

First-order barriers still matter in teachers' use of technology: An Exploratory study of multi-stakeholder perspectives of technology integration barriers

Emmanuel A. Abedi and Francis R. Ackah-Jnr
Griffith University, Australia

ABSTRACT

Education systems worldwide recognise the value and promise of technology as a catalyst for transforming pedagogy and promoting student learning. However, several factors stymie teachers' technology integration practices in pursuit of these desired aspirations. This qualitative study investigates, from the perspective of key education stakeholders, major barriers affecting teachers' adoption of technologies as meaningful pedagogical tools in Ghana's classrooms. Twenty teachers, five headteachers, and five education officials from two education districts completed in-depth phone interviews with open-ended questions on these barriers. Informed by Ertmer's barriers to change theoretical lens, the findings revealed six contextual factors impacting effective technology integration, namely, *first-order barriers* - technological resource availability; leadership support; teacher professional development, and *second-order barriers* - teacher technological know-how; pedagogical beliefs and interest in technology use; and students' familiarity with technology. The first-order barriers were perceived to have a more significant impact than the second-order barriers. The findings contradict the commonly held claim that the impact of first-order barriers is diminishing, as this was not evident in the context of the study. The study offers implications for research, policy, and practice concerning the barriers that demand the utmost attention to advance effective technology integration, especially in developing countries.

Keywords: *Barriers; Developing Countries; Qualitative; Teachers; Technology integration; First-order; Second-order*

INTRODUCTION

First-order barriers continue to be pertinent and impact teachers' pedagogical beliefs, knowledge, and practice regarding the use of technologies. However, current research debates on technology integration barriers contend that second-order barriers (internal and personal dispositional factors) are more influential and merit particular consideration. The impact of first-order barriers (institutional factors) on teachers' use of technology is commonly believed to be diminishing in many countries (Ertmer & Ottenbreit-Leftwich, 2010; Ertmer et al., 2012). This paper argues that the significance of either first-order or second-order barriers to technology integration is dependent on the local context of practice and is not universal. This argument supports Francom's (2020) claims that the impact of technology integration barriers varies across settings.

In recent decades, many educators, education officials, and policymakers have recognised digital technology's potential to transform education and learning. The increasing clamour for the integration of technology in educational systems worldwide demonstrates its value and prospect for pedagogical change, students' learning and the acquisition of modern skills required for the present knowledge economy and information society (Bigum, 2012). Despite the rising prevalence of computers in classrooms, the integration of technology to change pedagogy is still uncommon (Willermark, 2021). Research suggests that teachers, who are thought of as primary change agents and ground implementers of innovation, have yet to effectively adopt technology in teaching and learning, particularly for constructive instruction and to improve student learning (Ertmer & Ottenbreit-Leftwich, 2010). Rather, many teachers 'domesticate' technology to support existing traditional teaching practices (Bigum, 2012). According to Vegas et al., (2019), when teachers

absorb technology into teaching, it is often in a low-level, conventional, and teacher-centred way rather than for meaningful and student-centred approaches to transform teaching and learning.

Several interconnected change barriers, including both internal (second-order) and external (first-order) factors, have been identified in previous studies as impeding teachers' adoption of technology for constructivist and more effective teaching and learning (Inan & Lowther, 2010, Fu, 2013; Pettersson, 2018; Tosuntaş et al., 2019). More complicated than these change barriers, which need to be explored, are their unclear interrelationships, particularly how they affect one another, and which barriers carry more weight and require immediate intervention for teachers' effective use of technology in pedagogy (Ertmer, 1999; Sherman & Howard, 2012). The purpose of this paper is to investigate the barriers that prevent teachers from using technology to support transformative pedagogy. The study goes on to investigate the relationships between these barriers and determines which class of barriers has the greatest impact on teachers' use of technology in Ghana. The primary objective of this study is to determine which barriers to change are more impactful on teachers' use of technology in a developing country context. An understanding of this can inform recommendations for tailored strategies that can affect teacher knowledge, self-efficacy, and pedagogical belief change, enabling constructive pedagogy with technology that meets the needs of modern learners. While it is critical to address all technology integration barriers at the same time, and not to consider addressing one barrier group before the other due to their continual interactions (Ertmer, 1999), knowing which barriers are more pressing and require immediate attention is essential, especially in economically constrained contexts with limited resources.

TECHNOLOGY ADOPTION IN GHANAIAN SCHOOLS

Similar to numerous other countries around the world, Ghana acknowledges the significance of Information and Communication Technology (ICT) in cultivating human resources for the contemporary information-driven society and knowledge-based economy. Amidst the rapid pace of technological advancement, the government considers ICT as a pivotal catalyst and collaborator in the nation's socio-economic progress and endeavours towards reducing poverty (Tsapali et al., 2021). As a result, a range of educational policies and curriculum reforms have been instituted, accompanied by increased investments in technology infrastructure in recent times aimed at fostering the integration of technology in schools to facilitate student-centred teaching and learning (Abedi et al., 2023). Ghana's technology integration in education drive, manifested in its current policies and curricula, has the added prime goals of equipping all learners with the needed 21st-century skills to enable them to become active participants in the global knowledge economy, as well as preparing teachers to use technology as learning tools (MoE, 2015, 2018; Tsapali et al., 2021). Teachers' proficiency in pedagogic use of technology is recognised as one of the crucial moves towards quality education (Ackah et al., 2022).

Despite policies on ICT in education and the push in investments for technology's presence in schools and the curriculum, several studies indicate that many teachers grapple with effective technology use in Ghana's classrooms. It is claimed that the rate of technology adoption by teachers has not increased, and the education system reflects limited practices of constructive use of technology that can facilitate student-centred pedagogy as envisioned in schools (Abedi et al., 2022; Buabeng-Andoh & Yidana, 2015; Tsapali et al., 2021). Enhancing our knowledge of the most critical barriers that impact teachers' effective use of technology in instruction, as well as the interplay between these barriers to change, is imperative for informing the development of relevant policies and bespoke strategies aimed at promoting teachers' utilisation of educational technologies for improved learning outcomes. Few studies in Ghana investigate which barriers or factors most affect teachers' effective uptake of technology from a multi-stakeholder perspective, and particularly which class of barriers is most striking. Considering the limited understanding of

barriers and Ghana's initiatives to promote meaningful technology integration, this exploratory study investigates the barriers that affect teachers' use of technology and their relationships. The following research questions are investigated to identify key areas to address and improve practice:

1. What factors affect teachers' uptake of technology for instruction in schools?
2. How do technology integration barriers interact with one another, and which are deemed to be more pivotal to teachers' use of technology?

THEORETICAL BACKGROUND

Our study employed the 'Barriers to Change' theoretical framework of Ertmer (1999), which classifies two broad barriers to technology integration. According to this framework, the factors affecting teachers' integration of technology can be categorised as either extrinsic (first-order) or intrinsic (second-order). It recognises that teachers could encounter barriers from both categories.

First-order barriers encompass institutional and school-related factors that are external to teachers and largely beyond their control (Ertmer, 1999). They include access to technology resources, time, and professional development (Inan & Lowther, 2010; Pittman & Gaines, 2015). School ICT policies (Tondeur et al., 2008) and national ICT in education policies (Trucano, 2016; Eickelmann, 2018) also influence technology integration in schools. Support from school leaders is also critical to realising the full potential of ICT to support teaching and learning activities in schools (Dexter, 2018). Teachers' use of technology in schools is affected by the availability of technological resources and technical support (Lim & Oakley, 2013). Tosuntaş, Çubukçu, and Tuğba's (2019) review of the literature identified technological resource availability as one of three major factors influencing effective technology integration in schools. Furthermore, professional development is regarded as critical and is found to be positively associated with teachers' effective use of technology in classrooms (Lawless & Pellegrino, 2007). While historically considered the primary obstacles to technology integration, the significance of these external and institutional barriers has been debated to diminish in earlier research, possibly due to the growing prevalence of computers in educational institutions (Ertmer et al., 2012). Because first-order barriers are considered easy to measure and fix once funds are available, many initial technology integration efforts traditionally focused on removing these. The underlying premise is that technology integration could occur once sufficient resources are provided (Ertmer, 2005).

Second-order barriers to change are characterised as 'fundamental' obstacles that are less conspicuous and are intrinsic to the individual teacher, as described by Ertmer (1999). These barriers, often considered to be more resistant to change than first-order barriers, are inherent and commonly rooted in teachers' beliefs and attitudes towards integrating technology into teaching and learning. (Ertmer, 2005; Ertmer et al., 2012). These barriers often stem from professional contexts (Prestridge, 2012), socio-cultural influences, personal beliefs, and dispositions regarding the role of technology in educational settings. Second-order barriers include teacher beliefs, orientations, and values regarding educational technology use (Hur et al., 2016). Openness to change and resistance to innovations are other internal factors that influence teachers' decisions to integrate technology in classrooms (Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2018). Research indicates that teachers might be better prepared to overcome external barriers and embrace technology in classrooms if they have positive internal attitudes and dispositions towards technology use. Yet, second-order barriers prove challenging to detect and surmount due to the potential requirement for teachers to transform deeply entrenched beliefs and identities (Ertmer, 2005; Tondeur et al., 2017). Several researchers posit that second-order barriers, mainly internal beliefs, exert the most significant impact on teachers' acceptance and effective use of technology (Ertmer & Ottenbreit-Leftwich, 2010; Ertmer et al., 2012; Kim et al., 2013; Prestridge, 2012).

While external barriers continue to be acknowledged as important factors influencing teachers' technology use in classrooms, a number of scholars, including Ertmer et al. (2012), contend that in many developed countries like the United Kingdom and the United States of America, these barriers have diminished to a point where they no longer play a central role in determining how and if teachers will incorporate technology in instruction. According to Ertmer et al. (2012), time and resources would be better spent focusing on second-order barriers, which are strongly related to teachers' pedagogical practices with technology, as opposed to first-order barriers, which currently do not significantly impede teachers' use of technology in many countries. Rather than solely directing efforts towards the elimination of first-order barriers, Ertmer and her colleagues propose that researchers and policymakers shift their focus towards enhancing teachers' knowledge and skills, fostering supportive school cultures, and implementing effective professional development programs aimed at transforming teachers' pedagogical beliefs and personal disposition towards technology use (second-order barriers). Law, Pelgrum, & Plomp (2008) found a weak relationship between the degree of ICT access (first-order obstacles) and the percentage of teachers who reported using technology in classrooms. The most important predictors of technology integration were identified as teacher pedagogical beliefs, skills, and knowledge (second-order obstacles).

In summary, the contemporary literature is leaning towards the argument that second-order barriers are leading and major factors influencing teachers' effective use of educational technologies, necessitating immediate attention and prioritised intervention to address such intrinsic challenges to technology integration. However, some studies (Pittman & Gaines, 2015) suggest that first-order barriers, which are thought to have been reduced in many countries, may still be significant and warrant equal attention. What remains unclear is how the interaction of these 'first-order and second-order' barriers and their impacts vary across different countries and contexts. This aspect has received relatively little attention in research, as highlighted by Schmitz and colleagues (2022). Accordingly, this study aimed to explore the relationship between first-order and second-order barriers and to ascertain which of these barriers have the most pronounced impact on teachers' use of educational technologies in Ghana and the strategies to adopt to address them.

RESEARCH METHODOLOGY

This study, investigating the perspectives of multiple education stakeholders on what obstacles hinder teachers' adoption and effective use of technology in classrooms, employed an exploratory and interpretive qualitative study approach as the methodology for data production, meaning generation and interpretation. Because multiple sources of evidence allow researchers to address broad issues and develop convergent lines of inquiry (Cohen et al., 2018), data collection comprised of semi-structured telephone interviews that typically lasted 50-60 minutes and open-ended questions. The completion of the open-ended questionnaire followed the telephone interviews after participants had sufficient time to reflect on the initial interviews. Semi-structured and open-ended interview questions for all participant groups covered the influential factors that affect teachers' intentions and adoption of technology in classroom practices.

PARTICIPANTS

Twenty teachers, five headteachers, and five district education officials from two low-income educational districts in Ghana were recruited for the study through purposive and snowball sampling, as the researchers could not personally travel to the research field because of international travel restrictions and border closures arising from the COVID-19 pandemic. Although the study focuses primarily on elementary school teachers who are expected to integrate technology into their classrooms, headteachers and district education officials were interviewed for

their perspectives, as school leaders such as these are critical in teachers' use of technology in schools (Christensen et al. 2018). The two school districts were chosen not for comparison, but rather to provide a broader range of contexts in which the investigated phenomenon could be explored and understood. Participants' names in the extracts are marked with 'MT,' 'FT,' 'HT,' and 'EO' to indicate that they are male teachers, female teachers, headteachers, or education officials. Table 1 outlines the demographic characteristics of the different research participants.

Table 1: Study participants' characteristics

Participant groups	Participant characteristics
Teachers (n = 20)	75% were males, while females accounted for 25%. All teachers were professionally trained with a minimum qualification of a Diploma in Education. The least experienced teacher was two years into the teaching service.
Headteachers (n = 5)	All were males aged between 35-54 years. Headship experiences ranged from 6 to 2 years of service.
District education leaders (n = 5)	2-20 years of work experience. Job portfolios included Circuit supervisors, Municipal training officers, and Municipal ICT coordinators.

DATA ANALYSIS

Braun and Clarke's (2006) thematic analysis techniques were used to analyse data from the interviews and open-ended questions. The data analysis procedures included recording and transcribing data, categorising common codes from the aggregated data set, and looking for patterns and themes for meaning generation. In particular, the following six steps were undertaken: (1) data familiarisation, (2) generating initial codes, (3) theme generation, (4) theme revision, (5) theme definition and naming, and (6) findings writing. In all, two levels of thematic coding and analysis (inductive and deductive) were undertaken with the aid of NVivo 12. First, the data were inductively open-coded to identify general perceptions about barriers affecting teachers' use of technology. Second, the barriers identified from the initial coding phase were categorised using Ertmer's (1999) description and constructs of first-order and second-order barriers to change. The summary of the data is presented in Table 2.

Table 2: Technology integration barriers

Barrier categories	Sub-Themes (Barriers)	Main insights from the data
First-order	Technology resources availability	Insufficient technology resources. Large class sizes affect equitable access to computers in schools.
	Teacher professional development	Training is mostly reserved for ICT subject teachers. Limited technology PD and training opportunities.
	Technology leadership support	Non-prioritisation of technology integration by district leaders. Teachers are restricted from using mobile phones to teach by school leaders.
Second-order	Teacher beliefs, attitudes, and interest in ICT	Misconceptions about technology use as being for only ICT subject teachers. Elderly teachers perceive technology as being for young and beginning teachers.
	Teacher knowledge of technology integration	Inadequate teachers' knowledge of technology use for teaching.
	Learners' familiarity with technology	Students' unfamiliarity with ICT deters teachers from using it.

FINDINGS AND DISCUSSION

The study findings are presented and discussed in two parts: (1) what participants perceived as inhibitors to teachers' use of technology, using Ertmer's (1999) conceptual model of barriers to change, and (2) what the identified barriers tell us about their possible relationships and impact on teachers' use of technology.

First-order barriers affecting teachers' use of technology in schools

In this section, we present and discuss the first-order barriers, namely technology resource availability, teacher professional development for technology use, and technology leadership support identified in the study.

Technology resources availability

We found that the availability of technology learning materials and infrastructure resources are important school-level factors that affect how teachers use technology in the classroom. Most of the study participants (n=28), including five education officials, four headteachers, and 19 teachers, stated that many schools and classrooms lack the necessary technological resources for teachers' use, affecting their readiness and capacity to integrate technology. While some teachers are enthusiastic about using technology to facilitate teaching and learning, limited technology resources such as computers and stable Internet access in schools hinder them. Teachers' ability to incorporate technology into classrooms as the curriculum requires is also hampered by a lack of ICT tools. This was observed in a headteacher's statement:

Using technology to enhance other subjects has been introduced as part of the new curriculum, but it is not being implemented due to the lack of ICT tools in most schools... Internet access is also a barrier to technology integration in schools. (HT)

The few teachers who had access to ICT facilities in schools complained about their inadequacy due to large class sizes and student congestion, which hampered the effective use of technology in teaching. Due to the disparity between the number of students and available computers, it usually becomes difficult for all students to concurrently use computers during instruction, affecting effective integration.

The classroom setting is ideal for ICT integration. It has all the electrical appliances set up for ICT use, but we don't have many computers, which causes me problems... The number of students in the class exceeds what is available, making effective technology integration difficult. (MT)

Another teacher expressed a similar viewpoint, stating:

In my case, [technology integration] is difficult due to the large number of children [students] in the classroom... It's a problem because the student-to-laptop ratio is around 20:1. You cannot get all students to perform simultaneously (MT).

These excerpts show that teachers and school leaders think that having too many students and inadequate technology resources are key problems. This situation was perceived to impede teachers' capacity to teach with technology, despite their best intentions and dispositions to do so.

Our findings support the claims of Inan & Lowther (2010), Pittman & Gaines (2015) and Spiteri & Rundgren (2018) that limited technological resources greatly impede teachers' intentions and decisions to use technology in the classroom. This means that teachers' intentions, acceptance, and actual use of technology to facilitate teaching and learning are driven by the availability of technology in classrooms.

Teacher Professional Development for Technology Use

Seventeen study participants, including ten teachers, three education officials, and four school heads, identified a lack of specified pre-service training and in-service professional development as a major barrier to using technology for meaningful teaching. They reported that many professional development opportunities for technology integration were not openly available for all teachers to learn about integration. Instead, these training opportunities are earmarked solely for teachers who teach technology as a subject in the classroom. The perspectives of the participants below demonstrate how technology professional development is limited to only technology subject teachers, limiting other general subject teachers' access to the necessary technology preparation and support for meaningful technology use in teaching.

Training is organised for teachers who teach ICT as a subject, not for all teachers. I don't get to attend such workshops as I am not an ICT teacher. (MT)

I recall them organising [technology training] for only ICT teachers. Other subject teachers were excluded... I have never received any district training for [technology use] because I am not an ICT teacher. (MT)

Findings further show that teachers sometimes could receive technology training as part of general professional development programs the district education office organises. However, this type of training was deemed insufficient in providing teachers with the necessary preparation to teach with technology. As illustrated below, many teachers do not integrate technology into classrooms due to inadequate technology training.

Teachers occasionally attend workshops organised by the district, though these workshops are not specifically designed for ICT integration. They are incorporated into general training and other professional development activities... (HT).

Limited ICT training [for] the majority of teachers is a challenge to the integration of ICT...if the teacher [does not receive training] ... if you don't know the technology itself, how can you use it to teach? (MT)

The findings indicate that teachers have fewer opportunities to participate in specialised technology professional development programs, which discourages them from integrating technology. This means that having adequate technology preparation can be a panacea for some teachers to use technology in classrooms. Technology professional development for all teachers is thus critical in influencing teacher knowledge, and pedagogical beliefs change for meaningful technology integration (Ertmer & Ottenbreit-Leftwich, 2010; Muianga et al., 2019).

Technology leadership support

Twelve study participants, including eight teachers, two headteachers, and two education officials, identified inadequate school leadership support for technology use in teaching and learning as a

significant barrier. According to some participants, school leaders are crucial in cultivating positive school cultures and shared vision that support and sustain teachers' use of technology in the classroom. As a result, the lack of a vision for technology integration, ineffective implementation of ICT policies, and restrictions on teachers' use of smartphones for instruction were perceived as leadership deficits that hinder teachers' intent and use of technology in classrooms. According to one headteacher, there is usually a disconnect between existing ICT in education policies and teachers' actual use of technology in schools because many school leaders do little to enforce technology integration.

I think they [school leaders] should enforce it [technology integration] in our schools. As it stands, implementing ICT integration [in schools] is a major challenge. They [Ghana Education Service] have [ICT] policies in place, but when you get to the schools, its implementation is not very effective... (HT)

Some participants lamented and offered reasons school leaders are not doing adequately to implement existing national ICT in education policies in schools, which affects teachers' use of technology in teaching. They attributed this to the limited attention given to technology use in schools relative to other teaching disciplines. As one teacher explained:

...they [leaders] are solely focused on mathematics and science, ignoring ICT.

Additionally, one of the headteachers identified the non-prioritisation of technology implementation from the district leadership as a challenge because it impacts the resources and training programs offered to support teachers.

ICT integration training is not currently a high priority for most districts and schools. My district does not prioritise ICT integration. Reading and literacy are the district's top priorities for assisting children to read and write... Most of the training is focused on reading and literacy but not on ICT... (HT)

The headteacher's remark above implies that the lack of emphasis on technology integration because it does not align with the overall vision of the district, influences the professional development opportunities for teachers to learn about technology integration. This finding is consistent with previous research that a lack of a shared institutional vision and leadership that effectively guides both schools and teachers towards a common goal of technology integration is a major impediment to effective technology implementation in schools (Levin & Schrum, 2013; Petterson, 2018). As Tondeur et al. (2008) argued further, localised school and district-based ICT policies and plans are critical for fostering teachers' use of technology in schools.

Mobile phones are evolving into an important teaching and learning tool with great potential and promise in education (Sung et al., 2016). While many of the teacher participants in this study saw mobile phones as another viable option for integrating ICT, especially in the absence of other technological tools, school leaders' restrictions on their use as classroom teaching support limited teachers' use. The view of one of the teachers illustrates:

Another issue with ICT integration stems from our district education directors and headteachers, who do not allow teachers to use smartphones to teach in the classroom. (MT)

Restrictions on teachers using mobile phones in the classroom are a hindrance and a disincentive to technology integration because they can impair teachers' motivation and capacity to teach with

such tools (Buabeng-Andoh & Yidana, 2015). This is a significant challenge for technology integration because mobile phones have proven to be valuable tools for teachers in developing countries such as Nigeria and Kenya to access learning materials and deliver pedagogical content (McAleavy et al., 2018). We posit that the policy priorities and actions of district and school

leaders can have a major impact on teachers' beliefs and attitudes, and tendencies of using technology in classrooms.

Second-order barriers affecting teachers' use of technology in schools

In addition to the first-order barriers, these second-order barriers were also identified: *teacher knowledge of technology integration, teacher pedagogical beliefs, attitudes, interests, and perceptions of learners' familiarity with technology.*

Teacher knowledge of technology integration

Teachers' technological and pedagogical knowledge is critical for improving their pedagogical beliefs and self-efficacy to use technology meaningfully in the classroom to facilitate student learning (Ertmer & Ottenbreit-Leftwich, 2010). However, in this study, seven participants, including three teachers, three headteachers, and one education official, highlighted teachers' limited technology knowledge as a barrier to their confidence in using ICT in the classroom. According to some headteachers, teaching with technology is a significant challenge in primary schools, particularly for older teachers whose pre-service teacher education did not include integration technology training and thus lack adequate knowledge of technology use in teaching.

Most primary school teachers are unfamiliar with ICT, particularly those whose pre-service training predated the introduction of ICT into the basic education system... Many of them lack adequate preparation on ICT and how to integrate it when teaching other subjects. (HT)

Some teachers, particularly those in primary schools, do not know how to use computers to teach students... This is especially prevalent among older teachers who did not receive in-service technology training. (HT)

According to the comments of the headteachers, older teachers who received their teacher education training prior to the formal introduction of ICT in primary schools tend to struggle to integrate technology when teaching. The comments below illustrate a female teacher participant's view on some teachers' limited knowledge and skills in ICT, along with the impact on practical use of technology in instruction:

...inadequate ICT know-how and skills are obstacles to many teachers' effective use of technology for practical instruction. (FT)

The female teacher attributed the limited use of technology in instruction to many teachers' unfamiliarity with technology and inadequate pre-service training and in-service opportunities for technology professional development. The results of earlier studies provide support for this view (Buabeng-Andoh, 2015; Natia & Al-hassan, 2015). This finding suggests that lack of technology professional development and training, which results in teachers having insufficient technical and pedagogical knowledge, is a common barrier affecting teachers' ability and confidence to effectively integrate technology in Ghana's classrooms.

Teacher pedagogical beliefs, attitudes, and interest

We learned from the study that teachers' technological pedagogical beliefs and attitudes have an impact on their uptake and productive use of technology in the classroom. Seven participants, including three teachers, three headteachers, and one education official, reported that some teachers' unfavourable pedagogical beliefs and lack of awareness about the potential benefits of technology use for instruction affect their willingness to use technology in the classroom. In addition, the misconceptions of some older and more experienced teachers that technology use in classrooms are reserved for new teachers and those who teach ICT as a subject were noted to influence their intentions and decisions to use technology. One headteacher identified this as a key barrier and advocated for sensitisation training to foster positive teacher pedagogical beliefs and orientations towards the use of technology.

Most teachers do not integrate ICT into their instruction because they think they are not ICT teachers. They usually say I am not an ICT teacher, so why should I integrate ICT ... I believe that all teachers should receive adequate training and sensitisation about the importance of technology in the classroom. (HT)

In the view of the headteacher, pedagogical beliefs and perceptions of teachers about the use of technology in teaching and who it is intended for can have a negative impact on their use of technology in the classroom. One teacher backed this claim, saying that such misconceptions are especially common among older teachers as some of them believe that ICT is for the young and new teachers. According to Christensen & Knezek's (2016) 'will, skill, tool' model, teachers' attitudes regarding technology use can predict and influence their intentions and use of technology in teaching. For Ertmer & Ottenbreit-Leftwich (2010), such pedagogical beliefs and attitudes can change as teachers gain more knowledge through technology professional development.

Perceptions of learners' familiarity with technology

Learners' level of familiarity with technology instruction was found to influence whether teachers use technology or not in teaching. Six teachers, particularly those who taught in rural schools, identified that some learners' low digital literacy and familiarity levels with technology-supported teaching present challenges that affect teachers' intentions and decisions to teach with technology. The views of two teacher participants from rural community schools revealed that some students' low level of technology knowledge discourages teachers from incorporating technology into their lessons, and this can be challenging for both teachers and students.

The challenge, I would say, is that most of our students in rural schools are unfamiliar with ICT tools for teaching... When these tools are used in the classroom to teach, students struggle to understand... It is often best to avoid teaching with them [technologies]. (MT)

Some students' lack of ICT literacy makes it difficult for me to teach them. I believe it is due to where I teach. Because it is a rural community with few computers, it is difficult to teach using such tools. (FT)

As the teachers perceived, low ICT literacy levels among students from rural areas make it challenging for teachers to employ technologies to support teaching and learning in schools. The teachers' comments indicate that if students are unfamiliar with the technological tools used in instruction, teaching with them becomes difficult because students struggle to comprehend what is

taught using such tools. Thus, perceptions of students' abilities to cope with technological tools and technology-supported instruction influence some teachers' struggles and hesitations to teach with technology. This finding resonates with Ainley's (2018) and Aesaert et al.'s (2015) finding that learners' inadequate technological literacy competencies, which can be caused by limited access to technologies, influenced teachers' intentions to teach with technology.

How do the first and second-order barriers relate? Which are perceived as more impactful?

Teachers in the study context encounter both first-order and second-order barriers in their efforts to integrate technology, which is consistent with research indicating that most teachers face both sets of barriers to technology change (Petko et al., 2018; Vongkulluksn, & Bowman, 2018). The findings reveal that first-order barriers, such as the limited availability of technological resources and support, insufficient technical leadership and the absence of a shared vision, and limited technology professional development opportunities for teachers and school leaders, as well as second-order barriers, including teachers' technological know-how, interest, and motivation, especially affect teachers' readiness and confidence in using technology in Ghana's classrooms. A cursory examination of these barriers suggests a possible relationship between them and which category of barriers most influences teachers' use of technology. Compared to second-order barriers, most participants identified first-order barriers as a significant factor in teachers' difficulty in implementing technology in the classroom. From the findings, the total number of mentions (47) of first-order barriers as notably affecting technology integration was higher than the total number of mentions (15) of second-order barriers, inhibiting teachers' technology integration practices.

Findings show that first-order barriers tend to have more impact on second-order barriers, such as teachers' pedagogical beliefs and attitudes, interests, and technology know-how. The second-order barriers regarding teachers' dispositions were seen to be influenced and dependent on the availability or otherwise of the first-order barriers or factors. Participant responses suggest that the external institutional and school factors drive teachers' internal dispositions and skills acquisition to adopt and effectively teach with technology in classrooms. Specifically, most teachers, headteachers, and education officials stated that lack of technological resources was the main impediment to teachers' readiness, capacity, and interest in using technology. One headteacher noted that without available computers in schools, teachers are unable to integrate technology even if they want to or are trained to do so. Another headteacher stated that if the ICT tools are not available, it becomes difficult for teachers to integrate even if they are trained to do so. Further, without computers, the headteacher perceived that teachers often lament, "how am I going to do it?" when asked to integrate technology into teaching. While teachers may believe using technology is beneficial, these reactions suggest that a lack of adequate and appropriate technology resources hinders them.

Another conceivable relationship was observed between the availability of technology professional development and teachers' capacity and readiness to incorporate technology into teaching. Several participants asserted that teachers' lack of technology professional development opportunities limits their computer skills and willingness to teach effectively with technology. One male teacher noted that without adequate training and preparation, teachers could not do much to integrate technology. He stated:

...limited ICT training is a challenge to technology integration in schools. If a teacher doesn't have enough preparation...not abreast of technology use, he or she would not be able to teach [with technology]... (MT)

Further, another male teacher noted that limited technology professional development opportunities contribute to many teachers' unfamiliarity with technologies and reluctance to use

them for instruction. He noted:

... the majority of teachers lack adequate preparation about how to integrate ICT into teaching...many teachers are not familiar with integration. (MT)

The findings of Tondeur et al., (2017) reinforce this study's findings on the interrelationship between first-order and second-order barriers, particularly the one that exists between professional development and teachers' beliefs and capacity to use technology, with the former being a significant predictor of technology integration (Bowman et al., 2022; Lai et al., 2022; Muianga et al., 2019).

The impact of insufficient technology resources and limited technology professional development opportunities on teachers' use of technology specifies that the first-order barriers are momentous and are the primary barriers to most teachers' ability and willingness to use technology in Ghana's classrooms. This finding contradicts earlier studies, particularly those conducted in Western countries, suggesting that the first-order barriers, particularly access to ICT resources and professional development, are no longer a significant barrier to technology integration, as compared to the second-order barriers such as teacher dispositional factors (Ertmer et al., 2015; Ottenbreit-Leftwich et al., 2018). While it is suggested that first-order barriers have been greatly reduced, particularly in the United States and other Western countries, and that the current focus should be on second-order barriers, which are perceived as more difficult to change (Kim et al., 2013; Tondeur et al., 2017), our findings reveal that first-order barriers continue to matter and meaningfully influence teachers' use of technology in developing countries such as Ghana. We argue that these external factors are most influential in shaping teachers' internal dispositions and their beliefs about effective technology use in teaching. This is not downplaying the importance of teachers' knowledge, attitudes, and beliefs, which current research prioritises in fostering meaningful technology use in classrooms and improving student learning. The persistence and rippling potency of external factors manifested as first-order barriers in this study indicate that they must continue to occupy a significant space in the research space and be given equal attention as second-order barriers when addressing technology integration challenges. Our findings and claims resonate with the arguments of Tosuntaş et al. (2019) that teachers' knowledge, skills, attitudes, and beliefs should be emphasised after the elimination of external barriers to achieve meaningful technology integration outcomes in schools.

CONCLUSION AND IMPLICATIONS

Integrating technology into teaching to transform pedagogy and student learning is a best-practice goal, but many teachers, whose roles in this process are critical, struggle to implement it in the classroom. In Ghana, technology integration is not yet pervasive in schools, and many teachers persist in traditional uses of technology to supplement teacher-centred instruction (Abedi et al., 2023). Prior research indicates that teachers face both internal and external constraints in integrating technology, which must be tackled simultaneously because of their continuous interactions (Ertmer, 1999). However, in a resource-constrained setting like Ghana, the decisions of government, policy-makers, and non-governmental organisations (NGOs) to overcome these interlacing barriers should be guided by relevant research on contextual factors that primarily impact teachers' use of technology in teaching. These factors require utmost focus and addressing.

Drawing on the perspectives of multiple educational stakeholders and Ertmer's (1999) barriers to change framework, the study provides evidence of two interlacing barriers that affect technology integration practices of teachers in Ghana: (1) first-order barriers - limited technological resources,

inadequate technology leadership, and professional development; and (2) second-order barriers - teachers' limited technology knowledge, misconceptions, and negative attitudes toward ICT use. Between these barriers, the first-order barriers, particularly the lack of technological resources, appear to be the most impactful issue in the study's context, affecting most teachers' readiness, confidence, attitudes, and capacity to effectively teach with technology. This finding contradicts popular Western literature arguments that first-order barriers have been significantly reduced and no longer have a significant impact on teachers' use of technology in comparison to second-order barriers. This finding implies that in the Ghanaian context, as in other developing countries, first-order barriers such as limited professional development opportunities and technological infrastructure and resources should be prioritised and made available to teachers in order for them to transform existing pedagogical beliefs and other internal dispositions as they strive to integrate technology to achieve constructivist teaching and learning objectives. This study's findings and implications are consistent with those of Hennessy et al. (2010), who advocated for the prioritisation of technology resources and professional development for teachers in Sub-Saharan Africa, citing these external variables as primary barriers to teachers' knowledge, beliefs, and self-efficacy to effectively integrate technology in the classroom.

The findings of this study have implications for research, policy, and practice in developing countries comparable to Ghana, which is starting to focus on technology integration policies and practices in order to transform teaching and improve student learning. Specifically, we believe that supportive school leadership and culture with adequate provision of technology infrastructure, teacher motivation, and local school ICT policies that are aligned with national ICT in Education policies and curriculum are critical to providing direction to support technology integration efforts of teachers and their dispositions about meaningful practice in the classroom. We further advocate for the emphasis on transformative professional development programs aimed at shaping teachers' pedagogical beliefs, knowledge, and skills in order to promote the constructive use of technology in instruction and foster deeper student learning. While we do not claim that simply removing first-order barriers will result in effective technology integration by teachers, it is critical to note that multiple educational stakeholders in this study, including teachers regard such first-order barriers as most crucial. Thus, policymakers' focus on reducing their impact can be a first step towards positively shaping teachers' beliefs and knowledge about meaningful technology integration.

Overall, this study sheds essential light on interrelated internal and external barriers affecting teachers' use of technology and the barriers perceived to have the most significant impact on integration in a developing country context. Knowledge of these barriers provides educational leaders and policymakers with insights into which group of barriers are more impactful and the strategies to prioritise to circumvent these. With previous research arguing that the impact of first-order barriers is waning in most countries, our study's findings serve as a reminder that these barriers remain significant in some educational settings, particularly those in developing countries, and should be given the same level of consideration as second-order barriers that are centred on teachers' beliefs and dispositions. The study argues that the impact of barriers to technology integration differs depending on national contexts and the level of technology adoption in an educational system. Further research is suggested to investigate the relationship between first-order and second-order barriers and their weight of impact on teachers' technology use across different national contexts. Such research could assist school leaders, and policymakers in a variety of educational and national contexts in better understanding the most pressing challenges to technology use and enacting tailored strategies that align with local priorities, thereby enabling constructive technology integration that transforms student learning and classroom pedagogy.

STUDY LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This study has limitations stemming from its dependence on self-reported experiences gathered through telephone interviews for exploring and understanding the phenomenon under examination. This reliance on self-reports was necessitated by the researchers' inability to include observational data, attributed to COVID-19-related travel restrictions and international border closures that were in effect during the data collection period. Self-reporting methods can provide valid and dependable data collection instruments for technology integration (Christensen & Knezek, 2008). However, such methods, according to Lawless and Pellegrino (2007), may be problematic, particularly when investigating teachers' technology integration practices. They contended that self-reported data may contain prejudices because it often reflects personal convictions and social preferences rather than actual practices or behaviour. Thus, future research should broaden the scope of research methods to include methodologies such as on-site field observations of teachers' technology integration practices and the factors that impede effective integration. Such research could provide more firsthand data, as well as a more accurate picture and understanding of actual technology integration practices in classrooms, leading to more trustworthy findings and interpretations.

REFERENCES

- Abedi, E., Prestridge, S., & Geelan, D. (2022). Beginning Teachers' Reflections on Pre-service Technology Training and Sense of Preparedness. In *Society for Information Technology & Teacher Education International Conference* (pp. 302-311). Association for the Advancement of Computing in Education (AACE).
- Abedi, E. A., Prestridge, S., & Hodge, S. (2023). Teachers' beliefs about technology integration in Ghana: a qualitative study of teachers', headteachers' and education officials' perceptions. *Education and Information Technologies*, pp. 1-21.
- Ackah-Jnr, F. R., Appiah, J., Abedi, E. A., Opoku-Nkoom, I., & Salaam, M. A. (2022). Quality education: Critical policy considerations that impact teacher retention in schools. *European Journal of Education and Pedagogy*, vol. 3, no. 3, pp. 26-32.
- Ainley, J. (2018). Students and their computer literacy: Evidence and curriculum implications. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *Second handbook of information technology in primary and secondary education* (pp. 69-88). Switzerland: Springer.
- Bigum, C. (2012). Schools and computers: Tales of a digital romance. In *Transformative Approaches to New Technologies and Student Diversity in Futures Oriented Classrooms* (pp. 15-28). Springer, Dordrecht.
- Bowman, M. A., Vongkulluksn, V. W., Jiang, Z., & Xie, K. (2022). Teachers' exposure to professional development and the quality of their instructional technology use: The mediating role of teachers' value and ability beliefs. *Journal of Research on Technology in Education*, vol. 54, no. 2, pp. 188-204.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77-101.

- Buabeng-Andoh, C., & Yidana, I. (2015). Teachers' ICT usage in second-cycle institutions in Ghana: A qualitative study. *International Journal of Education and Development using ICT*, vol. 11, no. 2.
- Christensen, R., Eichhorn, K., Prestridge, S., Petko, D., Sligte, H., Baker, R., Knezek, G. (2018). Supporting learning leaders for the effective integration of technology into schools. *Technology, Knowledge and Learning*, vol. 23, no. 3, pp. 457-472.
- Christensen, R., & Knezek, G. (2008). Self-report measures and findings for information technology attitudes and competencies. In R. Christensen & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 349-365). Boston, MA: Springer.
- Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed). Milton Park, Abingdon, Oxon, England: Routledge.
- Dexter, S. (2018). The role of leadership for information technology in education: systems of practices. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *Second handbook of information technology in primary and secondary education* (pp. 483-498). Switzerland: Springer.
- Eickelmann, B. (2018). Cross-national policies on information and communication technology in primary and secondary schools: An international perspective. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *Second handbook of information technology in Primary and secondary education* (pp. 1227–1238). Switzerland: Springer.
- Ertmer, P. A. (1999). Addressing first-and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, vol. 47, no. 4, pp. 47-61.
- Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, vol. 53, no. 4, pp. 25-39.
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, vol. 59, no. 2, pp. 423-435.
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, vol. 42, no. 3, pp. 255-284.
- Francom, G. M. (2020). Barriers to technology integration: A time-series survey study. *Journal of Research on Technology in Education*, vol. 52, no. 1, pp. 1-16.
- Fu, J. (2013). The complexity of ICT in education: A critical literature review and its implications.,. *International Journal of Education and Development using ICT*, vol. 9, no. 2, pp. 112-125.
- Hennessy, S., Harrison, D., & Wamakote, L. (2010). Teacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale Online Journal of African Studies*, vol. 2, no. 1, pp. 39-54.

- Hur, J. W., Shannon, D., & Wolf, S. (2016). An investigation of relationships between internal and external factors affecting technology integration in classrooms. *Journal of Digital Learning in Teacher Education*, vol. 32, no. 3, pp. 105-114.
- Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development*, vol. 58, no. 2, pp. 137-154.
- Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, vol. 29, pp. 76-85.
- Lai, C., Wang, Q., & Huang, X. (2022). The differential interplay of TPACK, teacher beliefs, school culture and professional development with the nature of in-service EFL teachers' technology adoption. *British Journal of Educational Technology*, vol. 53, no. 5, pp. 1389-1411.
- Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of educational research*, vol. 77, no. 4, pp. 575-614.
- Law, N., Pelgrum, W. J., & Plomp, T. (2008). *Pedagogy and ICT use in schools around the world: Findings from the IEA SITES 2006 study* (Vol. 23). Hong Kong: Comparative Education Research Centre/ Kong Springer.
- Levin, B. B., & Schrum, L. (2013). Using systems thinking to leverage technology for school improvement: Lessons learned from award-winning secondary schools/districts. *Journal of Research on Technology in Education*, vol. 46, no. 1, pp. 29-51.
- Lim, C. P., & Oakley, G. (2013). Information and communication technologies (ICT) in primary education: Opportunities and supporting conditions. In L. Y. Tay & C. P. Lim (Eds.), *Creating Holistic Technology-Enhanced Learning Experiences* (pp. 1-18). Rotterdam: Sense Publishers.
- McAleavy, T., Hall-Chen, A., Horrocks, S., & Riggall, A. (2018). *Technology-Supported Professional Development for Teachers: Lessons from Developing Countries*. Education Development Trust. Highbridge House, 16-18 Duke Street, Reading Berkshire, England RG1 4RU, United Kingdom.
- Ministry of Education. (2015). *Ghana ICT in education policy*. Accra, Ghana: Ministry of Education.
- Ministry of Education. (2018). *National pre-tertiary education curriculum framework*. Accra, Ghana: Ministry of Education.
- Muianga, X. J., Barbutiu, S. M., Hansson, H., & Mutimucuo, I. V. (2019). Teachers' Perspectives on Professional Development in the Use of SCL Approaches and ICT: A Quantitative Case Study of Eduardo Mondlane University, Mozambique. *International Journal of Education and Development Using Information and Communication Technology*, vol.15, no. 2, pp. 79-97.

- Natia, J., & Al-hassan, S. (2015). Promoting teaching and learning in Ghanaian Basic Schools through ICT. *International Journal of Education and Development using ICT*, vol. 11, no. 2.
- Ottenbreit-Leftwich, A. T., Kopcha, T. J., & Ertmer, P. A. (2018). Information and communication technology dispositional factors and relationship to information and communication technology practices. In V. Joke, K. Gerald, C. Rhonda, & L. Kwok-Wing (Eds.), *Second handbook of information technology in primary and secondary education* (pp. 309-333). Cham, Switzerland: Springer.
- Petko, D., Prasse, D., & Cantieni, A. (2018). The Interplay of School Readiness and Teacher Readiness for Educational Technology Integration: A Structural Equation Model. *Computers in The Schools*, 35(1), 1-18. <https://doi:10.1080/07380569.2018.1428007>
- Pettersson, F. (2018). On the issues of digital competence in educational contexts – a review of literature. *Education and Information Technologies*, vol. 23, no. 3, pp. 1005-1021.
- Pittman, T., & Gaines, T. (2015). Technology integration in third, fourth and fifth grade classrooms in a Florida school district. *Educational Technology Research and Development*, vol. 63, no. 4, pp. 539-554.
- Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & Education*, vol. 58, no. 1, pp. 449-458.
- Sherman, K., & Howard, S. (2012). Teachers' Beliefs about First- and Second-Order Barriers to ICT Integration: Preliminary Findings from a South African Study.
- Schmitz, M.-L., Antonietti, C., Cattaneo, A., Gonon, P., & Petko, D. (2022). When barriers are not an issue: Tracing the relationship between hindering factors and technology use in secondary schools across Europe. *Computers & Education*, vol. 179, pp. 104411.
- Spiteri, M., & Rundgren, S. N. C. (2020). Literature review on the factors affecting primary teachers' use of digital technology. *Technology, Knowledge and Learning*, vol. 25, no. 1, pp. 115-128.
- Sung, Y.-T., Chang, K.-E., & Liu, T.-C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, vol. 94, pp. 252-275.
- Tsapali, M., Major, L., Damani, K., Mitchell, J., & Taddese, A. (2021). *Country-Level Research Review: EdTech in Ghana*. <https://doi.org/10.5281/zenodo.4613150>
- Tondeur, J., Van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence. *Educational Technology Research and Development*, vol. 65, no. 3, pp. 555-575.
- Tondeur, J., van Keer, H., van Braak, J., & Valcke, M. (2008). ICT integration in the classroom: Challenging the potential of a school policy. *Computers & Education*, vol. 51, no. 1, pp. 212-223.

- Tosuntaş, Ş. B., Çubukçu, Z., & Tuğba, İ. (2019). A holistic view to barriers to technology integration in education. *Turkish Online Journal of Qualitative Inquiry*, 10(4), 439-461. <https://doi.org/10.17569/tojqi.613969>
- Trucano, M. (2016). *Saber-ICT framework paper for policy analysis: Documenting national educational technology policies around the world and their evolution over time*: World Bank. World Bank Education, Technology & Innovation: SABER-ICT Technical Paper Series: <https://openknowledge.worldbank.org/handle/10986/26107>
- Vegas, E., Ziegler, L., & Zerbino, N. (2019). *How Ed-Tech Can Help Leapfrog Progress in Education*. Center for Universal Education at The Brookings Institution. <https://www.brookings.edu/research/how-ed-tech-can-help-leapfrog-progress-in-education/>
- Vongkulluksn, V. W., Xie, K., & Bowman, M. A. (2018). The role of value on teachers' internalisation of external barriers and externalisation of personal beliefs for classroom technology integration. *Computers & Education*, vol. 118, no. 3, pp. 70–81.
- Willermark, S. (2021). Teachers' technology-related knowledge for 21st century teaching. In H. Ulferts (Eds.), *Teaching as a Knowledge Profession: Studying Pedagogical Knowledge across Education Systems* (pp. 42-64). Educational Research and Innovation, Paris: OECD Publishing. <https://doi.org/10.1787/e823ef6e-en>

Copyright for articles published in this journal is retained by the authors, with first publication rights granted to the journal. By virtue of their appearance in this open access journal, articles are free to use with proper attribution, in educational and other non-commercial settings.