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Research paper

ICT Teaching-Learning Practices and Barriers in Rural Secondary Schools of Bangladesh

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ABSTRACT

This study investigates the teaching-learning practices of Information and Communication Technology (ICT) as a subject, and the challenges faced by teachers and students in rural secondary schools of Bangladesh, focusing on three key aspects: classroom practices, teacher challenges, and student learning barriers. As a Global South country, Bangladesh presents insights into ICT education barriers in resource-constrained settings. The study addresses a critical research gap by generating region-specific evidence from Rangpur, a district characterized by socio-economic vulnerabilities and infrastructural constraints that intensify educational inequalities. An interpretive qualitative design was employed, with data collected purposively from ICT teachers and students of ten rural schools through interviews and focus group discussions, which were then analyzed thematically. Findings revealed a severe gap in interactive instruction and hands-on practice due to resource constraints and limited pedagogical preparedness among teachers. Unreliable electricity and internet connectivity, inadequate ICT equipment, and insufficient technical support further constrained meaningful classroom implementation. Teachers' administrative and managerial overloads, curriculum-content mismatch, and inadequate professional development opportunities were also identified as barriers. Recommended solutions include infrastructural development, enhanced teacher training, equitable access to resources, and context-sensitive approaches to ICT education. The study provides targeted insights for policymakers and educators to promote inclusive ICT education, particularly for students in underserved areas.

Keywords: digital literacy, ICT education, rural secondary schools, challenges in rural education

Education is essential to the development of a digital society and the facilitation of positive social transitions (Alam et al., 2023; Chowdhury, 2021; Hasan et al., 2022). The Bangladeshi education system should implement strategic planning to effectively integrate ICT into the classroom with a view to ensuring the competitiveness of students in digital society and creating a skilled workforce (Ahmed et al., 2022; Alam et al., 2023; Hasan et al., 2022). Information and communication technology (ICT) education supports students' participation, cooperation, empathy, problem solving ability as well as academic and cognitive development (Magnago et al., 2024; Osmani & Tartari, 2024). However, these benefits depend on effective ICT education in the classroom- focusing on the curricular and pedagogical aspects that enhance learners' technological competencies and enable them to engage meaningfully in a technology driven world (Falloon, 2020; Ibrahimi et al., 2024; Rakisheva & Witt, 2023; Wing, 2006). Newer technologies, such as artificial intelligence, may further support competency development, although they raise persistent concerns about unequal access (Acar et al., 2025). A core of these competencies is ICT literacy,

defined as the ability to access, evaluate, manage, create, and communicate information securely and appropriately using digital technologies and devices connected to the internet which improves critical thinking skills and wise decision making about one's role in the workplace, home life and participation in social activities (International ICT Literacy Panel, 2002; Aesaert et al., 2017; Spante et al., 2018; Zhao et al., 2021).

However, many schools worldwide struggle to ensure effective ICT learning due to limited teacher training and inadequate resources (Abykanova et al., 2024; Nkomo et al., 2021; Osmani & Tartari, 2024; Tang & Fan, 2024). While these challenges are documented globally, they are particularly acute in Global South countries, where limited infrastructure, economic constraints, and systemic inequalities often exacerbate barriers to meaningful ICT integration. Bangladesh, as a Global South nation, exemplifies this reality; however, the specific manifestation of these challenges in its rural secondary schools requires further investigation. International research has consistently highlighted the importance of sustained professional development for effective ICT integration (Darling-Hammond et al., 2017; Philipsen et al., 2019), with recent studies from India (Anita, 2024) and Ireland (Nolan et al., 2024) emphasizing similar concerns regarding teacher preparedness and ICT integration in different educational contexts. Comparable issues have also been reported in Bangladesh, where limited teacher training, inadequate digital competencies, and resource constraints continue to impede effective ICT integration (Roshid & Haider, 2024; Sultana et al., 2023). Despite national policy frameworks emphasizing ICT education, classroom implementation in Bangladesh remains constrained by inadequate infrastructure, limited teacher preparation, and resource deficits, creating a persistent gap between policy aspirations and classroom practice (Imon, 2017; Roshid & Haider, 2024). Therefore, this study explored the teaching and learning practices of ICT as a school subject, as well as the challenges experienced by teachers and students, in rural secondary schools in Bangladesh.

Research problem

After the independence of Bangladesh, the first education commission (Bangladesh Education Commission, 1974) proposed inclusive science and technology education. Subsequent education commissions, education policies and curricula also emphasized science and technology education. Notably, the National Education Policy 2010 articulated a vision for technology-integrated education (Ministry of Education, 2010), while the Master Plan for ICT in Education (2012–2021) provided a comprehensive framework for ICT infrastructure development, teacher training, and digital content creation (Ministry of Education, 2012). More recently, the Smart Bangladesh: ICT Master Plan 2041 has reinforced the government's commitment to leveraging technology for educational transformation (Information and Communication Technology Division, 2023). Despite these policy commitments to technology education, rural secondary schools continue to face challenges in translating the policies into effective classroom practice. These challenges are multifaceted, encompassing critical deficits in teacher preparedness, infrastructure, digital literacy, and ICT integration in the classroom (Rahaman & Akter, 2017; Saha et al., 2022; Sultana et al., 2023; Chowdhury et al., 2019). However, existing research has primarily identified systematic barriers at the national level, lacking region-specific evidence that captures the nuanced challenges of rural contexts. To address this gap, the study focused on generating region-specific evidence by investigating the issue in Rangpur District.

Rangpur is in a region frequently affected by 'Monga' (seasonal food insecurity) and flooding, which exacerbate socio-economic vulnerabilities and infrastructure challenges (Paul et al., 2013; Kamal et al., 2024). These environmental and economic conditions intensify educational inequalities and make Rangpur a critical case for understanding barriers to ICT implementation in underserved settings. Consequently, Rangpur provides a theoretically and educationally significant context for examining how geographical, socio-economic, and infrastructural factors influence ICT teaching and learning. Findings from this context can contribute to a deeper understanding of ICT implementation challenges in similarly underserved rural regions of Bangladesh.

Research Questions

1. What are the existing classroom practices in teaching ICT as a subject in rural schools?
2. What are the challenges faced by rural teachers in teaching ICT as a subject?
3. What are the challenges faced by rural students in learning ICT as a subject?

REVIEW OF RELATED LITERATURE

Pedagogical practices and implementation gap in ICT Education

Digitalization in school requires a holistic approach that integrates infrastructure development and teacher training to foster meaningful teaching-learning experiences (Akter, 2024, Blankendaal-Tran et al., 2026). Effective ICT education requires a shift from instrumental instruction to constructivist, student-centred pedagogy, where technology is used as a tool to promote problem-solving, collaboration, and creativity (Mishra & Koehler, 2006;

Voogt et al., 2013). However, research consistently demonstrates a significant implementation gap between policy aspirations and classroom realities. Although ICT integration has the potential to enhance student engagement and socioemotional development (Magnago et al., 2024), challenges related to pre-service and in-service teacher training, infrastructure, and student engagement continue to hinder the successful implementation of ICT curricula across educational contexts (Fatekhah et al., 2024; Nkomo et al., 2021; Olarte, 2024; Tang & Fan, 2024). Collectively, these studies suggest that effective ICT education depends not only on the availability of technological resources but also on pedagogical approaches that enable meaningful student participation. Translating policy intentions into classroom practice remains a persistent challenge, particularly in resource-constrained educational settings. However, carefully supported pedagogical interventions can still shift teachers toward more facilitative, learner-centred practice even under such constraints (Tansen, 2026).

Teacher preparedness and professional development in rural contexts

In Bangladesh, ensuring equitable ICT education remains a significant geographical challenge, with rural schools facing greater challenges than urban schools in meeting curriculum standards (Rahaman & Akter, 2017; Saha et al., 2022). Teacher competence in integrating ICT into classroom practice is generally limited in rural schools; as many in-service training programmes are short-term and lack a strong theoretical foundation, contributing little to sustained improvements in classroom practice (Bobro, 2024; Khan, 2023; Sultana et al., 2023). Evaluations indicate that while digital content is generally well accepted, teachers often struggle to organize collaborative or student-centred learning around ICT (Power et al., 2017; Khalid et al., 2013). Although, ICT integration varies according to a country's digital infrastructure, international studies consistently highlight the necessity of sustained professional development to ensure its effective implementation (Anita, 2024; Darling-Hammond et al., 2017; Philipsen et al., 2019; Lawless & Pellegrino, 2007; Webb, 2026). Collectively, these studies suggest that effective ICT integration in rural schools requires sustained, contextually relevant professional development that strengthens teachers' digital competencies and pedagogical practices. However, such opportunities remain limited in many resource-constrained educational settings, particularly in rural Bangladesh, where teachers continue to face barriers to ongoing professional learning and classroom implementation. Consequently, professional development programmes that integrate technology are particularly important for rural teachers, who often have limited access to training opportunities and educational resources (Maher & Prescott, 2017; Robinson, 2008). In this regard, mobile devices such as smartphones and tablets have been proposed as practical tools for continuous teacher training (Abykanova et al., 2024).

Infrastructure and socio-economic barriers to digital equity

Digital integration in the classroom is essential for effective ICT education, as it promotes student engagement, learning outcomes, and digital competencies (Amin, 2013; Tumino & Bournissen, 2020; Msafiri et al., 2023). However, inconsistent electricity supply, unreliable internet, insufficient digital devices limit digital integration in classrooms (Abykanova et al., 2024; Osmani & Tartari, 2024; Asadullah & Bhattacharjee, 2022; Khalid et al., 2013; Mahfuz, 2015). In Bangladesh, student-to-computer ratios in rural schools are exceedingly high, limiting opportunities for practical, hands-on learning (Rahaman & Akter, 2017; Saha et al., 2022). Despite initiatives to provide digital technologies and reduce resource disparities, support measures remain unevenly distributed, leaving many rural schools underserved (Akter, 2024; Nolan et al., 2024).

Economic barriers often widen the digital divide, as students from poorer socio-economic backgrounds face difficulties in accessing devices and reliable internet, exacerbating existing educational inequalities (Tang & Fan, 2024; Fatekhah et al., 2024). Moreover, in Bangladesh, social safety-net programmes have improved women's access to education and empowerment, but persistent gender norms and implementation challenges continue to limit their impact (Tripura & Rakhi, 2026). The high-stakes examination culture in Bangladesh often marginalizes practical subjects like ICT, reducing instructional time and student motivation (Chowdhury et al., 2019). Digital distractions, such as social media and non-educational applications, may negatively affect student focus and motivation during lessons (Halubanza et al., 2023). Taken together, these studies indicate that infrastructural constraints, socio-economic disadvantages, and systemic educational factors interact to restrict meaningful ICT learning, with rural schools experiencing the greatest barriers to equitable implementation.

Literature gap

Although previous studies have examined ICT integration, teacher preparedness, infrastructure and digital divides in Bangladesh, limited qualitative evidence exists on how rural teachers and students experience ICT as a school subject in under-resourced secondary schools. This study addresses that gap by exploring classroom practices, teacher challenges, and student learning barriers in rural Rangpur, thereby generating context-specific evidence to inform educational policy and practice.

METHODOLOGY

An interpretive qualitative design was employed in this study to gain a comprehensive understanding of the teaching-learning practices of ICT as a subject in the rural secondary schools of Bangladesh. This approach underpinned the current study to investigate how research participants made sense of what they experienced and perceived within a given educational and socio-cultural setting or context (Creswell & Poth, 2018; Merriam & Tisdell, 2016). This study design is suitable for obtaining practice-oriented descriptive data without extensive theoretical categorization (Sandelowski, 2000).

Purposive sampling method was used to select the participants who are directly involved in teaching and learning of the ICT subject in rural schools of Northern Bangladesh. This sampling method is appropriate for thematic analysis and interpretation of the data that focuses on information richness, not on statistical representativeness (Etikan et al., 2016; Guest et al., 2006; Palinkas et al., 2015). Data were collected from ten ICT teachers (T1-T10) and corresponding student groups (G1-G10) from as many rural secondary schools in the Rangpur district of Bangladesh. Each of the ten schools contributed one ICT teacher and one focus group of students. The student focus groups consisted of 6-8 students each, for a total of 68 student participants (34 male, 34 female), drawn from grades eight to ten (aged 14-16 years). The teachers, all male, had teaching experience ranging from 2 to 18 years, with an average of 7.5 years. Majority of the teachers (six out of ten respondents) had no formal qualifications in ICT education.

In-depth interviews of the teachers helped generate detailed insights into their experiences and challenges (Rutledge & Hogg, 2020) while focus group discussion (FGDs) with students were employed to get holistic pictures about ideas and perceptions of the participants (Gibbs, 1997; Krueger & Casey, 2015). Interviews lasted 45-60 minutes each, while FGDs lasted 60-90 minutes each. All interviews and FGDs were conducted in Bengali and later translated to English for analysis. All sessions were audio-recorded with participant consent and transcribed verbatim. The unit of analysis of the current research was the teaching and learning processes of the ICT subject as experienced by the teachers and the students at the secondary schools located in the rural areas of Bangladesh.

Data were analyzed thematically using Braun & Clarke's (2006) six-phase framework: (1) familiarization with data through repeated reading; (2) generation of initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; (6) producing the report. An inductive approach was adopted for coding to allow themes to emerge from the data. The data were coded manually by the first author through systematic review of the interview transcripts and observation notes, identifying recurring patterns and organizing codes into broader themes. To enhance the credibility of the analysis, 20% of the data were independently coded by the second author, and any discrepancies were resolved through discussion until consensus was reached. Thematic analysis was chosen for its flexibility and its capability in identifying patterns and latent meanings in qualitative data (Braun & Clarke, 2006, 2019; Guest et al., 2012).

Trustworthiness

To ensure the trustworthiness of the findings, Lincoln and Guba's (1985) qualitative criteria were applied. Credibility was established through prolonged engagement with the research context, triangulation of data sources (teachers and students), and member checking, where a primary summary of findings was shared with participants to verify accuracy. Dependability was ensured through an audit trial, documenting all research decisions and procedures. Confirmability was enhanced through reflexivity, where researchers maintained reflective journals to acknowledge and mitigate potential biases. Transferability was supported by providing rich, detailed descriptions of the research context, participants, and findings, enabling readers to assess the applicability of the findings to other similar contexts.

Limitations of the Study

This study has several limitations that need to be considered while interpreting the findings. First and foremost, the purposefully selected small sample size may restrict the generalization of the study to all the schools in the rural areas across the country. However, the study may be analytically generalized to the other areas depending on the contextual similarity. Second, the geographic scope of the study was confined to Rangpur district only, and hence the study may not reflect the diverse experiences and contextual variations that may be present in the other rural schools in different regions of Bangladesh. Third, the exclusive focus on rural secondary schools means that the findings were shaped by the specific infrastructural and technological constraints characteristic of these contexts. Such constraints may be quite different from those that are present in the urban areas where the ICT facilities are more robust. Also, the study is based on the participants' self-reported accounts that may be based on the personal experiences and subjective understanding of the participants. Fourth, the study was conducted within a limited timeframe that may have constrained the depth and breadth, and contextual understanding. Despite the limitations

that are present in the study, the study offers meaningful insights into the ICT teaching-learning practices and challenges that are present in the rural areas, even in the 21st century.

FINDINGS

The findings illustrate the systemic challenges in pedagogical practice, institutional constraints, resource limitations, and the lack of academic feedback and support systems in rural schools.

Constraints on interactive classroom instruction

The findings revealed that most teachers (six out of ten participants) lacked formal education qualifications to teach ICT and received minimal preparatory training in ICT. The findings revealed that the teaching-learning process was significantly affected by teachers' lack of mastery and pedagogical skill in ICT. In other words, teachers' pedagogical knowledge was constrained to textbook lectures, which resulted in the lack of interactive, objective-outcome-based learning for students. Across all the rural schools investigated, ICT is being taught in a teacher-centric, lecture-based approach.

Teachers unanimously suffered from a lack of proper infrastructure, including functional computer labs, multimedia devices, and a stable internet connection. These barriers impeded their lesson plans and visions for lessons. Most of the teachers identified severe resource and time constraints that exacerbated their reliance on lecture-based instruction. As one teacher (T1) lamented, "We don't have any computer lab or multimedia facility available. So, usually I give lectures, sometimes make printouts and use them." Another teacher (T5) echoed this frustration: "Our school got a multimedia facility for just one class at the end of the year; fulfilling the lack of learning is tough now." These infrastructural deficits severely limited the implementation of the practical components of the curriculum. T4 described the situation more starkly:

> The computer lab facility is absent; we don't have any multimedia facility. There was one projector and one laptop; both are dysfunctional now. There is no chance for practice for my students; I don't know how to ensure the practice of their learning. The students in the rural schools are being deprived here.

Similarly, T7 highlighted the time constraints by saying,

> I have taken a few classes of students in different grades. Unfortunately, the computer lab facility is insufficient here, and integrating technology into each class is also tough. And we have to take classes beyond our schedule; we do not get enough time to make teaching aids. So, I mostly give lectures to the students.

The students also expressed their concern that the absence of multimedia integration on topics that require demonstrations made it difficult to understand those contents, such as content on programming and networking. Digital tools- projectors, programming software, coding platforms, and web development tools- were rarely available. One student from G3 shared that "In most of the classes, no digital tools were used by our teacher; he only used the textbook." A student from G4 indicated the lack of multimedia facilities, saying, "Our teacher occasionally came with a laptop for presentation, but as multimedia facilities are not available, he struggled to utilize it effectively throughout the entire class." The students of other groups shared the absence of group work, challenges to relate the contents to real life, and the absence of an activity-based classroom. As a result, a student from G8 described the lectures as "monotonous and insufficient to understand". The students of the other groups also reported occasional multimedia classes; nonetheless, inadequate internet connectivity impeded the seamless presentation of content. Lack of infrastructural support and equipment issues hindered interactive and technology-enhanced learning in these schools.

Scarcity of hands-on practice and practical activities

The lack of functional computer labs or multimedia facilities hindered sustainable learning and hands-on practice opportunities, which was a key concern for both students and teachers. As T8 revealed, "Hands-on practice was not possible as the computer lab was unavailable for most of the year; it was ready at the end of the year." Students from different grades and groups repeatedly mentioned their minimal or nonexistent opportunities for hands-on practice. On the other hand, in the schools with lab facilities, students shared that only a few had the chance to use computers due to equipment malfunction and a limited number of devices. A student from G7 noted, "Our teacher didn't even know what to do since there were no computer lab facilities available, so he simply instructed us to read the textbook." Echoing this sentiment, students from G1, G5, and G3 all emphasized the rarity of their lab experiences. One student from G1 stated, "We had the chance to go to the computer lab once or twice the whole year." Likewise, another student from G5 shared, "Our class didn't go to the computer lab once yet." Another student from G3 noted, "We rarely got any opportunity to practice due to the absence of devices, and we got the lab at the end of the year, so we missed nearly the whole year for practice and the scope of learning by doing."

Students expressed anxiety, uncertainty and frustration, especially when they were enquired about utilizing different digital tools and practicing their lectures. Having a very limited direct experience, a student from G9 stated, "We feel anxious due to insufficient practice and the defective devices. Whenever we take help from YouTube to learn something or see videos of classes, we get frustrated by seeing the opportunities the urban or the foreign students get." Furthermore, students described the overall learning environment as overcrowded and under-resourced, making it difficult to keep up, to understand any content that requires demonstration, practice, simulation rather than just lecture. This gap signified a disconnect between the curriculum's vision and successful implementation demands against the rural classroom realities, impeding skill development.

Managerial overload and curriculum-content mismatch

Managing a large class posed significant challenges for teachers. T9 described,

> The classes have an average of fifty-sixty students, giving them attention individually is very tough. And ensuring hands-on practice is not possible because the opportunities are absent. Ultimately students fail to achieve the intended outcome, and teachers fail to deliver a lesson effectively.

This concern was echoed by T6, who noted that, "There are too many students in a class. So, classroom management remains a challenge while teaching properly." Large class sizes in underprivileged rural schools reduced effectiveness of lectures and hindered the seamless learning of the students.

Teachers faced difficulties in implementing the curriculum effectively due to its practical nature and the gap between the expected competencies the students are supposed to achieve and available resources. T3 highlighted this disconnect and shared that,

> Some lessons like programming were unknown even to me as the training I got wasn't that much of any help in teaching these topics. On the other hand, due to the absence of multimedia facilities, I couldn't even suggest any alternatives to the students. Even if they learn the topic via mobile device at home, there is no scope in our school for practice.

Teachers often resorted to theoretical lectures rather than practical demonstrations, diminishing the quality of learning. The lack of resources enhanced the challenges of content delivery. The curriculum's demand for practical skills was at odds with the contextual realities of rural schools.

Inadequate professional development and systemic support

Teachers complained about inadequate training to effectively teach the content of ICT. They also admitted that lack of training and professional development opportunities limited their capacity to integrate technology into the classroom. T2 elaborated on this issue and explained,

> I had some training, but it was insufficient and ineffective. I think our trainers couldn't give us what they intended to. On the other hand, whatever we learned from the training, for infrastructural barriers, implementing those in the schools was not possible sometimes.

Similarly, T7 admitted, "I have not received any training." Moreover, the lack of basic facilities for ICT integration in the classroom- such as computer labs, internet access, and functional devices etc. was either insufficient or completely unavailable. As a result, this hindered the implementation of teachers' training skills within the classroom context. The teachers admitted their limited knowledge about different learning platforms for content development, assessment, and getting ideas about the potential approaches that could have fostered ICT learning of the students. The teachers expressed concern in providing hands-on practice opportunities, and the need for structured training, continuous monitoring and support but that was missing. Teachers revealed the absence of exposure to different educational tools and platforms used for programming, digital content creation, classroom management, and assessment in their training and academic supervision. T1 emphasized the need for comprehensive professional development, stating that, "training should cover both foundational tools and classroom integration strategies to bridge the gap between theory and practice. But insufficient training is affecting our teaching in the classroom scenario."

In addition to these pedagogical and infrastructural challenges, teachers expressed concern about their pay scale and financial support from authorities. T5 shared,

> Teachers are expected to independently explore some digital tools- such as learning platforms, presentation software, and online coding environments to effectively guide students, but we can't. Because along with the unavailability of devices, we don't have proper financial support, and the wage we get is too low. So, after school, we can't think of the next class tomorrow instead of thinking of other means to earn.

In the absence of both institutional support and individual capacity, neither teachers nor students were able to engage meaningfully with the intended digital learning experience. The lack of ongoing professional development

and support influenced teachers' confidence and ability to deliver the curriculum as intended. **Table 1** illustrates a summary of key themes and evidence

Table 1

Summary of Key Themes and Evidence

Theme	Evidence Source	Key Finding
Lecture-based ICT teaching	Teachers (T1-T10), Students (G1-G10)	ICT lessons depend mostly on textbook explanation across all schools
Lack of practical exposure	Students (G1-G10)	Lab use was rare or completely absent; students reported 1-2 lab visits per year or none
Teacher training gap	Teachers (T2, T7)	Training was insufficient or completely unavailable; training lacked practical integration strategies
Curriculum-resource mismatch	Teachers (T3, T4), Students (G3, G9)	Practical curriculum cannot be implemented without facilities; programming and networking topics cannot be demonstrated
Large class sizes	Teachers (T6, T9)	Classes of 50-60 students limit individualized attention and hands-on practice
Weak institutional support	Teachers (T1, T5, T10)	Lack of supervision, monitoring, and academic support; inadequate financial incentives
Lecture-based ICT teaching	Teachers (T1-T10), Students (G1-G10)	ICT lessons depend mostly on textbook explanation across all schools

DISCUSSION

This study explored the teaching and learning practices and challenges of the teachers and the students related to ICT education in rural secondary schools of Rangpur, Bangladesh, through the lived experiences of teachers and students. As a Global South country grappling with infrastructural deficits, economic constraints, and systemic inequalities, Bangladesh offers critical insights into the barriers facing ICT education in under-resourced settings. The discussion situates the findings within existing literature, relating global and national evidence to the contextual realities identified in this study. The findings suggest that in rural schools, ICT is not merely under-resourced; it is pedagogically transformed from a practical, skill-oriented subject into a theory-heavy, examination-oriented subject. Consequently, resource constraints reshape classroom practice, creating a curriculum-practice gap in which the intended practical curriculum is replaced by a predominantly theoretical mode of instruction.

Different studies strongly emphasized a shift from instrumental, teacher-centred instruction to constructivist, student-centred pedagogy where technology is a tool for creation and problem-solving (Mishra & Koehler, 2006; Voogt et al., 2013). However, as Roshid & Haider (2024) stated, there is a wide chasm between policy intention and classroom practice. Infrastructural deficiencies, shortage of devices and multimedia facilities- hamper the integration of ICT and effective classroom learning in the rural schools (Abykanova et al., 2024; Khalid et al., 2013; Rahaman & Akter, 2017; Saha et al., 2022). In Bangladesh, the classroom practice of the teachers mostly follows lecture-based instruction and textbook reading (Imon, 2017; Chowdhury et al., 2019). The findings of the current study reflected the scholarly assertions where the teachers revealed their reliance on lecture-based approaches, textbook reading, and rote learning in the classroom. This gap in pedagogical practices was primarily attributed to insufficient content-specific pedagogical knowledge, which was aggravated by the lack of formal qualifications in ICT education among teachers who were often assigned from diverse disciplines. In addition, infrastructural deficiencies, particularly the absence of computer labs and functional multimedia facilities, further compound these issues.

Effective ICT education requires learners to engage hands-on practices that transforms abstract concepts into functional skill, improving problem-solving, critical thinking, ICT literacy, and comprehension (Falloon, 2020; Hubwieser et al., 2015; Yadav et al., 2017; Sultana & Hasan, 2023). The schools in Bangladesh lack connectivity, functional computer labs, and essential resources (Rahaman & Akter, 2017: Sultana & Hasan, 2023). However, the current study revealed a near-total absence of hands-on practice in the schools, altering the subject's ontology. As a result, ICT teachers are heavily relying on lecture and rote memorization. This change represents a de facto curriculum rewrite at the classroom level, a type of pedagogical constraint where the mode of delivery results in resource deprivation, which in turn results in the curriculum-practice gap. This phenomenon is not unique to Bangladesh; similar patterns of curriculum-practice disjuncture have been documented across Global South countries, where resource constraints often force educators to prioritize theoretical instruction over practical skill development.

Existing literature has already identified a generic list of barriers in effective ICT education that include infrastructure, teacher training, teachers' pedagogical beliefs, motivation, and socio-economic issues (Ertmer, 1999;

Håkansson Lindqvist & Pettersson, 2019; Hew & Brush, 2007; Tondeur et al., 2017; Nkomo et al., 2021; Imon, 2017). Effective ICT integration hinges on skilled teachers, sustained professional development (PD) opportunities, and tool-focused training to pedagogical integration (Bobro, 2024; Nolan et al., 2024; Sultana et al., 2023). The significance of PD, even in rural areas, has been recognized, but its difficulties have also been pointed out (Maher & Prescott, 2017; Sultana & Hasan, 2023; Imon, 2017). The current study substantiates the proposition with its findings. The participants, i.e., teachers, revealed that the professional development opportunities were both inadequate and ineffective, corroborating national critiques of teacher training (Khan, 2023; Sultana & Hasan, 2023; Rahaman & Akter, 2017). Moreover, the teachers also reported the challenges related to the classroom-level implementation of the training programs such as infrastructural barriers, limited resource availability and an ineffective academic support system. Furthermore, oversized classroom sizes acted as an impediment to the provision of specialized support to meet the diverse learning needs of the students. In addition, lower monetary incentives led to disillusionment, eroded self-efficacy, and demotivated teachers from learning and practicing new skills.

Studies found that digital integration significantly supports improving engagement, socioemotional development, and digital literacy among the students (Magnago et al., 2024; Spante et al., 2018). On the other hand, the digital divide contributes to widening existing gaps in education, especially in rural and underserved areas (Tang & Fan, 2024; Chowdhury et al., 2019). The findings of the present study support the propositions, the experiences of the students serve not only as evidence in support of these facts, but they highlight the psychological and emotional dimensions of this digital divide that exists in this context.

Connectivity, access to computer labs, basic resource allocation, and financial support are necessary for ICT education (Msambwa et al., 2024; Lomos et al., 2023; Yousofi et al., 2025; Sultana & Hasan, 2023; Rahaman & Akter, 2017). In addition, structured supervision, monitoring, mentoring and continuous academic support are required to ensure that the pedagogical objectives are met and to overcome systemic challenges (Ertmer et al., 2012; Sudiarti et al., 2025; Tondeur et al., 2017; Sultana & Hasan, 2023). The participants in the current study discussed the lack of supervision and monitoring, as well as an ineffective support system. Moreover, the regional and environmental vulnerabilities of Rangpur (Monga, flooding) likely exacerbated the infrastructural delays and resource allocation issues discussed in the findings.

Absence of engaging, activity-based approaches to teaching and learning limits student engagement and increases demotivation (Muñoz-Losa & Corbacho-Cuello, 2025; Chowdhury et al., 2019). Students in the current study echoed this concern, reporting boredom, frustration, and inadequate practice opportunities. Whilst smartphones represent an important tool in bridging the access gap (Abykanova et al., 2024), the students expressed the shortage of devices, internet connectivity, and the opportunities available to them compared to urban or global students. Systemic challenges and resource limitations increased anxiety and distress among the students. Furthermore, the students lacked exposure and access to basic educational resources and platforms that are widely recognized to enhance sustainable learning experience and development of ICT skills (Hew & Brush, 2007; Helsa et al., 2023). The barriers led to ineffective and unequal teaching and learning practices. The study revealed a clear disjunction between national ICT policy and the contextual and local realities. The findings validated the generic barriers to ICT education in rural areas, such as Rangpur district, Bangladesh. Effective solutions to encounter the challenges in ICT education require an integrated, context-sensitive approach focusing on the development of infrastructure, capacity building of both teachers and trainers, equitable resource allocation and the establishment of an effective support system in rural schools (Hennessy et al., 2010; Zhao & Frank, 2003; Tondeur et al., 2017; van Dijk, 2020).

Directions for future research

Building on the present findings, future studies may expand the contextual scope by exploring ICT teaching-learning practices across multiple rural districts in Bangladesh, enabling comparative analyses that examine variations in infrastructural, socio-economic, and environmental conditions influencing sustainable ICT education. Longitudinal studies examining contemporary educational policies could offer valuable insights for improving classroom practice, teacher preparedness, and resource allocation. Such studies would contribute to more context-sensitive policy design and implementation strategies addressing the persistent gaps between policy intentions and rural educational practice.

RECOMMENDATIONS

1. **Strengthening ICT infrastructure in rural schools**

   Findings indicate that insufficient ICT infrastructure (computer labs, multimedia equipment, stable internet connection etc.) significantly constrained the successful implementation of ICT curriculum in rural secondary

schools. To address these challenges, policymakers should prioritize infrastructure development in underserved rural schools. Access to basic technology infrastructure and affordable digital facilities is essential for successful ICT teaching-learning as well as increased learner engagement (OECD, 2025; UNESCO, 2023; Warschauer, 2003). Investment in these facilities and support would ensure an interactive, practice-oriented teaching-learning environment.

2. **Designing context-based teacher professional development programs**

   Findings suggest that ICT instruction was largely theory-based with low to no practical interaction, suggesting limited pedagogical preparedness and insufficient training in technology-integrated teaching. Thus, continuous professional development programs should be designed incorporating technological competence and practical skills in line with pedagogical competence. Effective ICT teaching requires the integration of content knowledge, pedagogy and technology, conceptualized in the TPACK framework (Mishra & Koehler, 2006). Training programs should therefore include hands-on activities, student-centred pedagogies, assessment strategies for ICT teaching-learning. Additionally, training programs should be contextualised to rural requirements to ensure sustainability (Hashim & Radzil, 2025; Sepadi, 2025).

3. **Emphasizing hands-on and experiential learning**

   Findings revealed that students had minimal to no opportunity for practical engagement with ICT tools resulting in limited development of applied skills. Therefore, an activity-based experiential learning approach should be incorporated to enhance students' ICT competence (OECD, 2023; UNESCO, 2018; Voogt et al., 2013). Schools should be equipped with interactive learning platforms, low-cost digital platforms and tools to encourage active learning. Furthermore, teachers should be trained to integrate interactive activities that facilitate the development of students' problem-solving abilities using digital tools.

4. **Enhancing Support and Policy Interventions**

   Findings revealed that effective delivery of ICT education in rural schools is hindered by lack of policy interventions and limited institutional interventions. Therefore, priorities should be on monitoring and evaluating the efficiency of ICT education, incentives for teachers to participate in professional development programs, and financial support for schools to purchase digital tools as it is evident that all these enhance the effectiveness of ICT education (Annemann et al., 2025; OECD, 2023; UNESCO, 2023). Furthermore, there should be collaboration and support among the education administrators, teachers' training institutions, school management authorities and teachers to resolve challenges, share ideas and implement the ICT curriculum successfully.

5. **Adopting a Context-Sensitive Curriculum Implementation Approach**

   The study demonstrated that uniform ICT curriculum implementation throughout the country does not necessarily align with the unique challenges of rural settings. A context-sensitive approach is therefore essential. Flexible strategies and locally adapted instructional materials can help resolve some of the issues. Rural schools should also be provided with low-cost digital solutions that are compatible with their financial and infrastructural constraints.

CONCLUSION

This study explored ICT teaching-learning practices and barriers in rural secondary schools in Rangpur, Bangladesh. The findings show that ICT education in these schools is largely constrained by inadequate infrastructure, limited hands-on practice, insufficient teacher preparation, large class sizes, and weak institutional support. As a result, ICT is often taught as a theoretical subject rather than a practical, skill-based area of learning. The study highlights the need for context-sensitive policy implementation, continuous teacher development, functional ICT facilities, and stronger academic supervision. Addressing these issues is essential for making ICT education more inclusive, practical, and meaningful for rural students.

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Ethical Considerations

Permission to conduct the study was obtained from the headteachers and the respective class teachers at the participating schools. Informed consent forms were collected from all the teacher participants and parental consent was obtained for the student participants. Participation was voluntary, and participants were informed of their

right to withdraw from the study at any stage without penalty. Anonymity and confidentiality were maintained using identification codes, and all research data were stored securely and used solely for research purposes.

Competing interests

The authors declare that they have no competing interests.

Data availability

The data supporting the findings of this study are not publicly available due to ethical and privacy considerations involving human participants.

Author Contributions

MSH: Research concept and design; collection and/or assembly of data; data analysis and interpretation; writing the article; critical revision of the article; final approval of the article. IN: Research concept and design; writing the article; critical revision of the article; final approval of the article.

Data availability

The data supporting the findings of this study are not publicly available due to ethical and privacy considerations involving human participants.

AI disclosure

AI tools were used solely for proofreading and language editing to improve readability. The authors acknowledge full responsibility for all interpretations, analyses, arguments, and conclusions presented in this study. All content was reviewed and approved by the authors prior to submission.

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