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Multi-Level Digital Inequality in Rural Ghana: Internet Access, Continuity of Use, and Institutional Mediation in Basic Education

Hayford Mensah Ayerakwa

 [0000-0003-0489-2176](https://orcid.org/0000-0003-0489-2176)

University of Ghana

hayerakwa@ug.edu.gh

Millicent O. Awuku*

 [0000-0001-9080-865X](https://orcid.org/0000-0001-9080-865X)

Ashesi University

mawuku@ashesi.edu.gh

Antoinette Tsiboe-Darko

 [0000-0002-8852-9528](https://orcid.org/0000-0002-8852-9528)

University of Ghana

atsiboe-darko@ug.edu.gh

ABSTRACT

The expansion of digital technologies has created new opportunities for educational participation, yet substantial inequalities persist in learners' access to and use of digital resources. This study examines patterns of digital participation among Basic 8 students in rural Ghana and investigates how internet access, continuity of use, and institutional conditions shape opportunities for digital engagement. Guided by Digital Divide Theory and the Capability Approach, the study employs a convergent mixed-methods design combining survey data from 854 students with interviews, classroom observations, and field-based qualitative evidence collected across three socio-economically differentiated districts in the Central Region of Ghana. The findings reveal significant disparities in internet access, continuity of use, and digital participation across districts. While many students reported some form of internet access, opportunities for regular and meaningful engagement with digital technologies remained uneven. Digital participation frequently occurred outside formal school provision, with students relying heavily on personal mobile devices, household resources, and teacher-supported arrangements. The study further demonstrates that institutional conditions, including school infrastructure, connectivity, and teacher facilitation, play a critical role in shaping digital opportunities. In contexts where institutional support was limited, teachers often

compensated through personal resource contributions and informal facilitation strategies. The study contributes to digital inequality scholarship by showing that educational digital participation is shaped not only by access to technology but also by continuity of use and institutional mediation. The findings suggest that efforts to promote digital transformation in basic education should move beyond infrastructure provision and address the institutional and pedagogical conditions necessary for meaningful and equitable digital participation.

Keywords: *Digital inequality, digital participation, institutional mediation, digital transformation, Ghana.*

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**Corresponding author*

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1. Introduction

The rapid expansion of digital technologies has transformed educational systems worldwide, creating new opportunities for teaching, learning, communication, and knowledge acquisition. Increasingly, governments and educational institutions are investing in Information and Communication Technologies (ICTs) to improve educational access, enhance learning experiences, and equip learners with the digital competencies required for participation in contemporary knowledge economies (Balaban, Rienties, & Winne, 2023; Mochizuki & Vickers, 2024). As digital technologies become more deeply integrated into everyday life, access to digital resources and opportunities has become an increasingly important determinant of educational participation and future human capital development.

Despite significant advances in digitalisation globally, access to digital technologies and opportunities for meaningful digital participation remain unevenly distributed. These inequalities are particularly pronounced in many developing countries, where disparities in infrastructure, connectivity, affordability, and institutional capacity continue to shape educational experiences (Myovella et al., 2020; Asongu, Odhiambo, & Rahman, 2024). While considerable policy attention has focused on expanding access to digital technologies, emerging evidence suggests that access alone does not guarantee meaningful participation or educational benefit. Students may possess some level of connectivity but still face significant barriers related to the quality, continuity, and educational relevance of their digital engagement.

These concerns have become increasingly important within basic education systems. The basic education level plays a foundational role in developing literacy, numeracy, problem-solving abilities, and the digital competencies necessary for lifelong learning and participation in modern societies (Chandra, 2023; Dyussenov, Ibadildin & Hwang, 2025a). Consequently, improving opportunities for digital participation during the early years of schooling has become a major policy priority across many countries. Effective integration of digital technologies within basic education has been associated with enhanced access to information, improved learning opportunities, greater educational engagement, and the development of critical twenty-first-century skills (Nouri et al., 2020; Ozdamli & Karagozlu, 2022). However, these benefits

depend heavily on the availability of supportive institutional environments capable of facilitating meaningful digital engagement.

Ghana reflects many of the opportunities and challenges associated with educational digitalisation. Over the past decade, the Government of Ghana has introduced numerous initiatives aimed at promoting ICT integration within the education sector, including the One Laptop Per Child initiative, Ghana Learning TV, the Ghana Investment Fund for Electronic Communications (GIFEC), the e-Transform Ghana Project, and more recently the introduction of coding and robotics programmes within selected schools (Adarkwah, 2021). These initiatives reflect a broader national commitment to leveraging digital technologies to improve educational quality and prepare young people for participation in an increasingly digital economy.

Despite these efforts, significant inequalities remain. Recent evidence from the Ghana Statistical Service indicates that millions of school-aged children continue to experience limited access to ICT devices and digital learning opportunities, with rural communities facing particularly severe challenges (GSS, 2023). Many rural schools continue to operate under conditions characterised by inadequate ICT infrastructure, unreliable internet connectivity, limited electricity supply, insufficient technological resources, and shortages of teachers with appropriate digital competencies (Agyekum, 2023; Baako, Gidisu, & Umar, 2023). These constraints limit opportunities for meaningful digital participation and contribute to persistent educational inequalities between rural and urban communities. Importantly, the challenge extends beyond questions of access alone. Existing research increasingly suggests that digital inequality operates across multiple dimensions, including access, frequency of use, continuity of engagement, digital skills, and the ability to derive meaningful benefits from digital technologies (van Dijk, 2005; Hargittai, 2002). Students may have intermittent access to digital technologies but lack opportunities for sustained engagement or meaningful educational use. Similarly, schools may possess ICT resources but lack the institutional capacity to support effective integration into teaching and learning. Understanding digital participation therefore requires attention not only to technological access but also to the institutional conditions that shape how digital opportunities are experienced.

The concept of institutional mediation is particularly relevant in this regard. Schools serve as critical mediating institutions that can facilitate or constrain students' digital participation through the provision of infrastructure, connectivity, policies, pedagogical practices, and technological support (Warschauer, 2003; Selwyn, 2002). Within resource-constrained educational settings, teachers frequently play important mediating roles by creating opportunities for digital engagement, compensating for infrastructural limitations, and facilitating access to technological resources. Consequently, digital participation is often shaped not only by the availability of technology but also by the institutional and pedagogical environments within which learning occurs.

Although Ghana's digital divide has attracted increasing scholarly attention, much of the existing literature has focused on access to ICT infrastructure, technology adoption, digital literacy, or policy implementation (Aikins & Arthur-Nyarko, 2019; Agyei, 2021; Baako, Gidisu, & Umar, 2023). Comparatively limited attention has been devoted to understanding how district-level inequalities, continuity of internet use, and institutional mediation interact to shape students' opportunities for digital participation within rural basic schools. This represents an important gap, particularly given growing investments in educational digitalisation and ongoing concerns regarding educational inequality.

This study addresses this gap by examining patterns of internet access, continuity of use, digital participation, and institutional mediation among Basic 8 students in rural Ghana. Drawing on a mixed-methods design that combines survey data, interviews, and classroom observations, the study explores how infrastructural inequalities influence students' digital experiences and how schools and teachers mediate opportunities for digital engagement.

The study is guided by four research questions:

RQ1: How do patterns of internet access and continuity of use differ across socio-economically differentiated districts in rural Ghana?

RQ2: What forms of digital engagement do students undertake when internet access is available?

RQ3: How do institutional conditions within schools mediate students' opportunities for digital participation and learning?

RQ4: What role do teachers play in facilitating digital engagement in contexts characterised by infrastructural constraints?

By addressing these questions, the study contributes to scholarship on digital inequality, educational technology, and digital inclusion by demonstrating how access, continuity of use, and institutional mediation interact to shape digital participation in resource-constrained educational settings. The findings also provide evidence relevant to ongoing efforts to promote equitable digital transformation within Ghana's basic education system.

The remainder of the paper is organised as follows. The next section reviews the literature on digital inequality, continuity of internet use, institutional mediation, and educational participation. This is followed by the theoretical framework, methodology, findings, discussion, and conclusion.

2. Literature Review

2.1 Digital Inequality and Educational Access

The rapid expansion of digital technologies has generated significant optimism regarding their potential to improve educational access, learning opportunities, and human capital development. However, access to digital technologies remains highly uneven both within and between countries. This phenomenon is commonly described as the digital divide and refers to disparities in access to information and communication technologies, internet connectivity, digital skills, and the benefits derived from technology use (van Dijk, 2005).

While early studies conceptualised the digital divide primarily in terms of physical access to computers and internet connectivity, contemporary scholarship recognises digital inequality as a multidimensional phenomenon extending beyond simple access (Hargittai, 2002; van Dijk, 2020). Educational researchers increasingly argue that unequal access to digital technologies can reinforce existing social and educational inequalities by limiting opportunities for learning, information acquisition, and skill development (Warschauer, 2003).

These inequalities are particularly pronounced in developing countries, where infrastructural deficits, affordability constraints, unreliable electricity supply, and limited institutional capacity continue to hinder equitable access to digital technologies (Myovella, Karacuka, & Haucap, 2021). Across Sub-Saharan Africa, significant disparities persist between urban and rural communities, with learners in rural areas often facing greater barriers to connectivity and digital participation (Asongu, Odhiambo, & Rahman, 2024; Dlamini & Dewa, 2021).

The Ghanaian context reflects many of these broader challenges. Although national investments in ICT infrastructure and educational technology have expanded opportunities for digital learning, substantial disparities remain across regions and school types (Aikins & Arthur-Nyarko, 2019; Baako, Gidisu, & Umar, 2023). Rural schools frequently operate with limited technological resources, inadequate internet connectivity, and insufficient ICT support, constraining students' opportunities to engage meaningfully with digital technologies. Consequently, understanding educational digital inequality requires attention not only to whether technology is available but also to how access is distributed across different educational contexts.

2.2 Continuity of Internet Use and Digital Participation

Access to digital technologies does not necessarily guarantee meaningful participation in digital environments. Increasingly, scholars argue that continuity and frequency of internet use are equally important dimensions of digital inclusion (van Deursen & Helsper, 2015). Students may have occasional access to digital technologies yet lack opportunities for sustained engagement that would allow them to develop digital competencies and derive educational benefits.

Continuity of use refers to the extent to which individuals can access and utilise digital technologies consistently over time. Research suggests that irregular or intermittent access often limits the development of digital skills and reduces opportunities for educational engagement (Scheerder, van Deursen, & van Dijk, 2019). In educational settings, continuity of internet use influences learners' ability to access digital resources, complete assignments, participate in online learning activities, and develop confidence in using technology.

Recent studies indicate that meaningful digital participation depends not only on whether learners have internet access but also on the quality, frequency, and purpose of their engagement (Gui, Parma, & Comi, 2018; Sart et al., 2022). Students who engage regularly with digital technologies for educational purposes tend to demonstrate stronger digital competencies and greater academic engagement than those whose access is sporadic or primarily recreational.

Within many developing-country contexts, continuity of internet use remains constrained by affordability, unstable connectivity, limited device ownership, and infrastructural challenges (Chomunorwa, Mashonganyika, & Marevesa, 2023). Consequently, examining continuity of use provides a more nuanced understanding of digital participation than access indicators alone.

2.3 Institutional Mediation and Digital Participation

Although digital participation is often discussed in relation to individual access and skills, schools play a critical role in shaping how students experience digital technologies. Educational institutions function as mediating environments that influence the extent to which learners can translate access into meaningful educational opportunities (Warschauer, 2003).

The concept of institutional mediation emphasises the role of schools, educational policies, infrastructure, organisational support systems, and pedagogical practices in facilitating or constraining digital participation. Access to digital technologies alone does not guarantee meaningful learning outcomes if schools lack the resources and institutional capacity necessary to support effective integration into teaching and learning processes (Selwyn, 2002).

Research consistently demonstrates that schools with adequate ICT infrastructure, reliable internet connectivity, supportive leadership, and digitally competent teachers are better positioned to facilitate meaningful digital engagement among students (Tondeur et al., 2016). Conversely, schools operating under conditions of infrastructural scarcity often struggle to provide sustained opportunities for technology-enhanced learning. Teacher facilitation represents an important component of institutional mediation. Teachers influence students' digital experiences through instructional practices, technological support, resource provision, and the integration of digital tools into classroom activities (Flores-Tena, Ortega-Navas, & Sousa-Reis, 2021). In resource-constrained settings, teachers frequently act as critical intermediaries who compensate for institutional deficiencies by providing alternative pathways to digital participation.

Evidence from developing countries suggests that institutional factors often exert as much influence on digital participation as technological access itself (Ciuriak & Ptashkina, 2019; Sepúlveda, 2020). Recent studies on educational digital transformation further demonstrate that investments in infrastructure alone are insufficient unless accompanied by institutional support, teacher development, and governance structures capable of supporting meaningful digital engagement (Chomunorwa et al., 2023; Dyussenov, Ibadildin & Hwang, 2025b).

The concept of institutional mediation is particularly relevant in rural educational contexts where students frequently encounter multiple barriers to digital participation. Understanding how schools and teachers mediate digital opportunities is therefore essential for explaining variations in students' experiences of digital engagement.

2.4 Theoretical Framework

This study is informed by three complementary theoretical perspectives: the multi-level digital divide framework (van Dijk, 2005), second-level digital divide theory (Hargittai, 2002), and Sen's Capability Approach (Sen, 1999). The multi-level digital divide framework conceptualises digital inequality as extending beyond physical access to include differences in skills, patterns of use, and outcomes. First-level digital divides refer to inequalities in access to ICT infrastructure and connectivity, while second-level divides concern differences in the frequency, quality, and effectiveness of technology use. These perspectives are particularly relevant in rural educational contexts where access remains uneven and opportunities for meaningful digital participation vary substantially.

The Capability Approach provides a complementary lens by emphasising individuals' ability to convert resources into valued functionings. From this perspective, internet connectivity alone does not guarantee educational benefits. Rather, institutional environments, teacher support, and available infrastructure influence whether students can transform digital access into meaningful educational opportunities.

Building on Warschauer (2003) and Selwyn (2002), this study further introduces institutional mediation as the processes through which schools facilitate or constrain students' digital participation through infrastructure, policies, pedagogical practices, and resource allocation. Teacher mediation is conceptualised more narrowly as the actions undertaken by teachers to facilitate digital learning through instruction, resource provision, and technological support.

These frameworks provide an integrated analytical lens for examining how access, continuity of use, and institutional conditions interact to shape digital participation among students in rural Ghana.

3. Methodology

3.1 Research Design

This study adopted a concurrent mixed-methods design to investigate patterns of digital participation among Basic 8 students in public basic schools in Ghana's Central Region. Quantitative and qualitative evidence were collected during the same period and subsequently integrated during interpretation to develop a comprehensive understanding of digital inequality within school contexts. The quantitative component generated descriptive evidence on students' internet access, continuity of use, and online activities across districts, whereas qualitative interviews and classroom observations provided contextual explanations for the institutional, infrastructural, and pedagogical factors influencing these patterns. Integrating the two strands enabled the study to move beyond describing digital participation to explaining how educational environments shape students' opportunities to engage with digital technologies.

3.2 Study Context and Site Selection

Fieldwork was conducted between October and November 2024 in three districts within Ghana's Central Region: Cape Coast Metropolitan (CCM), Komenda-Edina-Eguafo-Abrem (KEEA) Municipality, and Ekumfi District (EKD). The study sites were selected purposively to capture variation in socio-economic conditions and educational infrastructure. Selection was informed by the Ghana Statistical Service's poverty mapping framework, which categorises districts according to relative levels of socio-economic endowment (GSS, 2015). Within this classification, Cape Coast Metropolitan represented a relatively well-resourced district, KEEA represented an intermediate context, while Ekumfi reflected comparatively lower levels of socio-economic development.

Selecting districts with contrasting socio-economic characteristics provided an opportunity to examine how contextual differences influence students' access to digital technologies and opportunities for educational internet use. Across the three districts, twenty-four public basic schools (eight from each district) were included in the study. Schools were identified in collaboration with district education authorities to ensure variation in geographical location, infrastructure, and ICT resource

availability. Concentrating on public schools allowed the study to examine digital participation within mainstream educational settings where disparities in technological resources are often most visible.

3.3 Study Population and Participant Selection

The study involved both student and teacher participants to capture multiple perspectives on digital participation within schools. The quantitative component focused on Basic 8 students because learners at this stage are increasingly expected to engage independently with digital technologies while simultaneously preparing for more advanced academic work requiring ICT competencies. Students who were enrolled in Basic 8, present during data collection, and had obtained the necessary institutional and parental or guardian consent were eligible to participate. A total of 854 students completed the survey.

To complement the survey findings, qualitative data were obtained from twelve students and ten teachers selected through purposive sampling. Student participants were chosen to reflect variation in gender, district, reported internet access, and observed patterns of digital engagement. Teacher participants were selected based on their involvement in ICT instruction, experience with integrating digital technologies into classroom practice, or familiarity with school-level ICT infrastructure. Rather than seeking statistical representation, the qualitative sample was intended to generate in-depth insights into the institutional and pedagogical processes underpinning students' experiences of digital participation. Classroom observations further enriched these accounts by documenting how technology was used within everyday teaching and learning environments.

3.4 Quantitative Data Collection

Data for the quantitative component were collected using a structured questionnaire designed to capture key dimensions of students' digital participation, including internet access, recency and frequency of internet use, locations of access, online learning activities, recreational internet use, and selected indicators of digital content creation. Questionnaire items were adapted from established literature on digital inequality and educational technology, with additional guidance drawn from the UNESCO Institute for Statistics' *Practical Guide to Implementing Surveys in ICT for Primary and Secondary Schools*. Prior to the main survey, the instrument was piloted in a school outside the study area to assess clarity, relevance, and age appropriateness. Feedback from the pilot informed revisions to item wording, sequencing, and administration procedures.

Although the questionnaire was originally developed for online administration using Microsoft Forms, preliminary field visits revealed substantial limitations in computer availability and internet connectivity across participating schools. Consequently, paper-based questionnaires were used throughout the study. Students who were able to complete the questionnaire independently did so through self-administration, while researcher-assisted administration was provided where clarification was necessary. Completed questionnaires were checked immediately after administration to identify missing responses before being digitised and imported into Stata for analysis.

3.5 Qualitative Data Collection

Interviews

Qualitative interviews were undertaken to gain a deeper understanding of the institutional and interpersonal factors shaping students' digital participation beyond what could be captured through the survey. Semi-structured interviews were conducted with twelve students and ten teachers drawn from the participating schools. Interview questions explored experiences of internet accessibility, the adequacy of school ICT infrastructure, instructional use of digital technologies, teacher support for technology-mediated learning, and challenges affecting students' engagement with online resources.

The semi-structured format allowed participants to discuss issues that were particularly relevant to their experiences while ensuring consistency across interviews. Individual interviews lasted approximately 20 to 40 minutes and were conducted in locations approved by school authorities to provide a quiet and comfortable environment for discussion. With participants' consent, detailed field notes were taken throughout the interviews, and where audio recording was impracticable, comprehensive notes were expanded immediately after each session to preserve participants' views and contextual information.

Classroom Observations

To complement interview and survey data, non-participant classroom observations were undertaken during ICT-related instructional activities. The observations focused on how digital technologies were incorporated into classroom teaching, the availability and functionality of ICT resources, patterns of student participation, teacher facilitation strategies, and the practical constraints encountered during technology-supported lessons.

A structured observation guide was used to ensure consistency across schools while allowing sufficient flexibility to document contextual issues unique to each setting. Observation records included descriptive accounts of classroom interactions, technology use, infrastructure availability, and interruptions arising from limited connectivity or equipment shortages. Recording these naturally occurring classroom practices provided an important means of comparing reported experiences with actual instructional practice and strengthened the contextual interpretation of the quantitative findings.

3.6 Analytical Procedures

Quantitative Analysis

Following data collection, completed questionnaires were digitised, verified, and imported into Stata for statistical analysis. Given the descriptive objectives of the study and the purposive selection of participating districts, the analysis focused on identifying patterns of digital participation rather than testing causal relationships. Descriptive statistics, including frequencies and percentages, were generated to summarise students' internet access, continuity of use, locations of access, and online activities. Cross-tabulations were subsequently employed to compare these indicators across districts, thereby highlighting spatial variations in digital participation associated with differing socio-economic contexts.

Qualitative Analysis

Qualitative data derived from interviews and classroom observations were analysed using thematic analysis. The analytical process commenced with repeated reading of interview notes and observation records to achieve familiarity with the data. Open coding was then undertaken to identify recurring concepts relating to internet accessibility, school infrastructure, teacher support, institutional constraints, continuity of internet use, and patterns of digital engagement.

As analysis progressed, related codes were consolidated into broader themes that captured the principal institutional and pedagogical influences on students' digital participation. These themes were subsequently compared with the quantitative findings to identify areas where the different forms of evidence converged or diverged. Integrating qualitative and quantitative evidence during interpretation enabled the study to provide richer explanations for observed district-level differences and strengthened the overall coherence of the findings.

3.7 Quality Assurance and Trustworthiness

The credibility of the study was enhanced through methodological triangulation, whereby evidence was drawn from three complementary sources: student surveys, semi-structured interviews, and classroom observations. Using multiple methods allowed the study to compare findings across different forms of evidence and reduced reliance on a single source of data. The integration of quantitative and qualitative findings during interpretation strengthened the robustness of the conclusions by enabling the identification of both convergent and divergent patterns.

Several procedures were implemented to improve the quality of the quantitative data. The survey instrument was piloted before the main fieldwork to assess clarity, relevance, and suitability for the target population. During data collection, questionnaires were administered using standardised procedures, with researcher assistance provided only where clarification was required. Completed questionnaires were reviewed immediately after administration to identify missing responses before digitization, thereby minimizing data entry errors and incomplete records.

The trustworthiness of the qualitative component was supported through systematic documentation of interviews and classroom observations. Interview notes were expanded immediately after each session to preserve contextual details and participants' perspectives, while observation records followed a structured guide to ensure consistency across schools. Throughout the analytical process, emerging themes were continually compared across interviews, observations, and survey findings to ensure that interpretations remained grounded in the empirical evidence.

3.8 Ethical Considerations

Ethical clearance for the study was obtained through the appropriate institutional approval processes before the commencement of fieldwork. Administrative permission was subsequently secured from the Ghana Education Service district education directorates, and the heads of participating schools before data collection began.

Given that the study involved minors, particular emphasis was placed on safeguarding participants' rights and welfare. Information explaining the purpose of the research, participation requirements, and data management procedures was

provided to school authorities, teachers, and participating students. Participation was entirely voluntary, and respondents were informed that they could decline participation or withdraw from the study at any stage without adverse consequences.

Confidentiality and anonymity were maintained throughout the research process. No personal identifiers were collected that could reveal the identity of participants or their schools in published reports. Interview notes, observation records, and survey data were securely stored and accessed only for research purposes. During analysis and reporting, all qualitative extracts were anonymised to protect the privacy of participants and ensure compliance with accepted ethical standards for educational research.

3.9 Conceptualisation of Key Constructs

To facilitate interpretation of the findings, two contextual constructs are used throughout this study.

Institutional mediation refers to the ways in which school-level policies, organisational practices, physical infrastructure, and the availability of educational resources shape students' opportunities to access and use digital technologies for learning. Within this study, institutional mediation encompasses factors such as ICT facilities, internet connectivity, electricity reliability, administrative support, and the broader learning environment that either enables or constrains digital participation.

Teacher mediation describes the instructional and supportive roles played by teachers in facilitating students' engagement with digital technologies. These roles include classroom instruction, guidance on the educational use of digital resources, supervision of technology-based activities, provision of alternative learning resources where digital infrastructure is inadequate, and other forms of pedagogical support that influence students' digital experiences.

Neither institutional mediation nor teacher mediation was operationalised as a quantitative variable within the survey. Instead, both constructs emerged inductively from interview narratives and classroom observations and are therefore employed as interpretive concepts to explain patterns identified in the quantitative analysis rather than as statistically tested predictors.

3.10 Researcher Reflexivity

The researcher's direct involvement in administering the survey, conducting interviews, and undertaking classroom observations provided valuable familiarity with the educational contexts in which the study was conducted. This close engagement facilitated rapport with participants and enhanced the interpretation of contextual factors that may not have been apparent through quantitative data alone. At the same time, the researcher's proximity to the field created the potential for subjective interpretation during data collection and analysis.

To minimise this possibility, several reflexive strategies were adopted throughout the study. Observation records distinguished clearly between descriptive accounts of events and the researcher's interpretations, thereby reducing the risk of conflating observation with inference. Interview findings were continuously compared with survey results and classroom observations to ensure that emerging interpretations were supported by multiple sources of evidence. In addition, analytic decisions were

revisited throughout the coding process to maintain consistency and ensure that conclusions remained firmly grounded in the data rather than in prior assumptions.

4. Results

4.1 District-Level Inequalities in Internet Access

Differential Access Across Districts (First-Level Divide)

Substantial district-level disparities in internet access were observed. While 70.2% of students in Cape Coast Metropolitan (CCM) reported ever using the internet, the proportion declined to 50.6% in Ekumfi District (EKD) and 57.7% in Komenda Edina Eguafo Abrem (KEEA) (Table 1). These patterns correspond with CCM's urban status, stronger ICT infrastructure, and institutional density.

These findings are consistent with first-level digital divide theory, which conceptualises inequality primarily as differential access to infrastructure (van Dijk, 2005). In EKD, where some communities and schools lack stable mobile network connectivity, digital exclusion appears infrastructural rather than motivational.

Continuity and Recency of Use (Second-Level Divide)

Among students who had ever accessed the internet, 65.9% reported doing so within the past three months. However, 20.4% indicated their last use occurred more than 12 months prior. Notably, the proportion of students reporting over 12 months since last use was nearly twice as high in EKD and KEEA as in CCM. Additionally, 40.6% of students reported no internet use within the three months preceding the survey. These findings suggest layered inequalities beyond initial access. Variations in frequency, continuity, and recency of engagement align with second-level digital divide theory, which emphasises differences in usage intensity and skill development (Hargittai, 2002).

Table 1: Frequency of use of the Internet among students

Description	CCM	EKD	KEEA	Total
Ever used the internet from any location	70.2	50.6	57.7	
Last internet usage				
<i>Between 3 and 12 months</i>	11.4	9.7	17.6	13.7
<i>Less than 3 months</i>	75.1	66.2	58.0	65.9
<i>More than 12 months</i>	13.6	24.0	24.4	20.4
Where internet was used most				
<i>Another person's home</i>	8.1	9.6	13.6	10.8
<i>At home</i>	78.7	68.5	64.1	70.2
<i>At school</i>	8.1	21.2	18.4	15.2
<i>Internet Café</i>	4.8	0.7	3.3	3.3
<i>Other</i>	0.4	0.0	0.6	0.4

How often was the internet used in the last 3 months?

<i>At least once a day</i>	4.3	15.3	18.6	13.0
<i>At least once a week</i>	56.7	29.4	35.0	41.3
<i>Less than once a week</i>	3.9	9.4	4.0	5.1
<i>Never</i>	35.1	45.9	42.3	40.6

Source: Authors' computation from field data

CCM: Cape Coast Metropolitan; EKD: Ekumfi District, KEEA: Komenda Edina Eguafo Abirem

4.2 Spatial Distribution of Access: Home Dominance and School Marginality

Privatised Access Patterns

Internet access was predominantly home-based. Approximately 70.2% of students reported accessing the internet primarily at their own homes, and 10.8% at another person's home (Table 1). In contrast, only 15.2% identified school as their primary access location. Across all study sites, only two schools possessed functional computer laboratories with internet connectivity. This spatial pattern indicates a shift from institutional to household-based connectivity, effectively privatising digital opportunity.

Classroom-Level Evidence of Institutional Deficit

Qualitative classroom observations reinforce this pattern. During one ICT lesson:

"The lesson for the day required the use of the internet... she connected her personal mobile hotspot to access the internet as the school had none. After nearly five minutes of no action, the researcher offered to make his personal data available to facilitate the lesson."

Similarly, a teacher from KEEA reported:

"I use my own data, my own laptop to teach. Nobody pays for the data, but I am fine. It helps me teach the students better... Sometimes I connect my hotspot to my laptop and the students come around in groups to see specific activities that I am performing online."

These excerpts demonstrate that internet-enabled instruction is contingent upon teacher improvisation rather than institutional provisioning.

Digital instruction was thus contingent upon teacher-owned devices and privately funded data. This description reveals two structural dynamics: financial externalisation of ICT costs onto teachers and group-based observational learning due to limited bandwidth and devices.

Another teacher highlighted network instability:

"I wish it was possible to download specific videos before the class because sometimes the internet is very unstable and ends up delaying the lesson."

These accounts collectively demonstrate that digital pedagogy is improvised rather than institutionalised.

4.3 Patterns of Internet Use

Media-Oriented and Informational Uses

The most frequently reported activity was watching videos, movies, or TV series (75.7%), particularly in CCM (83.6%) (Table 2¹). Additional activities included: reading or watching news (67.5%); social media use (63.6%); and sharing texts or images (59.4%). These patterns indicate substantial engagement with entertainment and communication-oriented digital platforms.

Academic and Productive Uses

Students also reported considerable educational engagement: 72.1% completed assignments online; 69.8% completed homework; 58.9% conducted school research; 43.4% studied for tests; 40.9% took tests online; 67.4% learned how to do something new online, 31.1% created a game, application, or computer program. These findings indicate that when access is available, students engage in both consumption and production-oriented digital practices.

Table 2: Patterns of Internet use

Description	CCM	EKD	KEEA	Total
Looked up information out of curiosity?	65.8	42.4	40.7	49.8
Watched video clips, shows, movies or a TV series	83.6	76.3	69.3	75.7
Shared texts, images or videos	68.3	52.9	55.4	59.4
Read or watched the news	66.3	77.1	64	67.5
Used instant messaging	61.7	58.6	41	51.9
Posted texts, images or videos you created	54.3	43.2	37	44.3
Used maps	24.7	35.3	27.7	28.3
Used social media, e.g. WhatsApp, Facebook, Instagram, Twitter	71.3	58.2	60.2	63.6
Learned to do something you did not know how to do	75.4	56.5	66.3	67.4
Taught other people to do something they did not know how to do	46	41.2	41.7	43.1
Created a game, application or computer program	32.1	32	29.9	31.1
Read a book or an e-book	60.9	51.5	53.8	55.8
Done an assignment (individual or group)	70.1	72.9	73.2	72.1
Done homework or exercises assigned by the teacher	73.1	64.7	69.7	69.8
Done school research	69.8	47.7	55.7	58.9

¹ Portions of Table 2 has been published in Ayerakwa et al., 2026

Done presentations to classmates	31.9	43.8	38.7	37.4
Played educational electronic games	51.8	50.3	36.7	44.8
Communicated with your teachers online	23.8	18.9	27	24.2
Taken part in online courses	29.2	18.8	30.5	27.6
Studied for a test	47.9	26.6	47.8	43.4
Researched on class topics	68	51.8	55.2	58.9
Shared school projects	26	16.5	27.6	24.7
Taken tests	43.1	30.2	44.4	40.9
Done school projects with classmates	42.2	40.6	46	43.5

Source: Authors' computation from field data

CCM: Cape Coast Metropolitan; EKD: Ekumfi District, KEEA: Komenda Edina Eguafo Abirem

4.4 Teacher Mediation and Participation Constraints

Teachers functioned as key mediators of digital learning. They provided personal laptops and smartphones, financed mobile data, curated online resources, and demonstrated digital processes in real time. However, participation was often constrained. In one observed ICT lesson, only two students practised sending emails while others looked on as passive observers due to limited devices and unstable connectivity. Another teacher remarked:

"I wish it were possible to have the requisite ICT gadgets that one can connect with and share videos with the students in class, but this is not possible, and when you want to use your own devices too, the connectivity is very bad".

These findings illustrate infrastructural fragility and the predominance of demonstration-based rather than participatory digital instruction.

4.5 Triangulation of Quantitative and Qualitative Findings

The integration of quantitative and qualitative evidence revealed both convergence and divergence across data sources. A clear area of convergence emerged regarding the limited role of schools in providing internet access. Quantitative findings showed that only 15.2% of students reported accessing the internet primarily through their schools. This pattern was strongly corroborated by interviews and classroom observations, which revealed widespread dependence on teacher-provided devices, personal mobile hotspots, and self-funded data subscriptions. Together, these findings indicate that digital participation in the study districts is largely dependent on household and individual teacher resources rather than institutional provision.

Another area of convergence concerned district-level inequalities in access and continuity of internet use. Students in the less-resourced districts reported lower levels of internet access and longer periods since their last online activity. These findings aligned closely with teacher accounts describing unstable network coverage, inadequate ICT infrastructure, and limited availability of digital devices.

A notable divergence emerged in relation to educational uses of the internet. Survey results suggested relatively high levels of engagement in online assignments, homework completion, and school-related research. However, classroom

observations indicated that students often participated in digital lessons indirectly through observation rather than hands-on interaction because of limited devices and unreliable connectivity. This suggests that while students may engage with educational technologies outside school settings, opportunities for active digital participation within classroom environments remain constrained.

5. Discussion

5.1 Digital Access and Continuity of Use in Rural Educational Contexts

The findings reveal substantial inequalities in students' access to and continuity of internet use across the study districts. Although a majority of students reported having used the internet at some point, levels of regular access and recent internet use varied considerably. These findings suggest that digital participation among students in rural Ghana remains uneven despite broader national efforts to expand connectivity and digital inclusion.

From the perspective of Digital Divide Theory, these findings illustrate the persistence of first-level digital divides characterised by unequal access to digital infrastructure and internet connectivity (van Dijk, 2005). While mobile technologies have expanded opportunities for internet access, significant disparities remain in students' ability to connect regularly and reliably. Access therefore remains an important determinant of digital participation, particularly in rural and resource-constrained educational environments.

The observed disparities are consistent with evidence from other Sub-Saharan African countries. Studies from South Africa, Kenya, Tanzania, and Zimbabwe similarly report that rural learners continue to face infrastructural barriers despite increasing national investments in digital technologies (Myovella et al., 2021). Across many African educational systems, unreliable connectivity, limited ICT infrastructure, and high data costs continue to constrain meaningful participation in digital learning. The Ghanaian experience therefore reflects broader regional patterns in which access has improved but remains unevenly distributed.

The findings further suggest that digital participation cannot be understood solely in terms of whether students possess internet access. Continuity of use emerged as an equally important dimension. Students who experienced more regular internet access were also more likely to report educational uses of digital technologies. This supports arguments that meaningful digital inclusion requires not only connectivity but also sustained opportunities to engage with digital resources over time.

5.2 Digital Participation Beyond School Infrastructure

One of the most significant findings of the study is that digital participation frequently occurred outside formal institutional provision. Survey results indicated that relatively few students accessed the internet primarily through school infrastructure. Instead, access was commonly facilitated through personal mobile devices, family-owned smartphones, community networks, and teacher-supported arrangements.

The triangulation of quantitative and qualitative evidence provides strong support for this finding. Survey data showed that only a small proportion of students identified schools as their primary source of internet access. This pattern was corroborated by interviews and classroom observations, which revealed that many schools lacked

adequate connectivity, functioning ICT laboratories, or sufficient digital devices. Students therefore relied heavily on household and community resources to participate in digital activities.

This finding extends current understandings of digital participation by highlighting the importance of non-institutional pathways through which learners access digital opportunities. While educational technology policies often assume that schools function as the primary gateway to digital learning, the evidence suggests that students frequently develop digital experiences through arrangements that exist outside formal educational provision. Digital participation in these contexts is therefore shaped not only by educational institutions but also by household resources, social networks, and community-level opportunities.

5.3 Institutional Mediation and Teacher Facilitation

The study demonstrates that institutional conditions play a critical role in shaping students' opportunities for digital participation. Significant differences in digital engagement were observed across schools and districts, reflecting variations in infrastructure, connectivity, and access to technological resources.

Drawing on Warschauer (2003) and Selwyn (2002), these findings highlight the importance of institutional mediation in determining how digital opportunities are experienced. Institutional mediation refers to how schools facilitate or constrain digital participation through infrastructure provision, resource allocation, organisational support, and educational policies. Access to digital technologies alone does not guarantee meaningful educational participation; rather, students' ability to benefit from digital opportunities depends heavily on the institutional environments within which learning occurs.

The findings indicate that many schools lacked the resources required to support sustained digital engagement. In several instances, digital participation was dependent upon the initiative of individual teachers who used personal devices, personal internet subscriptions, or informal arrangements to support students' learning.

This distinction between institutional mediation and teacher mediation is important. While institutional mediation reflects broader organisational capacities and structures, teacher mediation refers to the direct actions undertaken by teachers to facilitate students' engagement with digital technologies. The findings suggest that where institutional support was weak, teacher agency often served as a compensatory mechanism. However, reliance on individual teachers is unlikely to provide a sustainable basis for digital inclusion, particularly in under-resourced schools.

From a Capability Approach perspective (Sen, 1999), these findings illustrate that digital technologies represent resources whose educational value depends on the presence of enabling conditions. Schools and teachers function as conversion factors that influence students' ability to transform digital access into meaningful educational opportunities. Consequently, improving infrastructure alone may be insufficient if institutional and pedagogical capacities remain underdeveloped.

5.4 Educational Engagement and the Second-Level Digital Divide

The study further reveals important differences in how students use digital technologies for educational purposes. Although many students reported using the internet for assignments, information searches, and school-related activities, qualitative evidence suggested that opportunities for active digital engagement remained constrained.

A notable example of triangulation emerged in relation to educational internet use. Survey findings suggested relatively high levels of engagement in online educational activities. However, classroom observations indicated that many students participated in digital lessons indirectly through observation rather than direct interaction because of limited devices and unstable connectivity. This divergence highlights the importance of combining quantitative and qualitative evidence when examining digital participation.

These findings align closely with second-level digital divide theory (Hargittai, 2002), which emphasises inequalities in digital skills, patterns of use, and the ability to derive meaningful benefits from technology. Possessing internet access does not necessarily translate into effective educational participation. Rather, differences in the quality, frequency, and purpose of digital engagement contribute to unequal educational outcomes.

The findings therefore suggest that educational inequalities increasingly reflect differences not only in access but also in opportunities for meaningful digital participation. Students who possess greater opportunities to engage actively with digital technologies are likely to acquire stronger digital competencies and derive greater educational benefits than students whose engagement remains intermittent or largely observational.

5.5 Implications for Digital Inclusion and Human Capital Development

The findings have important implications for digital inclusion and human capital development within Ghana's education system. The evidence suggests that expanding connectivity alone is unlikely to achieve the transformative educational outcomes often associated with digital technologies. Instead, meaningful digital inclusion requires simultaneous investments in infrastructure, institutional capacity, teacher support, and opportunities for active student engagement.

The study contributes to digital divide scholarship by demonstrating that digital inequality in rural educational settings operates simultaneously at access, continuity, and institutional levels. The findings extend existing research by showing how institutional mediation influences students' ability to convert digital resources into educational opportunities. In this regard, the study shifts attention from simple measures of connectivity towards broader questions concerning the quality of digital participation and the institutional conditions that support it.

Overall, the findings suggest that sustainable digital transformation in education requires more than technology deployment. It requires the development of enabling institutional environments capable of supporting equitable, meaningful, and continuous digital participation among learners.

6. Conclusion

This study examined patterns of digital participation among Basic 8 students in rural Ghana and explored how internet access, continuity of use, and institutional conditions shape opportunities for digital engagement. Drawing on survey data, interviews, and classroom observations, the study provides evidence that digital participation remains highly uneven despite broader efforts to expand digital connectivity within Ghana's education sector.

The findings reveal that significant disparities persist in students' access to and continuity of internet use across districts and schools. While many students reported some level of internet access, opportunities for regular and meaningful engagement with digital technologies varied considerably. Importantly, the study demonstrates that digital participation frequently occurs outside formal institutional provision, with students relying heavily on personal mobile devices, household resources, community networks, and teacher-supported arrangements rather than school-based infrastructure.

The study further highlights the critical role of institutional mediation in shaping digital opportunities. Schools with limited connectivity, inadequate ICT infrastructure, and constrained technological resources were less able to support sustained student engagement with digital technologies. In many instances, individual teachers acted as important facilitators of digital participation by providing access to devices, internet connectivity, and learning support. These findings suggest that digital inclusion in educational settings depends not only on technological access but also on the institutional and pedagogical conditions that enable students to transform digital resources into meaningful learning opportunities.

Theoretically, the study contributes to digital divide scholarship by demonstrating that digital inequality in rural educational contexts operates across multiple dimensions, including access, continuity of use, and institutional support. By integrating Digital Divide Theory and the Capability Approach, the study shows that internet connectivity alone is insufficient for meaningful participation. Rather, the educational benefits of digital technologies depend on the extent to which learners can convert access into valued educational outcomes through supportive institutional environments and effective teacher facilitation.

The findings carry important implications for educational policy and digital transformation initiatives in Ghana. Efforts to promote digital inclusion should move beyond a narrow emphasis on infrastructure provision and address broader institutional constraints that limit meaningful participation. Investments in school connectivity, ICT infrastructure, teacher professional development, and digital learning resources remain essential if digital technologies are to contribute effectively to human capital development. Policies should also recognise the important role that households and communities currently play in supporting students' digital engagement and seek to strengthen these complementary pathways.

Several limitations should be acknowledged. The study focused on selected districts within one region of Ghana and therefore may not fully capture patterns of digital participation across the country. In addition, the cross-sectional design limits the ability to examine changes in digital participation over time. Future research could employ longitudinal approaches to investigate how digital engagement evolves as connectivity expands and could examine institutional mediation across different educational levels and geographical contexts.

Overall, the study demonstrates that the challenge facing educational digital transformation in rural Ghana is not simply one of expanding access, but of creating the institutional, pedagogical, and infrastructural conditions necessary for meaningful and equitable digital participation. Sustainable digital inclusion requires more than connectivity; it requires educational systems capable of converting digital opportunities into genuine learning and human development outcomes.

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Author Bio:

Dr. Hayford Mensah Ayerakwa is a development economist specialising in community development, digital learning innovations, sustainable agrifood systems, and education. His research, policy engagement, and youth-focused capacity building advance evidence-based, technology-enabled solutions that strengthen communities, improve learning outcomes, and promote inclusive, sustainable development in Ghana and beyond.

Millicent Otopabea Awuku, Ph.D., is a Lecturer in Economics at Ashesi University, Ghana. Her research focuses on health economics, environmental sustainability, energy policy, and digital education. She holds a PhD in Development Economics from the University of Ghana, via UNU-WIDER. Her publications include work on food security and digital education.

Dr. Antoinette Tsiboe-Darko is a Research Fellow at the Centre for Social Policy Studies, University of Ghana. Her research focus is in social issues and community development in natural resource endowed regions. Her publications cover a broad range of issues including health, education, civil society, and natural resources.