressing beyond basic awareness to the practical adoption of technology in teaching and learning activities. Although awareness of ICT among teachers has improved considerably over time, there remains limited empirical evidence regarding the extent to which such awareness results in meaningful classroom application, particularly in Sabon Gari Local Government Area of Kaduna State where limited empirical evidence on teachers' ICT integration practices in the area, making it an appropriate setting for the study, there is a need to investigate how secondary school teachers translate their knowledge of ICT into actual instructional practice. Therefore, this study examines ICT integration among secondary school teachers in the area, with particular emphasis on the transition from awareness to adoption. In particular, this study addresses the following research questions:

1. How do Computer Science teachers in secondary schools experience the availability and utilization of ICT resources in their instructional practice
2. How do Computer Science teachers construct their understanding of ICT competence and preparedness for technology-enhanced teaching?
3. What contextual factors shape the adoption and effective integration of ICT among secondary school Computer Science teachers?

Addressing these research questions will generate empirical insights into the availability and utilization of Information and Communication Technology (ICT) resources in the teaching and learning of Computer Science. The outcomes of the investigation are expected to enhance understanding of the prospects and constraints surrounding ICT adoption in secondary education. The evidence derived from the study may help teachers refine their instructional approaches, enable school administrators and policymakers to make evidence-based decisions regarding the provision of ICT facilities and professional development opportunities, and assist curriculum developers in formulating effective strategies for integrating technology into classroom practices. In addition, the findings will contribute to the growing body of literature on educational technology and serve as a valuable reference for subsequent studies in this field.

2 Theoretical Framework

This study is anchored on the diffusion of innovation theory and the technology acceptance model (TAM). These theories provide a comprehensive explanation of how teachers become aware of technological innovations and the factors that influence their decision to adopt and utilize such technologies in educational practice. The diffusion of innovation theory was developed by Rogers (2003) to explain how new ideas, technologies, and innovations spread within a social system over time. The theory emerged from the recognition that individuals differ in their willingness to embrace innovations and

that adoption is a gradual process rather than an instantaneous event. Rogers proposed that individuals progress through five stages before fully adopting an innovation: knowledge, persuasion, decision, implementation, and confirmation. The knowledge stage involves becoming aware of an innovation and understanding its functions. During the persuasion stage, individuals develop favourable or unfavourable attitudes toward innovation. This is followed by the decision stage, where individuals choose either to adopt or reject the innovation. Implementation occurs when the innovation is put into use, while confirmation involves continued use based on the perceived benefits derived from the innovation. Rogers further identified five characteristics that influence adoption: relative advantage, compatibility, complexity, trialability, and observability. These characteristics determine the speed and extent to which an innovation is accepted within a social system.

The assumptions of the diffusion of innovation theory align strongly with ICT integration in education because the adoption of technological tools by teachers follows a similar progression from awareness to utilization. In this study, the knowledge stage informed the investigation of ICT awareness, explaining how teachers become aware of ICT tools and their instructional potential; the persuasion stage informed the examination of teachers' perceptions of ICT, reflecting how their attitudes toward the usefulness and relevance of ICT shape adoption decisions; the decision and implementation stages informed the investigation of ICT adoption, focusing on teachers' decisions to use ICT and its actual integration into classroom practice; while the confirmation stage informed the understanding of sustained ICT integration, whereby continued use is reinforced through positive teaching experiences, institutional support, and observed instructional benefits. Complementing the DOI Theory, the Technology Acceptance Model (TAM) developed by Davis (1989) explains technology acceptance through the constructs of perceived usefulness and perceived ease of use. In this study, perceived usefulness informed the exploration of teachers' beliefs about the extent to which ICT enhances instructional effectiveness and student learning, whereas perceived ease of use informed the examination of teachers' confidence in using ICT and the influence of technological complexity on their willingness to integrate ICT into classroom instruction.

The relevance of TAM to this study lies in its explanation of the factors that influence teachers' willingness to adopt ICT in educational settings. Teachers who perceive ICT as useful for improving lesson delivery, enhancing student engagement, and facilitating classroom management are more likely to incorporate it into their instructional practices. Similarly, when teachers possess adequate technological skills and receive the necessary support and training, they are more likely to view ICT as easy to use and therefore adopt it more readily. The model therefore helps explain why some teachers who are aware of ICT successfully integrate it into teaching, while others remain reluctant despite having similar levels of awareness. Those theories were strengthened by incorporating a critical comparison of empirical studies that applied DOI Theory and the TAM. The comparisons findings from previous studies show that DOI-based studies primarily explain the diffusion of ICT innovations through innovation characteristics and adoption processes (Rogers, 2003), whereas TAM-based studies identify perceived usefulness and perceived ease of use as the key determinants of teachers' technology acceptance (Davis, 1989). Furthermore, the framework justifies the integration of DOI and TAM by demonstrating that their combined application provides a more comprehensive explanation of ICT adoption, capturing both the organizational processes of innovation diffusion and the individual factors influencing teachers' acceptance and utilization of ICT (Dwivedi et al., 2021). Although the DOI Theory and the TAM have made significant contributions to understanding technology adoption, both have been subject to scholarly criticism.

The DOI Theory has been criticized for assuming that innovation adoption follows a relatively linear and predictable process, which may not adequately capture the complex realities of educational settings where adoption is influenced by institutional policies, resource availability, leadership support, and socio-cultural contexts. Empirical studies have shown that teachers' decisions to adopt educational technologies are shaped by multiple contextual and organizational factors beyond the innovation attributes proposed by the theory (Greenhalgh et al., 2004; Straub, 2009). Similarly, the Technology Acceptance Model has been criticized for its strong emphasis on individual cognitive perceptions particularly perceived usefulness and perceived ease of use while paying insufficient attention to external variables such as organizational support, facilitating conditions, social influence, and technological infrastructure that significantly affect technology adoption in educational environments (Venkatesh & Bala, 2008; Venkatesh et al., 2016). Despite these limitations, the two theories remain among the most widely applied frameworks in studies of educational technology and innovation adoption. The prospects of both theories remain strong in contemporary educational research due to the increasing emphasis on digital learning, technology-enhanced instruction, and teacher digital competence. As educational institutions continue to invest in technological innovations, understanding how teachers move from awareness to adoption becomes increasingly important. The diffusion of innovation theory explains the process through which ICT spreads among teachers, while the TAM explains the factors that influence their acceptance and utilization of technology. Together, the theories provide a robust theoretical foundation for examining ICT integration among secondary school teachers in Sabon Gari Local Government Area of Kaduna State, Nigeria.

3 Methodology

3.1 Research Design

This study employed phenomenological qualitative research design as described by (Creswell & Creswell, 2017; Zakariya et al. 2026; Van Manen, 2016) to explore ICT integration among secondary school teachers in Sabon Gari Local Government Area of Kaduna State, Nigeria. The qualitative approach was considered appropriate because it provides an opportunity to gain an in-depth understanding of teachers' experiences, perceptions, and practices regarding ICT awareness and adoption in teaching and learning. The design enabled participants to express their views freely on factors influencing ICT integration, challenges encountered, and strategies that could enhance the effective use of technology in schools. Through this approach, the study generated rich and detailed information concerning the transition from ICT awareness to actual adoption among secondary school teachers.

3.2 Participants and Sampling Procedure

The participants for this study consisted of eight secondary school computer science teachers drawn from selected public secondary schools in Sabon Gari Local Government Area, Kaduna State. A purposive sampling technique was utilized to identify and select teachers who possessed prior knowledge of ICT and had practical experience in using technological tools for instructional purposes. This sampling method was considered appropriate because it allowed the selection of information-rich participants capable of providing relevant insights into the phenomenon under investigation. The participants represented diverse demographic and professional characteristics, including differences in age, gender, educational qualifications, teaching experience, and administrative responsibilities. Such diversity was considered essential for capturing a broad range of perspectives on ICT awareness and adoption. According to Hennink and Kaiser (2022) the selection of eight participants was considered sufficient to ensure the credibility, adequacy, and trustworthiness of the study findings. Interview sessions were arranged at times and locations that were convenient for the participants within their respective schools. To maintain confidentiality and anonymity, each participant was assigned a unique identification code such as R1, R2, R3, and so forth. These identifiers were consistently used throughout the data collection, analysis, and reporting stages of the study. Data collection continued until data saturation was achieved, defined as the stage at which additional interviews no longer generated new themes, categories, or meaningful insights (Braun & Clarke, 2021; Hennink & Kaiser, 2022). Saturation was reached after the eighth interview, as participants' responses became repetitive and no new information emerged.

Table 1

Interviewed teachers code and experience

Respondent	Gender	School Type	Experience	Qualification	Age Range
R1	Female	Private	7 years	BSc. Computer Science	30 – 35
R2	Female	Private	8 years	BSc.Ed Computer Science	31 – 35
R3	Male	Public	2 years	NCE Computer/Mathematics	25 – 29
R4	Female	Public	2 years	BSc.Ed Computer Science	22 – 25
R5	Male	Private	5 years	BSc. Mathematics	30 – 35
R6	Male	Private	6 years	BSc. Computer Science	27– 31
R7	Male	Private	3 years	M.Ed Computer Science	28 – 34
R8	Male	Public	6 years	BSc. Computer Science	30 – 35

3.3 Method of Data Collection

Data for this study was collected through semi-structured interviews. The semi-structured interview approach was considered suitable because it allowed participants to provide detailed explanations of their experiences while enabling the researcher to probe additional information where necessary. An interview guide was developed based on the objectives of the study and relevant literature on ICT integration in education. The guide contained questions relating to teachers' awareness of ICT, the extent of ICT adoption, factors influencing technology use, challenges encountered, and possible strategies for improving ICT integration in secondary schools. Example Interview Questions: Participants were asked

questions such as: "What ICT resources are available in your school?", "How do you integrate ICT into your classroom instruction?", "How would you describe your competence in using ICT for teaching?", "What factors facilitate or hinder your use of ICT in teaching?", and "What strategies would you recommend for improving ICT integration in secondary schools?" Follow-up probing questions were asked where necessary to obtain more detailed responses. Before each interview, ethical approval was obtained from an institutional review board, the purpose and objectives of the study were clearly explained to the participants, and informed consent was obtained. Participants were assured that all information provided would be treated with strict confidentiality and used solely for academic purposes. With the permission of the participants, all interviews were audio-recorded to facilitate accurate data capture and transcription. The interviews were conducted in comfortable and convenient locations within the school environment and lasted approximately 30 to 45 minutes.

3.4 Method of Data Analysis

The interview data was analyzed using the Three-Phase Thematic Analysis approach proposed by (Braun and Clarke 2006, 2021). This analytical technique was adopted because of its effectiveness in identifying, organizing, and interpreting recurring patterns and meanings embedded within qualitative data. Following data collection, all recorded interviews were transcribed verbatim and carefully reviewed to ensure the accuracy and completeness of the information obtained. The first phase involved familiarization with data and coding. During this stage, the researcher repeatedly read the interview transcripts to gain a deep understanding of the participants' responses. Relevant statements, concepts, and ideas related to the objectives of the study were identified and assigned codes. This coding process facilitated the organization of the data into meaningful segments and aided the identification of recurring patterns.

The second phase focused on the development and categorization of themes. At this stage, related codes were systematically examined and grouped according to their similarities and relationships. Through this process, broader categories and thematic patterns emerged from the data. The researcher carefully reviewed the coded extracts to ensure that the emerging themes accurately represented participants' experiences and viewpoints concerning ICT awareness, ICT adoption, enabling factors, and challenges associated with technology integration. The third phase involved theme interpretation and presentation of findings. During this stage, the identified themes were refined, interpreted, and linked to the objectives and theoretical foundations of the study. The findings were subsequently presented in a narrative form and supported with direct quotations from participants where appropriate. This analytical process provided a comprehensive understanding of ICT integration among secondary school teachers in Sabon Gari Local Government Area. The analysis ultimately generated major themes relating to ICT awareness, technology adoption practices, facilitators of ICT integration, barriers to technology utilization, and strategies for enhancing ICT implementation in secondary schools.

3.5 Research Quality and Trustworthiness

To ensure the trustworthiness of the study, several strategies were employed throughout the research process. We maintained neutrality during data collection and analysis, which allow participants to express their views freely and seeking clarification where necessary to ensure accurate interpretation. Credibility was enhanced through member checking, in which the audio-recorded interviews were transcribed verbatim, and the transcripts were returned to the respective participants for review. Participants were asked to verify that their views had been accurately captured, clarify any ambiguous statements, correct inaccuracies, and provide additional comments where necessary before the transcripts were finalized for coding and thematic analysis. This process ensured that the findings accurately reflected the participants' intended meanings. In addition, the inclusion of teachers from different secondary schools provided diverse perspectives on ICT integration, thereby enriching the data. Anonymity was ensured through the use of participant codes instead of real names. Dependability was established by maintaining detailed records of interviews, field notes, transcripts, coding processes, and theme development, thereby creating a comprehensive audit trail for transparency. Transferability was supported through detailed descriptions of the study context, participants, and research procedures, as well as the use of verbatim quotations to substantiate the findings. Collectively, these measures enhanced the credibility, dependability, confirmability, and transferability of the study (Lincoln & Guba, 1985; Nowell et al., 2017).

4 Results

4.1 Theme 1: Unequal ICT Infrastructure Shapes Teachers' Opportunities for Technology Integration

The findings revealed substantial variation in ICT infrastructure across schools, creating distinctly different experiences of technology integration among computer science teachers. While some teachers worked in highly digitized environments, others operated in contexts characterized by severe technological limitations.

Teachers from well-resourced private schools described extensive access to digital technologies. (R1) explained:

"We have a modern ICT laboratory with over 40 functional desktop computers, laptops for all teachers, interactive smart boards in all classrooms, multimedia projectors, high-speed internet access, computer servers, scanners, printers, and a dedicated school Wi-Fi network."

Similarly, (R2) reported:

"We have a well-equipped ICT laboratory with desktop computers, laptops for teachers, projectors in all classrooms, interactive smart boards, stable internet access."

Conversely, teachers from public and less-resourced schools consistently reported inadequate ICT facilities. (R3) stated:

"the computer facility is not actually available and is not much to go around for the students to carry out their practical activities."

Likewise, R4 explained:

"our facilities are not sufficient. We need enough computers for the teaching and learning of ICT."

R7 similarly observed:

"the only ICT facility that we have is computer."

R8 emphasized that student populations far exceeded available resources:

"the students are even more than the computer system that we have in the laboratories."

The data further revealed that teachers frequently improvised to compensate for infrastructure shortages. Several participants reported using personal laptops and devices to support instruction. Such practices indicate commitment to innovation despite structural limitations, but they also highlight inequitable access across educational settings.

4.2 Theme 2: ICT Competence is Constructed through Continuous Learning, Experience, and Professional Engagement

The second theme demonstrates that teachers viewed ICT competence as an evolving professional capability acquired through formal training, informal learning, and continuous practical engagement.

Across the dataset, respondents reported high awareness of ICT tools. R1 stated:

"I would describe my awareness as very high. I constantly attend online ICT training programs, participate in educational technology webinars, and make sure I stay updated with new digital tools."

Similarly, R2 reported:

"I constantly update myself through online courses, webinars, and WhatsApp professional groups."

Many participants linked competence directly to professional development opportunities. R1 reported participation in Microsoft Innovative Educator training, Google for Educators workshops, and school-based ICT development programs. According to her:

"These trainings improved my digital teaching skills and exposed me to global best practices."

R6 similarly noted:

"The training was very helpful in expanding my knowledge and skills in using ICT effectively."

Teachers also viewed competence as emerging through repeated use of technology.

R3 explained:

"I'm very confident and I'm competent in terms of using these tools in terms of teaching."

Likewise, R8 attributed his confidence to accumulated experience:

"I've been teaching computer science for the past six years so that gives me confidence and makes me to be competent."

These accounts suggest that ICT competence was not perceived as a fixed attribute but as a continuously developing capability shaped through practice.

The findings also revealed diverse forms of ICT use. Teachers described employing PowerPoint presentations, Google Classroom, Microsoft Teams, Code.org, Scratch, learning management systems, coding platforms, online assessments, and interactive smart boards.

For example, R6 reported:

"I have online coding platform to conduct live coding platform section allowing students to interactively learn and practice program"

The ability to select and integrate various technologies reflects advanced technological-pedagogical competence and demonstrates progression beyond awareness to implementation.

4.3 Theme 3: Adoption of ICT is Influenced by Interacting Institutional, Technological, and Professional Contexts

The third theme reveals that ICT adoption is shaped by a combination of enabling and constraining contextual factors. Participants consistently identified infrastructural challenges as major barriers. These included inadequate facilities, unreliable internet access, unstable electricity supply, and outdated equipment.

R6 stated:

"The major challenges there include inadequate infrastructure, limited internet, outdated hardware and insufficient training and support."

Similarly, R5 explained:

"we have poor facilities like electricity and ICT tools too."

R3 further highlighted teacher-related barriers:

"most teachers have limited knowledge on how to use these tools."

At the organizational level, support systems emerged as important determinants of ICT integration. Teachers from well-equipped schools described structured maintenance systems.

R1 explained:

"Maintenance is done weekly by our in-house IT technician."

R2 similarly reported:

"we have an in-house ICT technician who handles routine checks and repairs."

Such support structures facilitate implementation and reduce technological disruptions, thereby enhancing adoption.

Participants also emphasized the importance of external support. Many called for government investment, NGO involvement, partnerships with technology companies, and expanded teacher training opportunities.

R8 stated:

"the government should come in and organize seminars, workshops and teachings basically on ICT to all teachers."

R1 recommended:

"government support for digital education programs, and collaboration with technology companies for equipment donations."

R6 suggested:

"establish a mentorship program where experienced teachers can guide others."

These responses indicate that adoption is not merely an individual decision but is influenced by broader institutional ecosystems.

Importantly, teachers overwhelmingly perceived ICT as highly advantageous for teaching and learning. Participants repeatedly associated ICT with improved student understanding, practical learning, learner engagement, participation, digital literacy development, and preparation for future careers.

According to R2:

"ICT is fundamental. It brings lessons to life, increases student engagement, supports practical learning, and helps students build real 21st-century skills."

Similarly, R1 stated:

"It makes lessons practical, interactive, and easier to understand."

These results indicate that ICT adoption among secondary school Computer Science teachers in Sabon Gari LGA is not constrained by lack of awareness. Rather, adoption is shaped by the interaction between teachers' competence, infrastructural conditions, organizational support systems, and opportunities for continuous professional learning. The diffusion process appears more advanced in resource-rich private schools, while public and less-resourced schools continue to face structural barriers that limit effective implementation despite positive attitudes toward ICT. This pattern aligns closely with Diffusion of Innovations theory, which emphasizes that successful adoption requires not only awareness and positive perceptions but also supportive social systems and access to enabling resources.

4.4 Summary of the Major Findings

The study revealed that ICT infrastructure varies considerably across secondary schools in Sabon Gari Local Government Area, resulting in unequal opportunities for ICT integration among Computer Science teachers. Teachers in well-resourced schools reported access to adequate digital facilities, which enhanced technology adoption, whereas those in less-resourced schools experienced infrastructural deficiencies that constrained effective ICT utilization.

The findings further showed that teachers generally possessed a high level of ICT awareness and competence, which they developed through formal training, continuous professional development, self-directed learning, and practical teaching experience. Increased competence reduced the perceived complexity of ICT and enhanced teachers' confidence in integrating digital technologies into classroom instruction.

In addition, the study established that ICT adoption is influenced by the interaction of institutional, technological, and professional factors. Although teachers overwhelmingly recognized the instructional benefits of ICT and demonstrated positive attitudes toward its use, inadequate infrastructure, unreliable electricity, limited internet connectivity, insufficient technical support, and inadequate professional development opportunities remained major barriers to effective integration. Overall, the findings indicate that successful ICT adoption depends not only on teachers' awareness and competence but also on the availability of enabling resources and supportive institutional environments, consistent with the Diffusion of Innovation Theory.

5 Discussion of Findings

The findings revealed significant disparities in ICT infrastructure among secondary schools in Sabon Gari Local Government Area, Kaduna State, creating unequal opportunities for technology integration. While some teachers reported access to ICT laboratories, internet connectivity, projectors, laptops, and other digital technologies, others indicated severe shortages of technological resources. Teachers in well-resourced schools reported greater opportunities to utilize technology for lesson delivery, student engagement, practical demonstrations, and assessment activities. This finding supports previous studies which reported that access to adequate technological infrastructure facilitates effective ICT

integration and encourages teachers to adopt innovative instructional practices (Zakariya et al., 2024). Similarly, Tondeur et al. (2021) emphasized that the successful integration of digital technologies in education is strongly influenced by the availability of supportive technological environments. Conversely, participants from less-resourced schools reported inadequate computers, limited internet access, and insufficient ICT facilities to support effective teaching and learning. However, the findings of this study contradict Dele-Ajayi, et al. (2021) found that although infrastructure was important, teachers' concerns, beliefs, and readiness were stronger determinants of ICT integration than the mere availability of ICT resources. Some teachers with access to ICT facilities still demonstrated low classroom integration because of pedagogical and personal concerns. These findings indicate that awareness of ICT alone does not guarantee adoption when teachers lack access to the necessary technological resources. This observation is consistent with Rogers' Diffusion of Innovation Theory, which posits that access to an innovation is essential for its adoption and continued use (Rogers, 2003). Another important finding was that some teachers relied on personal devices to compensate for institutional shortages, demonstrating commitment to technology integration while highlighting inequalities in educational provision. The findings therefore suggest that improving ICT infrastructure should remain a priority for educational stakeholders seeking to promote meaningful technology integration in secondary schools.

The findings revealed that teachers perceived ICT competence as a continuously developing capability acquired through professional development, self-directed learning, practical experience, and ongoing engagement with technology. Most participants reported high levels of awareness of ICT tools and emphasized the importance of workshops, webinars, online courses, and professional learning networks in improving their technological skills. The findings support existing literature which emphasizes the importance of continuous professional development in strengthening teachers' digital competencies and enhancing technology integration. According to Redecker (2017), teachers require ongoing opportunities for professional learning to effectively integrate digital technologies into teaching and learning processes. Similarly, Cabero-Almenara et al. (2021) observed that sustained training programmes significantly improve teachers' confidence, competence, and readiness to utilize technology in educational settings. Participants further indicated that repeated use of digital technologies contributed significantly to their confidence and competence, with several teachers attributing their ability to use ICT effectively to years of teaching experience and regular interaction with technological tools. This finding aligns with Falloon (2020), who argued that digital competence develops through practical engagement with technology rather than through theoretical knowledge alone. The findings also revealed that teachers utilized a variety of technologies, including PowerPoint presentations, learning management systems, online coding platforms, Google Classroom, Microsoft Teams, and interactive smart boards. Such diversity in technology use demonstrates progression beyond mere awareness toward meaningful implementation. This observation is consistent with the Technology Acceptance Model, which suggests that users are more likely to adopt technologies that they perceive as useful and manageable within their professional contexts (Oketunbi & Afolabi, 2022). Overall, the findings indicate that ICT competence is shaped by continuous professional development, practical experience, and active engagement with technological innovations.

The findings showed that ICT adoption among secondary school teachers is influenced by institutional, technological, and professional factors. Although participants expressed positive attitudes toward ICT, challenges such as inadequate infrastructure, unstable electricity supply, poor internet connectivity, outdated equipment, and limited professional development constrained effective integration. This finding is consistent with Zakariya et al. (2024), which identified technological infrastructure and institutional support as key determinants of ICT adoption. Similarly, Rogers (2003) argued that innovations that are difficult to access or utilize are less likely to be adopted. The findings further highlighted the importance of organizational support, as teachers from well-equipped schools reported access to technical personnel who assisted in maintaining ICT facilities. This aligns with Tondeur et al. (2021), who emphasized the role of institutional support and leadership in successful technology integration. Participants also stressed the need for government intervention, partnerships, mentorship programmes, and continuous professional development, supporting UNESCO's (2023) recommendation for greater investment in teacher training and digital support systems. Despite these challenges, teachers perceived ICT as beneficial for improving student engagement, understanding, participation, practical learning, and digital literacy. These positive perceptions reflect Rogers' (2003) concept of relative advantage. Overall, the findings suggest that effective ICT adoption depends not only on teachers' awareness and competence but also on adequate infrastructure, institutional support, and continuous professional learning, consistent with Diffusion of Innovation Theory. However, Osode et al. (2024) reported that organisational support alone did not sufficiently explain technology adoption. Instead, teachers' behavioural intentions, perceived usefulness, and social influence were stronger predictors of Learning Management System adoption than institutional provision of ICT resources.

6 Limitations of the Study

This study has a few limitations. First, it involved only eight participants, which, although adequate for achieving data saturation in qualitative research, may not reflect the experiences of all secondary school Computer Science teachers. Second, the study was limited to Sabon Gari Local Government Area of Kaduna State; therefore, the findings may not be applicable to other Local Government Areas or states with different contexts. Third, the qualitative research design emphasizes in-depth understanding rather than statistical generalization, limiting the generalizability of the findings. Finally, the study relied on self-reported interview data, which may have been influenced by participants' personal perceptions and responses. Future research should extend the scope of the study by involving participants from several Local Government Areas or different states to enhance the breadth and contextual relevance of the findings. Researchers are also encouraged to adopt mixed methods approaches to integrate the rich, in-depth insights of qualitative research with the wider applicability of quantitative evidence. Additionally, future studies should explore students' perceptions and experiences of ICT integration to provide a more holistic understanding of technology-enhanced teaching and learning. Further investigations may examine ICT integration across various subject disciplines and school categories, while also assessing the influence of school leadership, educational policies, infrastructural support, and continuous professional development on teachers' effective use of ICT in classroom practice.

7 Conclusion

The study concludes that secondary school teachers in Sabon Gari Local Government Area are generally aware of ICT and recognize its importance in enhancing teaching and learning. However, effective ICT integration depends on the availability of technological infrastructure, teachers' digital competence, institutional support, and continuous professional development. Although teachers demonstrated positive attitudes toward technology and willingness to use digital tools, challenges such as inadequate ICT facilities, limited technical support, poor internet connectivity, and unstable electricity supply continue to hinder implementation, particularly in less-resourced schools. The study further reveals that ICT competence develops through continuous learning and practical experience, while successful adoption requires supportive resources and institutional conditions. Therefore, improving ICT infrastructure, strengthening teacher training, and enhancing institutional support are essential for sustainable ICT integration in secondary schools. Also, study recommends that policymakers provide adequate ICT infrastructure and funding for secondary schools, school administrators strengthen institutional support through regular ICT training and access to functional facilities, and teacher education institutions integrate practical ICT pedagogical skills into pre-service and in-service teacher preparation programmes.

8 Conflict of Interest

The authors declare that there is no conflict of interest.

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10 Author Contributions

Author 1: Formal analysis, data curation, writing original draft preparation. Author 2: Conceptualization, methodology, investigation, data collection, data analysis, writing review and editing, and supervision. Both authors read and approved the final version of the manuscript.

11 Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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