The sustainability of information and communication technology (ICT) in previously disadvantaged public schools in Gauteng, South Africa

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In 2015, a Member of the Executive Council (MEC) of the Gauteng provincial legislature, South Africa, introduced the "Classroom of the Future" programme in previously disadvantaged schools, allowing an integration of information and communication technology into classrooms. In this article we focus on the sustainability of ICT in these schools. We regard sustainability as meeting one's needs without compromising the ability of future generations to meet their own needs. The sample constituted 18 participants from 6 disadvantaged schools in the Classroom of the Future initiative. Semi-structured face-to-face and telephonic interviews were employed for data collection. Our results show that ineffective teacher professional development for ICT, and inconsistent and timeous service delivery from the Gauteng Department of Education (GDE) technicians/teacher trainers were a major deterrent to effective ICT implementation. Additionally, the phasing-in approach to the rollout of ICT was a serious challenge to ICT sustainability in schools. We recommend improved teacher professional development initiatives pertaining to ICT to be instituted in schools where heads of department[i] take responsibility for empowering post-level one (PL 1) teachers on ICT to improve classroom learning. We also advocate for new improved service delivery from GDE technicians/teacher trainers, who are held accountable for fulfilling their mandates.

Keywords: information and communication technology (ICT); principal; professional development; public schools; schooling system; sustainability; teacher

Introduction and Background to the Study

Literature on ICT implementation highlights the importance of effective ICT integration into South African classrooms, focusing on its benefits to improving the teaching and learning process, as well as enabling South African learners to fit into a global ICT society. The *White Paper on e-Education* (Department of Education [DoE], Republic of South Africa [RSA], 2004) was articulated as an indispensable document to validate the government's strong views on enabling South African education through ICT. This white paper is a specific policy in support of ICTs in education, principally in schools.

The South African DoE outlined as a significant goal in its *e*-Education white paper policy document (2004) that: "All South African learners from grades one to twelve would be ICT-capable by 2013" (Bialobrzeska & Cohen, 2005:14). Even though these ambitions were not realised by 2013, Chisango and Marongwe (2021), Minty and Moll (2020), and Zhong (2011), indicate that the number of schools with improved ICT resources had increased speedily. Thus, we are drawn to the discourse that South African education leaders aim to transform teaching and learning through the appropriate use of ICT. This may be seen mainly in Gauteng and the Western Cape where large-scale rollouts of computer provision have occurred (Bialobrzeska & Cohen, 2005; Isaacs, 2007; Staff Writer, 2015; Van Wyk, 2012), namely:

- The Khanya Project of the Western Cape DoE in 2011
- The Gauteng-on-line Project in 2012
- Operation Phakisa in Gauteng in 2016
- Classroom of the Future Initiative in 2015 (the focus of this article)

The Classroom of the Future Initiative

The aim with the Classroom of the Future initiative was to guarantee all schools access to the internet through state infrastructure at classroom level (DoE, RSA, 2004). The aim with the employment of ICT in schools was to improve communication, inspire learner engagement, save teachers' time, and equip both teachers and learners with the skill of becoming cyber citizens (Jamieson-Proctor, 2018; Pholotho & Mtsweni, 2016; Van Wyk, 2012). In 2014 the fifth political administration of a democratic South Africa merged all ICT stand-alone projects into one massive rollout. By 2015, the ICT/e-learning rollout was approved. The ICT agenda for the massive rollout was aligned to the strategic vision as outlined in the following strategies, plans, and targets:

- National Development Plan for 2030 (NDP);
- Department of Basic Education (DBE) ICT Strategy;
- Gauteng Provincial Government (GPG) Strategic Pillars;
- Transformation, Modernisation, and Re-industrialisation (TMR);
- GDE Strategic Objective (Pillar 6, ICT in education); and
- The Gauteng City Region (GCR) Delivery Targets.

The purpose with the massive rollout of ICT was to enhance educational outcomes and learner attainment speedily and at scale.

The Gauteng Department of Education did not have the available finances to roll out ICTs to all Gauteng classrooms. Thus, the only way to facilitate a useful ICT rollout was to focus on ordinary public schools, starting with township schools from Grade 12 down to Grade 8, where a phased-in approach was adopted. This meant that not all classrooms were equipped with ICT devices. It is important to mention that the rollout of ICT entailed more than the handing out of ICT devices. Security measures to ensure that the devices were protected, revamping of the schools' infrastructure, service delivery from GDE technicians/teacher trainers, as well as the appropriate training of teachers were all involved in the effective rollout of ICT devices. However, in this article we only focus on the effective training of teachers, the phased-in approach to the rollout of ICT, and the service delivery from GDE technicians/teacher trainers on technical matters as well as pedagogical workshops pertaining to ICT.

Towards an ICT-based Schooling System in South Africa

During the 2019 State of the Nation Address, the president of South Africa, Mr Cyril Ramaphosa, asserted that South Africa's education system would advance when every child at school is given digital workbooks and textbooks on a tablet device over a period of 6 years. This assertion demonstrated that South Africa's leaders were making a concerted effort to improve education by using ICT, thus trying to bridge the inequality gaps caused by the previous apartheid regime. Nevertheless, Meyer and Gent (2016) offer criticism of South Africa's initiatives for successful integration of ICTs into the classroom. They point out that even though policies and strategies to use ICT existed, the implementation was sluggish, and human capacity was limited. Access to technology was limited and unequal across provinces as well as schools in different quintiles. Consequently, equitable initiatives, which were fair to all learners needed to be carefully discussed, well thought through, and room for improvement should be considered.

According to Belland (2009) and Ibrahim-Dasuki, Abbott and Kashefi (2012), the procurement of computing devices for teacher education in South Africa is on the rise. The contestation over teachers receiving useful ICT professional training seems to be a persistent crisis in South Africa and other developing countries such as Kenya, Nigeria, and Ethiopia (Afemikhe, 2004; Dlamini & Mbatha, 2018; Majumdar, 2015; Makhanu, 2010; Olofsson, Lindberg, Fransson & Hauge, 2015; Seyoum, 2004).

The Need for Continuing Professional Development Programmes on ICT Implementation and the Capacitation of Teachers

Studies conducted by Dlamini (2022) and Kolobe and Mihai (2021) highlight that the participants in their respective studies demonstrated a lack of readiness to use the interactive activities available to them due to a lack of appropriate professional development initiatives. We concur with the above findings and call for professional development programmes to enable teachers to move towards becoming specialists in their practice with continuous professional development opportunities, as opposed to irregular, once-off workshops that provide only the slightest benefit toward enriched classroom practice (Guskey, 2002; Wirch, 2021). ICT professional development should be content-specific to permit teachers to adjust their pedagogy to allow maximum learning through the proper use of technological devices (Chan & Chan, 2011; Cox, Webb, Abbott, Blakeley, Beauchamp & Rhodes, 2004; Gonzalez-Sanmamed, Sangrà & Muñoz-Carril, 2017; Mingaine, 2013).

We argue that for educational outcomes relevant to ICT implementation to be reached, GDE officials should train teachers, as well as heads of department (HoDs). The capacities of teachers should be developed to enable them to use the technological devices in a manner most suited to the content of their subjects. Technological training without content/pedagogical training is futile for the sustainable use of ICT (Chen, W 2013; Chen, L & Chen, 2008; Hennessy, Onguko, Harrison, Ang'ondi, Namalefe, Naseem & Wamakote, 2010; Herring, Koehler, Mishra, Rosenberg & Teske, 2016; Mingaine, 2013).

Theoretical Framework that Underpinned This Study: Cultural-historical Activity Theory (CHAT)

We grounded this research study within the Cultural Historical Activity Theory (CHAT) and used this as a lens to examine various social interactions in the implementation of ICT in classrooms (Engeström, 1999; Hasan & Kazlauskas, 2014; Jonassen & Rohrer-Murphy, 1999; Kaptelinin & Nardi, 2018). CHAT-centred inquiry proposes that a system exists where people from diverse situations construct meanings, learning occurs from those meanings and change may transpire from them (Capper & Williams, 2004; Foot, 2014). As our lens, we recognised that the interactions between various stakeholders (HoDs, PL 1 teachers, and GDE technicians/teacher trainers) are crucial. These interactions are important because they may enable effective sustainable integration of ICT in the classroom. Similarly, we were interested in the activity that occurs in different situations: firstly, during the interactions between HoDs and their respective PL 1 teachers; secondly, interactions

between schools and GDE technicians/teacher trainers; and lastly, interactions between schools and GDE when it came to the phasing-in approach. The outcome of one activity affected the other. CHAT may assist the GDE (pertaining to their technicians and the phasing-in approach) in understanding their own and others' work contexts to bring about change (Kolokouri, Theodoraki & Plakitsi, 2012; Wilson, 2014). Hence this theory is relevant, as the interaction between schools and the GDE encompasses the notion of activity, and it is self-evident that learning cannot occur without activity. Below we provide a synthesis of the CHAT theory as perceived by the authors, and as it is relevant to the study.

The activity theory framework (Engeström, 2007) demonstrates that to reach the outcome of any activity, aspects such as subject, object, community, division of labour, rules, and tools are important considerations. These crucial aspects play a role in enabling or disabling the intended outcome of an activity. Each factor is discussed below, and their links to the research paper are clarified (Bertelsen & Bødker, 2003). The subject was viewed as a person or group engaged in the activity, working towards achieving goals (Wilson, 2014) and is moulded by social factors such as collaborative experiences with those whom they considered significant (Stetsenko, 2013; Stetsenko & Arievitch, 2010). The object offers awareness of why people perform diverse actions and highlights that the object determines an activity. The object of the activity system encourages the actions of the subject. The object of activity encompasses the activity's focus and purpose with the intent of change or growth taking place (Engeström, 1999; Sezen-Barrie, Tran, McDonald & Kelly, 2014; Wilson, 2014). Therefore, without an object, there is no activity (Foot, 2014; Lewin, Cranmer & McNicol, 2018).

Community refers to all people who share the same goals (Capper & Williams, 2004; Postholm, 2008). The human systems – social, cultural, and organisational – within which we work, also mediate the ways in which we conduct our activities (Capper & Williams, 2004). Humans, therefore, work together, learn by doing, and communicate through their actions (Foot, 2014). In respect of this paper, the subject and community may be regarded as the HoDs or GDE offering long-term support and effective courses to teachers, enabling them to enhance their pedagogy of teaching through ICT.

Instruments (also known as tools and artifacts) refer to internal or external mediating items which help to achieve the outcomes of the activity (De Beer, 2019). A tool is anything we use to help us manipulate the environment to meet our needs (Capper & Williams, 2004; Miettinen, 2006). These tools affect the overall shape and direction of an activity system and act to mobilise participants for improving collaborative activity and instructional processes (Foot, 2014; Lee, 2011).

Within CHAT, rules standardise actions and interactions within the activity system. The various rules are set in place in the school generally, and in the classroom itself, and this is bound to affect the activity of classroom learning and the way that teachers are trained within the school (De Beer, 2019; Engeström, 1999; Van der Walt, 2019). Through the subjects' participation in the activities of the community, the individual begins to recognise the rules of acceptable behaviour within the community, and how diverse tasks need to be achieved in that community. In this study, ICT implementation and sustainability are subjected to rules.

The division of labour involves work being distributed between people belonging to the community (Tsui & Law, 2007; Van der Walt & Wolhuter, 2018), since an activity system presupposes interrelatedness (De Beer, 2019; Van der Walt & Wolhuter, 2018).

Pertaining to the outcome of an activity, the object goes through numerous changes involving subjects and their experiences, artifacts, and the activity at hand, until it stabilises as a complete outcome. To attain an outcome, subjects need to work together (Engeström, 1999). The outcomes of the activity can be the intended goal, or an unintended outcome that may arise. The CHAT paradigm, therefore, undertakes that those outcomes are built by interaction within an activity involving subjects and environmental factors within a context (Al Khader, 2018; Koszalka & Wu, 2004).

Hence, all aspects of an activity system relate to each other and in this study, we determined how the various subjects (teachers, HoDs, GDE technicians) interacted within this activity (ICT implementation) towards maintaining sustainability in the change process. The subject's position is influenced by the rules of the system, the community, and the division of labour (Barab, Barnett, Yamagata-Lynch, Squire & Keating, 2002; Engeström, 1999; Gronn, 2002; Hardman, 2015). The overall depiction of the objects signifies that the object-orientated actions are characterised by interpretation and potential for change within the system (Engeström, 1999; Leontiev, Mostinsky, Polonsky, Styrikovich & Chernika, 1981) and in this study that was the schools where ICT was integrated.

This study was directed by three research questions:
- What influence does teacher development have on ICT sustainability in schools?
- How did the ICT phasing-in approach affect sustainability?
- How does the responsiveness of the GDE technicians affect ICT sustainability?

Research Methodology and Design
Research Paradigm
A research paradigm guides the action of conducting research (Babbie, Mouton & Strydom, 2011; Creswell, 2012; Rubin & Babbie, 2010). In this study we used symbolic interactionism as the paradigm, which is a vital framework in sociological theory (Blumer, 1986; Denzin, 2016; Quist-Adade, 2019; Stryker, 2017). Symbolic interaction theory tries to understand the subjective meanings that people ascribe to objects, events, and behaviour. Subjective meanings are deemed significant as it is assumed that people behave based on what they believe and not just on what is objectively true. Consequently, if a school seems to be functioning well in the implementation, integration, and use of ICT (or not), the interactionist is keen to discover the reasoning around it. Concerning symbolic interaction, action is not simply a result of psychological qualities or regulated by social structures; rather, it results from an ongoing process of making meaning, which is always evolving, and subject to change. Throughout this process, the person builds and adjusts pieces and may weigh up positives and negatives (Altheide, 2004; Babbie et al., 2011; Williams & Copes, 2005). Symbolic interactionists direct their attention to the nature of the interaction. Hence, it links to the theoretical framework of this study, namely, CHAT, as they both sought to understand the different interactions in various activity systems and posit that the activity and interaction between participants may lead to change in a system. For this reason, context is always evolving (Babbie et al., 2011; Benzies & Allen, 2001; Carter & Fuller, 2015).

Research Design and Approach
We viewed the research design as the various steps that we needed to take to reach a product of good quality (Babbie & Mouton, 2007; Bless, Higson-Smith & Kagee, 2006). In this study we used a qualitative design in a multiple case study approach (Yin, 2003, cited in Baxter & Jack, 2008) to explore and report on the intricate moving and unfolding interactions of events and human relationships (Creswell, 2012; Klassen, Creswell, Plano Clark, Smith & Meissner, 2012; Mohajan, 2018).

Research Sites and Participants
A purposeful sampling approach was adopted, where selected individuals and research sites were chosen to learn from or understand the central phenomenon (McMillan & Schumacher, 2010; Thomas, 2003). The sample constituted 18 participants from six disadvantaged schools that formed part of the Classroom of the Future initiative in the Gauteng province, South Africa. The sample involved PL 1 teachers and HoDs because they played a significant role in the training of PL 1 teachers in their departments. Moreover, bearing in mind that more than one research site was used, we delved into the differences and similarities within and between cases (Creswell, 2009; Creswell, Hanson, Clark Plano & Morales, 2007).

Data Collection
The qualitative research approach allowed us to interact with participants to recognise their insights and experiences (Bricki & Green, 2007). Semi-structured individual interviews were used to collect data. The use of a qualitative research approach linked well with the case study research design, as we focused on a detailed exploration of the actual cases in their real-life contexts (Babbie & Mouton, 2007; Creswell, 2012). During the second quarter of 2021, we conducted semi-structured interviews with participants in schools where the principals permitted in-person interactions notwithstanding the Coronavirus disease (COVID-19) pandemic. Additional interviews were conducted telephonically and through video calling. After encountering numerous obstacles when trying to access schools to conduct in-person interviews, we had no choice but to use these methods of data collection. The advantage of telephonic interviews was that we connected with the participants for clarification if there were any further questions after completing the transcriptions. This contributed to us collecting rich, comprehensive data. Three key focus areas, namely, teacher professional development, the phased-in strategy to ICT rollout, and the responsiveness of GDE technicians were the focus of the interview questions, which related to ICT sustainability in the schools.

Data Analysis
We adopted content analysis as an analytical tool to evaluate large quantities of text that arose from the transcriptions. This involved the examination of transcribed text, which we coded and then grouped into categories. We compared the categories and drew conclusions from the text (Cohen, Manion & Morrison, 2007; Mohajan, 2018). The application of content analysis follows a systematic classification of data for the precise analysis, examination, and corroboration of the content of written data (Bricki & Green, 2007; Cohen et al., 2007; Glesne, 2016; Lyons, 2010; Mayring, 2014). This form of data analysis was relevant for this research study as it allowed us to study various texts to draw conclusions.

Findings
In line with the qualitative method, the research questions are supported with excerpts from the interviews and an analysis pertaining each question is presented in this section. The answers to all three primary research questions will assist readers to understand the different stakeholders' (HoDs,

GDE technicians and teacher trainers) involvement in effective ICT implementation as well as the way in which ICTs were rolled out in schools, and how these factors affected the sustainability of ICT in South African classrooms.

Research Question 1: What Influence does Teacher Professional Development have on ICT Sustainability in Schools?
An important inquiry framed our rationale: How could teachers contribute towards ICT integration, implementation, and its sustainability in schools? According to Brown and Brown (2008), Dlamini (2022) and Voogt, Gorokhovatsky and Almekinders (2003), teachers require upskilling in 21st century ICT pedagogy. The espousal process should not be slowed down by the teachers' lack of ICT expertise. There should be possibilities for ICT teacher development together with strong computational learning materials to fill the gaps. The findings show that only School 1 in Research area A had a fully functional ICT committee that promoted effective ICT training to ensure that valuable integration in the classroom could follow. The HoDs from School 1 used the knowledge received from the GDE teacher trainers during training workshops to inspire PL 1 teachers to integrate ICT effectively in the classroom. At the same school, teachers completed a survey once a week, indicating their ICT-related needs. The school management team (SMT) then arranged professional development training for those needs to be addressed.

HoD 1 at the same school validated this claim by stating as follows: "*In ICT committee meetings, we plan to initiate the training if teachers ask for assistance.*" At the same school we asked HoD 2 how they determined whether teachers had achieved the anticipated outcomes of their training. He responded as follows: "*We do a pre-test, and then we do a post-test.*" We then asked a follow-up question: "*If the post-test tells you that teachers have not reached the intended outcomes, then what do you do about it?*" The HoD responded as follows: "*We sit down and request more training from the GDE, we also consult with the respective subject facilitators and then the SMT sits down and creates a training.*" These findings from School 1, Research area A are remarkable, as HoDs take the lead in identifying teacher challenges and addressing them through constant professional development. This is admirable for a previously disadvantaged school in South Africa.

In line with the above we found that HoD 6 in School 5 in Research area B worked hard at offering support and training to the PL 1 teachers: "*In my department, I've trained Mr. Grey on his interactive smartboard. I loaded a lot of resources for him on his board. I've shown him how to do functions on his board, how to use the ruler, a compass, and a protractor. I did the same thing with Mrs. King. My department couldn't even type a question paper on the laptop, I had to train them, and they sit in my class during break and after school and in the computer room.*" Teacher 6 (T6) confirmed this HoD's claim and stated that she has trained and supported him in both the technological and pedagogical aspects of ICT for classroom learning. This is credible given that she (HoD 6) was not sufficiently trained by the GDE, yet she was prepared to acquire more knowledge. Beneficial leadership is realised in the excerpts above.

The data highlight concerns at the other five research sites, where HoDs were not being held accountable for training PL 1 teachers in their departments. HoDs attended the workshops presented by GDE contractors, however, they did not pass on the information to their PL 1 teachers. HoD 5 confirmed the above: "*We have never had a conversation about training.*" HoD 4 shared the same attitude: "*I admit that I do not support or train my PL 1 teachers in any way.*"

According to the CHAT-based inquiry, a system where individuals from various backgrounds create meanings may lead to change (Anastasiou & Hajisoteriou, 2022; Capper & Williams, 2004; Lee, 2011). In some schools, it was evident that PL 1 teachers had a positive attitude toward the adoption and integration of ICT in their classrooms when the HOD provided support on how to use ICT for teaching and learning. Conversely, in cases where the HoDs failed to aid PL 1 teachers, the teachers were negative about the integration of ICT as nothing changed in the classrooms of said teachers. In fact, a few of them gave up and went back to traditional classroom instruction, employing chalkboard and discussions. CHAT assisted us in understanding the relationship between the HoD and the PL 1 teacher to understand whether their relationship either enabled or hindered change within the schooling system regarding sustainable implementation of ICT.

Aside from HoDs having the responsibility for training certain teachers on the integration of ICT, GDE contractors/teacher trainers have also been hired to train teachers on the effective integration of ICT. Both PL 1 teachers and HoDs quite strongly raised concerns about the training offered by GDE contractors. According to them, their once-off workshops left them with little to no new knowledge or skills to incorporate ICTs into their teaching. In response to a question about the training, T6 responded as follows: "*It was basically a once-off thing.*" Hence, teachers left the training sessions feeling as if their time had been wasted as they hadn't gained enough knowledge and skills to integrate ICT devices into their teaching (McChesney & Aldridge, 2021; Sedova,

Sedlacek & Svaricek, 2016; Tondeur, Forkosh-Baruch, Prestridge, Albion & Edirisinghe, 2016).

Several teachers indicated that the GDE training was futile and insisted that the GDE-sponsored training should be content-specific and continuous. The following excerpts highlight teacher experiences and expectations concerning the GDE's ICT training programmes.

> *The training was useless because she showed us how to colour, and how to copy and paste, etc. It was useless to me as I am a mathematics teacher, and her training did not properly equip me to integrate the device into my mathematics classroom. I learned on my own.* (HoD 6)
> *The training was general, it wasn't specifically for my subject, and I'd really like to have training that's specific to my subject. There are so many resources on these smart boards, we do not know how to search for them, or how to use them....* (HoD 3)
> *The trainers should target where there are needs, not only what the trainee feels she wants to give. That's the problem with the outside trainers* (HoD 4).

Various scholars argue that merely offering ICT-related professional development opportunities to teachers does not result in a high degree of ICT integration in the classroom (Chen, J 2016; Darling-Hammond, Hyler & Gardner, 2017; Dlamini, 2022; Fischer, Fishman, Dede, Eisenkraft, Frumin, Foster, Lawrenz, Levy & McCoy, 2018; Mishra & Koehler, 2006). On the contrary, only relevant support and guidance will enhance the use of digital infrastructure and ICT resources in schools and their impact on instruction and learning. Our study promotes for the same and reveals that many teachers advocated for professional development and training that was specific to their needs. They did not need standardised professional development that did not fulfil their classroom needs. Mere ICT proficiency or technical knowledge of ICT resources are unhelpful in achieving effective ICT integration in teaching and learning.

Research Question 2: How did the ICT Phasing-in Approach Affect its Sustainability in Schools?

In a perfect society, the intention of the South African leaders to roll out ICT is commendable; however, the financial standing of the country compromised the rollout of ICT to all South African schools. Yet, the reality is that a phasing-in approach had to take place for schools to gain access to ICT and only a select few were able to become full ICT schools. The phasing-in approach came with several challenges. Full ICT schools were initially identified using the following criteria: schools achieving 100% matric pass rates, schools approved for twinning with other schools, schools of specialisation, and special intervention schools. Within full ICT schools all classrooms have interactive smartboards, teachers have laptops, and

learners have tablet devices. In the phasing-in approach only certain grades receive ICT devices depending on the phase-in approach for that school.

School 1 in Research area A (a school of specialisation) was a full ICT school whereas the phase-in approach was applied to the five other schools mentioned in this article. At the outset, the GDE began with the rollout at full ICT schools. However, due to financial constraints, the attention shifted towards equipping Grade 12 learners with ICT devices due to their specific needs and the fact that the country's Matric results were a matter of national importance. Consequently, a phased-in approach was espoused which started with Grade 12. The rollout continued with Grade 9 and 10 learners. In schools where a phased-in approach was adopted, all identified classrooms were equipped with interactive smartboards, selected teachers were given laptops, but not all learners were provided with tablets.

Even though the GDE had noble intentions for improving educational outcomes through ICT, schools with full ICT offered more benefits to teachers and learners as opposed to schools where a phased-in approach was implemented.

Teacher 1 from School 1 in Research area A (full ICT) revealed that in the teaching of the topic, geographic information systems (GIS), learners could use their ICT devices to search for the locations of places on their tablets in real time while connected to Wi-Fi. This gave the learners an enhanced understanding of what GIS was. This example highlights the importance of schools having workable internet facilities, thereby enabling opportunities for learning in creative ways. In the same vein, HoD 2 at the same school said: "*you'll find at times, learners are responsible for their own learning, you give them an activity and they quickly do it before you can even ask them to do it.*" This remark elucidates the influence of ICT on independent learning.

Moreover, HoD 2 also mentioned the following: "*I use the smartboard as an interactive board for them. I can reflect the lesson on their tablets, we mark in class on their tablets as well and the feedback from their assessments reflect onto my device. Rather than taking books home to mark, it makes things easier.*" This demonstrates that the use of the various functions of the ICT devices made teachers' lives easier. Learners were also advantaged as they could receive feedback on their tasks in real time.

In a school where the phasing-in approach was applied, T8 voiced her concerns: "*If they need to do research in my class, they'll be able to if they had their tablets and an internet connection; unfortunately, our learners haven't received tablets yet, nor do we have a good internet line.*" This illustrates the drawback of learners not receiving tablets. Moreover, this school not having a proper

internet line further hampered the ICT learning experience. At T8's school, only Grade 10 classrooms were fitted with smartboards. When teaching Grade 9 learners, T8 taught in a Grade 9 classroom without a smartboard and was forced to teach in a traditional manner. This situation illustrates the persistent inequality divide at South African schools due to a lack of finances to furnish every classroom with full ICT capability.

HoD 1 at School 1 in Research area A said the following: "*Our learners don't have physical textbooks; their textbooks are loaded into the tablets.*" The learners in this school were clearly advantaged as they were spared from carrying heavy textbooks while walking to and from school. T9 from another research site raised concerns about the situation: "*The phasing-in approach is discriminatory. Our learners don't have tablets. We don't have smartboards in all classrooms. Here we are with smartboards, but our kids are still carrying heavy bags every day. They should have rolled it out to all classrooms.*" In addition, HoD 6 stated the following: "*Unfortunately, only myself and one teacher have a smartboard in the maths department. The others cannot use it because they don't have access to it in their classrooms. The challenge that we're facing is the rollout of the ICTs. Some teachers are lagging, and some are moving forward.*" Various other teachers also raised their distress about not having interactive smartboards in all their classrooms and learners not having tablets at all.

Using CHAT as the theoretical lens in our study to look at the social context of ICT (Holland & Lave, 2019; Rivera, Galarza, Entz & Tharp, 2002; Veraksa & Veraksa, 2018), we discovered that the advantages of ICTs for education were not always apparent. The context of each research site was another contributing factor to the failure or success of ICT initiatives (Dlamini, 2022). When we analysed the data and compared schools where ICTs were rolled out using a phasing-in approach versus the full ICT schools (School 1, Research area A), it was evident that classrooms with full ICT and good internet infrastructure were at an advantage.

Research Question 3: How does the Responsiveness of GDE Technicians affect ICT Sustainability in Schools?

Numerous participants in this study shared opinions about the poor technical support received from the GDE. Teaching and learning was hampered by the GDE's slow turnaround times regarding repairs of devices or software installations. The inadequate response from the GDE technicians left teachers and learners feeling frustrated and overwhelmed. This impaired ICT integration and diminished the long-term sustainability of ICT in the classroom.

Teachers noted unsatisfactory maintenance of malfunctioning resources and that the turnaround times for assistance from the GDE were extremely long. HoD 4 commented as follows: "*we sometimes must log a call and then they send someone out to assist with that. But nothing is happening, we wait for them to respond to our challenges for a very long time.*"

HoD 7 agreed:

In terms of technical assistance, we need to call the GDE help desk and they need to send out a technician for us, but the turnaround time is huge. They employed interns at one point to assist us, however, these technicians at times know less than what the teachers know, so they cannot really help us.

It must be noted that it is an enormous setback for South African education when teachers, eager to use the devices offered to them, cannot do so due to GDE's lack of timeous responses. T5 stated: "*I use my smartboard often; however, I can't access the smart note now because it says that the subscription is over.*" T4 also commented on the issue: "*the lack of support from GDE technicians is a challenge – when I am prepared with my lesson and there's a broken or non-existent smartboard in the venue.*"

T5 added the following: "*On the technical side, the admin passwords restrict me from accessing certain things, the tablets just shut down when learners are busy, some learners were given tablets that aren't even working, and even our teacher laptops don't work.*" T8 corroborated this: "*My laptop from the time I got it, it was like something was wrong with it, so I had to send it back – I'm currently waiting for them to give me another one.*"

Discussion

We align ourselves with other scholars, who highlight a significant issue impacting ICT sustainability (Apsorn, Sisan & Tungkunanan, 2019; Håkansson Lindqvist & Pettersson, 2019; Karakose, Polat & Papadakis, 2021). Most school leaders lack the relevant skillsets necessary for ICT leadership and effective, sustainable implementation. Research points to this being a global phenomenon (Karakose et al., 2021; Yamamoto & Yamaguchi, 2019). Although educational leaders can serve as good role models for teachers and staff regarding the use and decision-making regarding ICT, very few are ICT experts. School leaders are required to become change agents for improving the use of technology by inspiring and developing a clear vision for ICT integration. The creation of a suitable environment, where resources are readily available and opportunities for growth in ICT implementation is most pertinent, the use of technology can be regarded as a "knowledge transfer highway" (Pondiwa, Nabahany & Phiri, 2022:136 in their study conducted in Zanzibar and Zimbabwe). School leaders should be committed to

continuously enhancing teachers' ICT proficiency. In addition, they should provide programmes that enhance professional development and help all staff become proficient in the use of technology (Apsorn et al., 2019; Wei, Piaw & Kannan, 2016; Yamamoto & Yamaguchi, 2019).

Over the past few decades there has been widespread recognition of the importance of teacher professional development (TPD), which is thought to have a positive impact on both school improvement and educational reform. Furthermore, numerous studies have demonstrated that professional development can result in a notable enhancement of teachers' competencies, self-efficacy, motivation, and long-term viability connected to their jobs (Cordingley, 2015; Gaikhorst, März, Du Pré & Geijsel, 2019; Snoek, Enthoven, Kessels & Volman, 2017). Participants highlighted the need for professional teacher development to include training on the technical usage of devices, as well as its integration into their specific teaching subject. This observation is supported by various authors who corroborate the same need (Hokanson & Hooper, 2000; Maholwana-Sotashe, 2007; Semerci & Aydın, 2018; Wilson-Strydom, Thomson & Hodgkinson-Williams, 2005). Given the data collected, it is apparent that the quality of teacher professional development training and support in South African schools is disputed, and this is a contributing factor to the ineffective ICT integration and sustainability in the classroom.

The DoE, through the GDE stakeholders involved in teacher development and training, working together with HoDs at schools, play a vital role in delivering quality, professional teacher training that includes an effective and highly functional ICT component (Hu, Yuan, Luo & Wang, 2021; Pharis, Wu, Sullivan & Moore, 2019; Sims & Fletcher-Wood, 2021). We, therefore, argue that when teachers are not trained and supported by their HoDs and the GDE stakeholders regarding both technical and pedagogical (content) training, it affects ICT sustainability adversely. Once-off workshops that omit crucial content, only focusing on the technicality of devices, result in teachers feeling vanquished, which hampers ICT sustainability.

It is obvious that at full ICT schools teachers and learners benefited. However, in schools where ICTs were rolled out in a phased-in fashion (only in certain classrooms and grades) both teachers and learners were disadvantaged. Another concern is that teachers who had received ICT training were not able to use the knowledge and skills gained, given that there were no interactive smartboards in their classrooms. Furthermore, most schools subjected to a phased-in approach did not have good internet services and, therefore, teachers were unable to fully use their interactive devices while

teaching. In the same vein, Yamamoto and Yamaguchi (2019), highlight that to completely integrate ICT in educational practice, strategic implementation is still required. We concur with these findings given the challenges from the phasing-in approach to the ICT rollout.

Where ICT sustainability is concerned, South African education leadership needs to call on external investors to assist in the rollout of ICT. Furthermore, where schools are full ICT schools, ICT integration, and its successful implementation is the business of all staff members. It seems that a phased-in approach leads to limited buy-in from teachers, which affects ICT sustainability adversely.

The data show that the slow turnaround time from the GDE hinders ICT sustainability, thus impacting teaching and learning processes. GDE technicians need to address the issue of sub-standard ICT devices as this causes frustration and disruptions to the teaching and learning activities. Other data also demonstrate that teachers received sub-par service relating to the technological and pedagogical use of their ICT devices (Colby, Bradshaw & Joyner, 2002; Williams & Copes, 2005; Xie, Kim, Cheng & Luthy, 2017). These shortcomings regarding the provision, installation, training, and maintenance of technological devices are cause for concern and amount to empty promises by the GDE when it comes to supporting teachers in the effective integration of ICT (Kganyago, 2018; Mooketsi, 2020). The delays, disruptions and missed opportunities caused by the failings of the GDE technicians effectively erodes the quality of the teaching and learning experience at schools.

We were able to learn more about the functions that district officials, teachers, and school leadership play in integrating ICT since CHAT theory considers the many roles that agents play in an activity system (Kolokouri et al., 2012; Nussbaumer, 2012; Sims & Fletcher-Wood, 2021). The various responsibilities that each agent assumes determine how smoothly the integration process progresses because each agent's performance impacts the entire community of the activity system.

Limitations Pertaining to the Study

Since this study was conducted during the peak of the COVID-19 pandemic, some schools implemented preventative measures and forbade anyone who was not directly connected to the school from entering the building. Hence, we were unable to observe teachers as they enacted their ICT lessons. In response, we decided to conduct telephonic interviews using voice and video calls and during the interviews, we asked participants to relate or explain their experiences of using ICT in teaching and learning. We then compiled the data

and drew findings on the ways in which ICT impacted or affected learning. We were able to get in touch with the research participants and build a more thorough database in instances where we had any clarification-seeking queries throughout the transcription process.

The limited number of research participants was another limitation of the study. We argue that this study provides a base on ICT implementation and sustainability. This study could be replicated with more research sites (schools) that formed part of the Classroom of the Future initiative. We also purport that the goal of laying the groundwork for future research by supplying a general and preliminary understanding of the sustainability of ICT in secondary schools was achieved in this study.

Recommendations and Conclusion

We conclude that full-service ICT schools were at an advantage compared to schools where a phased-in approach was employed. Teachers and learners at phased-in schools faced various challenges and this is cause for concern about the role of ICT in achieving sustainable education well into the future.

We also uncovered the significance of the role played by each stakeholder in contributing to the sustainability of the ICT intervention in classrooms at previously disadvantaged government schools in South Africa. Training in content and pedagogical knowledge is vital for effective ICT integration. Teacher training initiatives, whether provided by HoDs or GDE stakeholders, is of great concern. There is room for improvement in the scope of teacher training to ensure that the adoption of sustainable practices, whether large or small, has significant positive impacts in the long term.

We recommend that professional development should be subject-specific, not merely technical. HoDs should empower relevant PL 1 teachers to use ICT effectively for improved classroom learning through the provision of helpful training and support. We also advocate that GDE technicians/teacher trainers provide better service delivery and that they should be held accountable for failing to fulfil their duties. We, therefore, propose that the GDE should identify good practices to hold HoDs and GDE employees and contractors accountable for poor ICT implementation, support, and training.

Lastly, we would like to reiterate that while a phased-in approach is understandable given the government's limited resources, the DoE should nevertheless attempt to secure external investors to supplement ICT budgets. In this way, the provision of devices can be extended to entire schools beyond the current focus on the higher grades. Broader learner and teacher access to vital ICT equipment, paired with improved GDE training, maintenance, and general responsiveness, would go a long way towards improving and transforming the quality of instruction and technology-enhanced learning at schools in South Africa.

Authors' Contributions

Both authors contributed equally to the manuscript. Both authors reviewed the final manuscript.

Notes

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