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Exploring the Digital Technology Integration in Public Schools

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Alan Bhekisisa Buthelezi
University of Zululand
ButheleziA@unizulu.ac.za

Dr Mandla Alfred Twala
University of Zululand
mandla.twala@gauteng.gov.za

&

Boniswa Charlotte Twala
University of Zululand

Abstract

The rapid expansion of digital technology has intensified global efforts to integrate digital competencies into primary education systems, particularly in developing contexts where digital inequality remains pronounced. In South Africa, curriculum reforms introducing coding, robotics, and digital literacy aim to prepare learners for participation in the Fourth Industrial Revolution (4IR) while addressing persistent socio-economic disparities. Despite these policy commitments, limited empirical research examines how digital integration is experienced at the learner level within public primary schools. This study investigates institutional readiness, digital technology integration, and perceived educational outcomes at Park Senior Primary School in Johannesburg, South Africa. A quantitative descriptive case study design was employed to systematically investigate the variables under consideration. Data were collected from 60 Grade 7 learners using a structured Likert-scale questionnaire assessing four domains: digital understanding and access, institutional policy and procedural readiness, perceived educational benefits, and demographic characteristics. Descriptive statistics, including frequencies and percentages,

were used to analyse the data. Findings reveal high levels of learner awareness and overwhelmingly positive attitudes toward digital technology. Most respondents perceived digital tools as enhancing academic knowledge, learner engagement, parental involvement, and overall system efficiency. The curriculum was widely viewed as responsive to 4IR skill demands. However, perceptions regarding infrastructure adequacy, procedural clarity, and the availability of dedicated digital technology educators indicate a moderate yet uneven level of institutional readiness. Educator preparedness emerged as a key factor influencing perceived effectiveness. Although limited to a single-school context and based on learner perceptions, the findings suggest alignment between national digital reform objectives and perceived educational benefits. Continued investment in infrastructure, professional development, and institutional standardisation is necessary to ensure equitable and sustainable digital transformation in public primary education.

Keywords: *Digital Technology Integration, Institutional Readiness, Learner Perceptions, Public Primary Education, Fourth Industrial Revolution (4IR), Coding And Robotics*

1. INTRODUCTION AND BACKGROUND OF THE STUDY

The rapid growth of digital technology has transformed economies, societies, and education systems, making digital competence essential for employability, innovation, and participation in the Fourth Industrial Revolution (4IR). In South Africa, this creates a dual challenge of improving global competitiveness while addressing socio-economic inequalities.

Limited access to digital infrastructure and connectivity continues to reflect systemic structural disparities, positioning public schools as critical institutions for bridging the digital divide and developing learners' digital skills (Livingstone, 2012). In response, the Department of Basic Education has introduced curriculum reforms incorporating coding, robotics, and digital literacy to promote computational thinking and problem-solving skills. Coding, as a core component of these reforms, is viewed not only as a technical skill but also as a tool for developing higher-order cognitive abilities and supporting learner-centered, inquiry-based education (Rivette, 2019).

Despite strong policy commitments, effective implementation depends on infrastructure, educator competence, and access. The relationship between digital technology and improved learning outcomes is documented, yet the evidence is often fragmented and contingent

upon specific institutional and socio-economic contexts (Mckinsey, 2019). Research on learner perspectives in South African public primary schools is limited, with only a few studies addressing disadvantaged contexts and e-learning challenges (Mhlane, 2003; Chomunorwa & Mugobo, 2023), and broader reviews highlighting this gap (Hart, 2023). Existing research focuses mainly on policy, infrastructure, and teacher development rather than learner experiences (Barnett & Nthimbane, 2025; Graham, Kruger & Van Ryneveld, 2024). Large-scale and qualitative studies highlight inequalities and institutional challenges but do not adequately capture learners' perceptions (Sepadi, Kgaphola, & Molapo, 2025).

Against this backdrop, the present study investigates institutional readiness, digital technology integration, and perceived educational outcomes at Park Senior Primary School in Johannesburg, South Africa. By exploring learners' experiences of digital usage, awareness of policy initiatives, adequacy of resources, and perceptions of both academic and systemic outcomes, the study seeks to assess how digital transformation initiatives are experienced in practice within a public primary school context. In doing so, it addresses a critical gap in the literature by providing context specific insights into the alignment between policy driven digital integration and learner perceived educational outcomes, thereby justifying the need for this research within the broader field of digital education reform.

2. LITERATURE REVIEW

2.1. Policy Reform and the Integration of Coding in South Africa

The integration of coding and digital technologies into school curricula has become a strategic priority in global education reform. In South Africa, the Department of Basic Education (DBE) initiated curriculum revisions aimed at equipping learners with digital competencies required for participation in technology-driven economies. These reforms seek to prepare learners not only for traditional employment but also for entrepreneurship and innovation within an increasingly digitised labour market.

The DBE's coding and robotics initiative, piloted in approximately 1,000 schools across five provinces beginning in 2020, reflects a structured attempt to align basic education with Fourth Industrial Revolution (4IR) demands (Nagy, 2018). Large-scale educator training has accompanied this reform, with over 43,000 teachers receiving

foundational computer skills training. Additional professional development initiatives have been implemented in collaboration with institutions such as the University of South Africa (UNISA), which provided ICT laboratory support for coding instruction (Nagy, 2018). These efforts demonstrate a clear institutional commitment; however, significant questions remain regarding the consistency of implementation, the adequacy of infrastructure, and the achievement of measurable educational outcomes in public schools.

2.2. Conceptualising Coding as Digital Literacy

Coding is commonly defined as the creation of computational instructions using programming languages to achieve specific goals or solve problems. It underpins the development of software applications, websites, and mobile technologies, forming the foundation of digital systems across industries (Rivette, 2019). Increasingly, coding is conceptualised not merely as a technical skill but as a form of digital literacy comparable to language acquisition. Like linguistic systems, coding operates through structured syntax, grammar, and logical rules that must be learned and applied systematically.

2.3. International Trends in Coding Education

Internationally, coding has been incorporated into national curricula across several countries, reflecting broad recognition of its strategic importance. For example, the United Kingdom introduced compulsory computing education in 2013, embedding programming within primary and secondary schooling. Other European nations, including Austria, Bulgaria, the Czech Republic, Denmark, Estonia, France, Hungary, Ireland, Lithuania, Malta, Spain, Poland, Portugal, and Slovakia, have integrated coding into their national frameworks to varying extents (Rivette, 2019).

2.4. Pedagogical Implications and Robotics Integration

The introduction of robotics alongside coding represents a significant extension of digital curriculum reform within the South African educational landscape. Implementation strategies have included both technology-intensive approaches and low-cost, hands-on "maker space" models designed to encourage experimentation, design, and innovation (Nagy, 2018). Such approaches emphasise experiential learning, allowing

learners to engage in building, testing, and refining solutions. Pedagogically, coding aligns with active learning methodologies that prioritise participation over passive reception. Learners are encouraged to practice coding in real time, often collaboratively within integrated development environments (IDEs), enabling immediate feedback, debugging, and iterative problem-solving. This experiential engagement may enhance conceptual understanding, procedural memory, and skill transferability (Nagy, 2018).

2.5. Gaps in the Existing Literature

While the literature highlights strong policy support, educator training, and potential educational benefits of digital technology, empirical evidence on learner-level outcomes in South African public primary schools remains limited. Most studies focus on policy implementation or infrastructure rather than whether digital integration improves academic performance, digital competence, or institutional effectiveness. Research by Padayachee (2017) and Mahlo and Waghid (2022) identifies infrastructural, institutional, and teacher-related barriers but provides limited guidance on addressing them sustainably at the classroom level.

Similarly, Sepadi et al. (2025), using the TPACK framework, explore the interplay of technological, pedagogical, and content knowledge in rural contexts, yet longitudinal evidence on the effectiveness of professional development is lacking. Mwapwele (2019) notes teachers' positive attitudes despite structural limitations but does not fully examine how readiness can translate into sustained pedagogical transformation. Collectively, Rather than simply documenting challenges, these findings highlight the need for a shift in research focus towards practical interventions and context-sensitive strategies that prioritise measurable impact within the South African school system.

3. METHODOLOGY

3.1. Research Design

The study employed a quantitative descriptive case study design to examine the integration of digital technology and its perceived educational outcomes in a public primary school. A quantitative approach enabled systematic measurement of learner perceptions using numerical data (Creswell, 2014), while descriptive research identified

patterns without manipulation (Bryman, 2012). The case study design allowed for in-depth analysis within a real-life school context (Yin, 2018).

3.2. Sample Size and Sampling Strategy

The study was conducted at Park Senior Primary School in Johannesburg, involving 60 Grade 7 learners selected through purposive sampling based on their prior exposure to digital technology (Etikan, Musa, & Alkassim, 2016). The sample achieved a 100% response rate, with a balanced gender distribution. While limited to one school, the sample size was adequate for descriptive analysis and aligned with case study principles emphasising contextual depth (Creswell, 2014; Bryman, 2012; Yin, 2018).

3.3. Data Collection Instrument

Data were collected using a structured questionnaire designed to measure demographics, access to digital technology, institutional readiness, and perceived educational benefits. The instrument used closed-ended Likert-scale items, suitable for capturing attitudes and enabling statistical analysis (Creswell, 2014; Bryman, 2012), and was informed by existing ICT integration literature.

3.4. Data Collection Procedure

Ethical approval and school permission were obtained, ensuring voluntary participation, confidentiality, and informed consent (Creswell, 2014). To ensure clarity and maintain consistency, the questionnaire was administered within a supervised classroom environment. All responses were completed on the same day, resulting in a complete dataset.

3.5. Data Analysis

Data were analysed using descriptive statistics, specifically frequencies and percentages, to identify patterns and trends (Bryman, 2012). Findings were presented through graphs and narrative interpretation, with descriptive analysis deemed appropriate for the study's exploratory and perception-based focus. The results are presented in graphical form and supported by narrative interpretation in the Results and Discussion section. Given the exploratory and perception-based nature of the study,

descriptive analysis was deemed suitable for addressing the research objectives.

4. RESULTS AND DISCUSSION

4.1. Responses by Gender Distribution

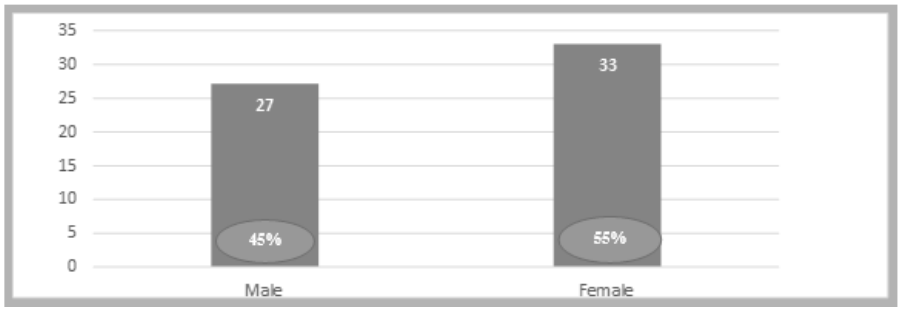

Figure 4.1.1: Responses by Gender

Gender Distribution: Figure 4.1.1 indicates that 33 (55%) of respondents were female and 27 (45%) were male. The credibility of the results is bolstered by the equitable gender distribution, which prevents the data on digital technology perceptions from being skewed by the experiences of one specific group.

Given that most learners had reportedly been at the school for three to four years, it can be reasonably inferred that participants had sustained exposure to the school's digital environment. This prolonged exposure enhances the reliability of their perceptions regarding institutional readiness and educational outcomes. Sustained interaction with school-based ICT initiatives is important because meaningful technology integration develops over time rather than through short-term exposure (OECD, 2015).

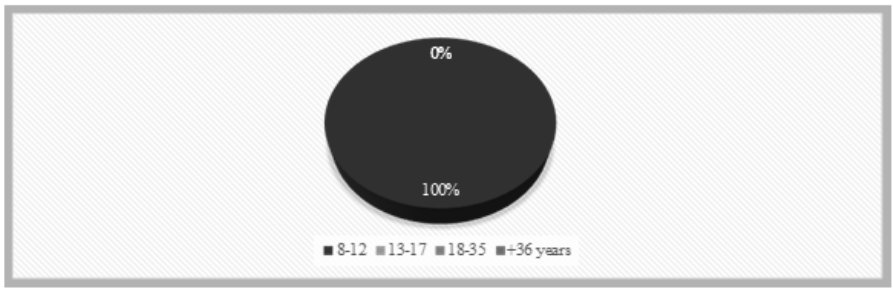

Figure 4.1.2: Responses by Age Category

Age Category Figure 4.1.2 above illustrates that all 60 respondents (100%) were between 8 and 12 years old, confirming that the study reflects the perceptions of upper primary learners. Although respondents indicated limited prior computer experience, research suggests that structured exposure to digital tools at the primary level can enhance collaboration, critical thinking, and interactive learning (Fraillon & Friedman, 2014; OECD, 2015).

This finding is important in a public-school context where digital equity remains a concern. Early exposure to digital tools can be a significant factor in developing long-term digital competence, a skillset increasingly regarded as essential for active participation in contemporary society.

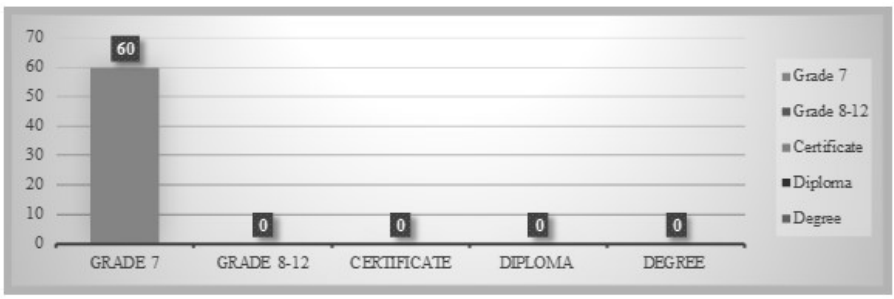

Figure 4.1.3: Responses by level of Education

Educational Level: Figure 4.1.3 above illustrates that all participants were in Grade 7. This homogeneity strengthens internal consistency, as learners share similar curricular exposure. Research demonstrates that ICT integration at the upper primary level can positively influence learning outcomes, particularly in core subjects such as mathematics and English (Cox et al., 2003). Thus, focusing on Grade 7 learners provides a

relevant basis for examining perceived academic benefits and institutional readiness within a public-school setting.

4.2. Digital Technology

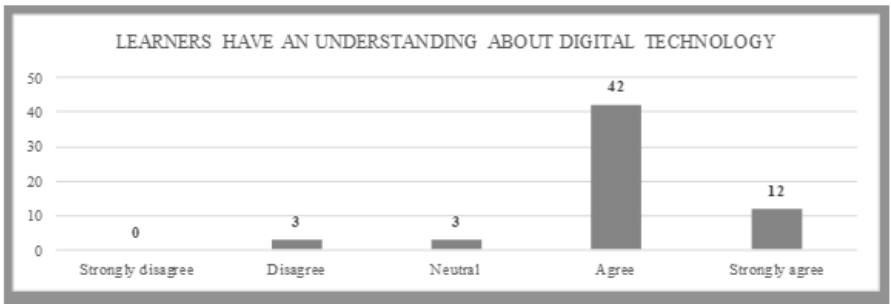

Figure 4.2.1: Learners have an understanding about Digital Technology

As illustrated in Figure 4.2.1, a significant majority of respondents (54 out of 60) either agreed or strongly agreed that they understand digital technology, while only three expressed disagreement. This suggests a generally high level of digital awareness among learners.

This aligns with literature indicating that contemporary learners are increasingly familiar with digital environments, necessitating pedagogical adaptation (Prensky, 2001). However, awareness alone is insufficient for achieving advanced digital competence, as the effective use of technology is contingent upon the provision of structured and ongoing educational support (OECD, 2015). Therefore, while learner understanding appears positive, sustained instructional guidance remains essential.

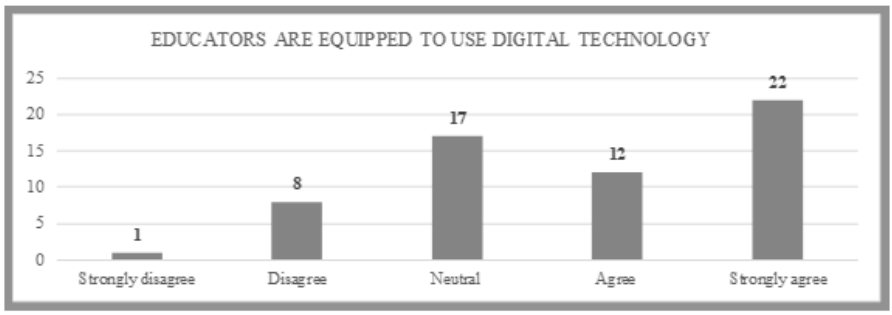

Figure 4.2.2: Educators are equipped to use Digital Technology

Educator Preparedness Figure 4.2.2 above illustrates that thirty-four respondents (57%) either agreed or strongly agreed that educators are equipped to use digital technology, while 17 remained neutral and 9 disagreed. The substantial proportion of neutral and negative responses

suggests significant variability in the perceived competence of teachers regarding digital integration.

Research consistently emphasises that teacher preparedness is a critical determinant of successful ICT integration (Harper & Wright, 2018; US Department of Education, 2017). Technology enhances engagement and personalisation only when effectively implemented. Thus, while the majority perception is positive, professional development may be necessary to address inconsistencies.

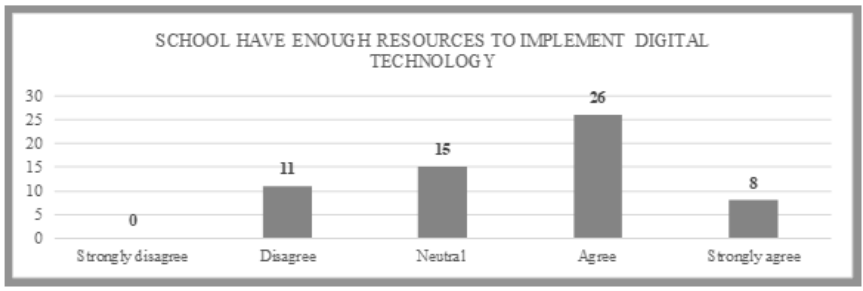

Figure 4.2.3: School have adequate resources to implement Digital Technology

Adequacy of School Resources Figure 4.2.3 above illustrates that thirty-four learners perceived the school as adequately resourced, 15 were neutral, and 11 disagreed. Although the majority response was positive, the notable minority expressing concern indicates potential resource disparities.

International evidence shows that infrastructure gaps significantly affect ICT effectiveness in schools (OECD, 2014; 2017). Even where policy frameworks support digital transformation, disparities in resource distribution often constrain the achievement of intended educational outcomes. Therefore, while readiness appears moderate to strong, resource sustainability remains a consideration.

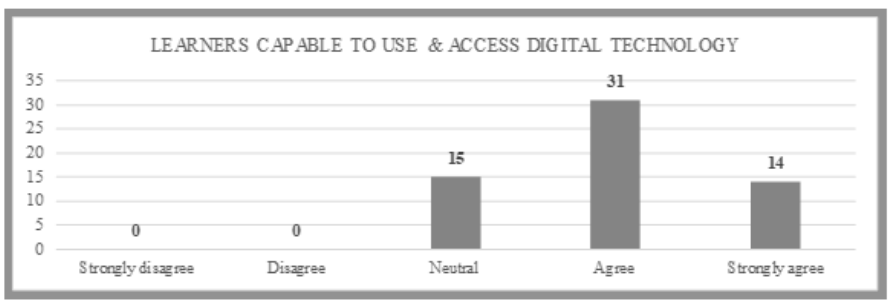

Figure 4.2.4: Learners Capable to use and access Digital Technology

Learner Capability and Access Figure 4.2.4 above illustrates that thirty-one respondents agreed that learners are capable of using and accessing digital technologies, yet 14 strongly disagreed and 15 were neutral. This divergence suggests unequal access or varying skill levels among learners.

Educational equity frameworks emphasise that all learners are entitled to access digital competencies (DfE, 2002). These varied results indicate that prior digital exposure and home-based resources are uneven, reinforcing the necessity for schools to provide standardised, structured support to bridge the gap.

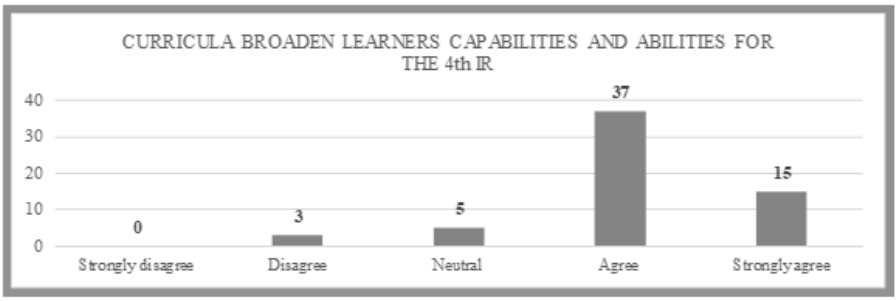

Figure 4.2.5: Curricula Broaden Learners' Capabilities and Abilities for the 4th IR

Curriculum and Fourth Industrial Revolution Figure 4.2.5 above illustrates that a substantial majority (52 respondents) agreed or strongly agreed that the curriculum broadens competencies for the Fourth Industrial Revolution (4IR). This suggests alignment between curriculum delivery and digital-era skill development.

Educational innovation models emphasise the necessity of integrating digital tools with curriculum reform to equip learners for rapidly evolving technological environments (Korhonen et al., 2014). Thus, respondents perceive the curriculum as forward-looking and responsive to technological change.

4.3. Policy and Procedures

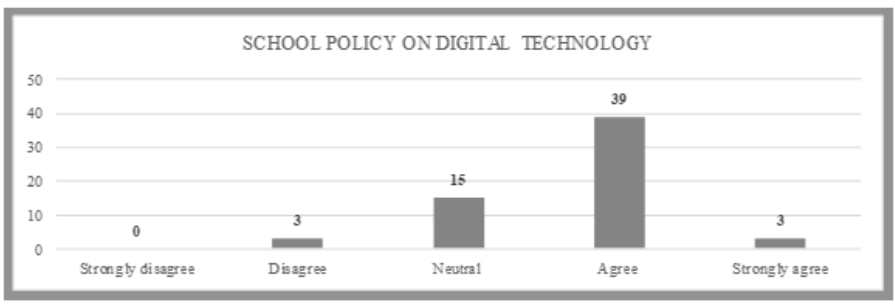

Figure 4.3.1: School Policy on Digital Technology

As illustrated in Figure 4.3.1, forty-two respondents indicated that their school has an established digital technology policy. Policy presence is crucial, as institutional guidance shapes consistent implementation (Lindqvist, 2015). However, Hammond (2014) cautions that policy alone does not guarantee improved teaching outcomes. Effective translation into classroom practice remains essential.

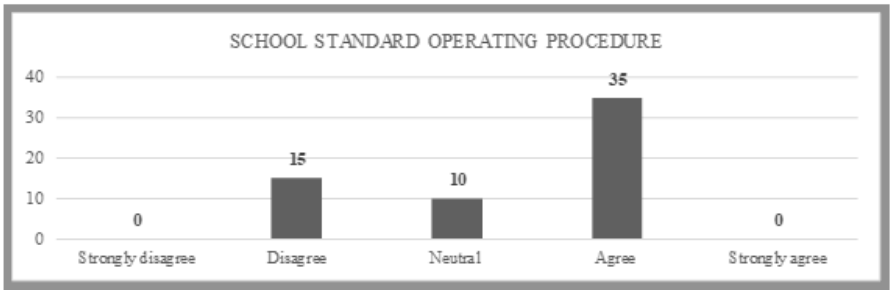

Figure 4.3.2: School Standard Operating Procedure

Standard Operating Procedures Figure 4.3.2 above illustrates that although 35% agreed that the school follows standard operating procedures, 15 learners disagreed. This lack of full procedural clarity presents a challenge, as the successful integration of digital tools is contingent upon structured implementation strategies and formal governance (Fraillon & Friedman, 2014), strengthening procedural transparency may enhance confidence and effectiveness.

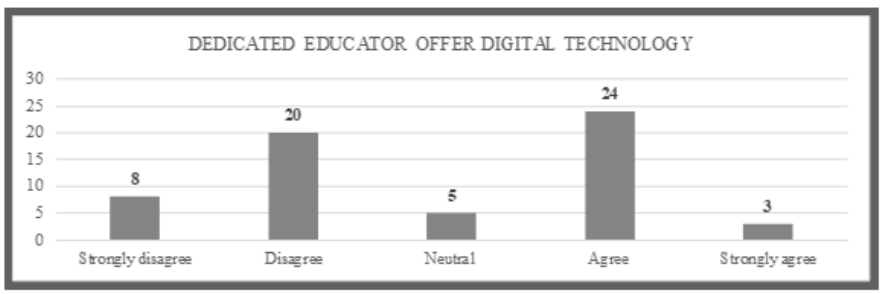

Figure 4.3.3: Schools have a dedicated Educator to offer Digital Technology

Dedicated Digital Educator Figure 4.3.3 above illustrates that a significant portion of learners indicated that the school does not have a dedicated digital technology educator. This may influence the consistency of delivery. Research shows that institutional and environmental factors are fundamental in shaping perceptions of the benefits associated with digital technology (Perrotta, 2013). Specialist expertise can enhance both teacher capacity and learner outcomes.

4.4. Importance and Benefits

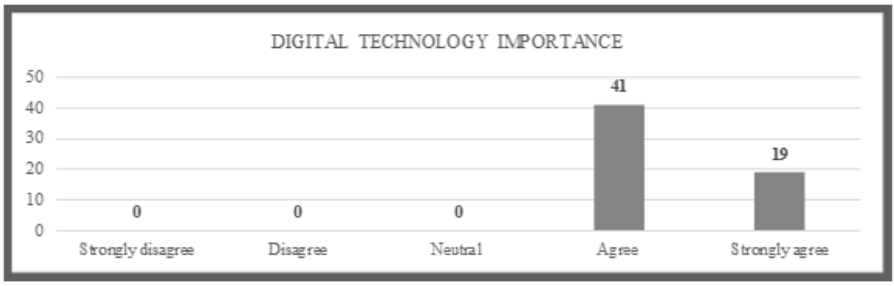

Figure 4.4.1: Digital Technology Importance

Importance of Digital Technology Figure 4.4.1 above illustrates that all respondents agreed or strongly agreed that digital technology is centrally important. This unanimous perception underscores the normalisation of digital tools within the learning environment.

Attitudes toward technology significantly influence classroom integration (Van Braak, Tondeur, & Valcke, 2004). Therefore, positive learner attitudes provide a strong foundation for sustained adoption.

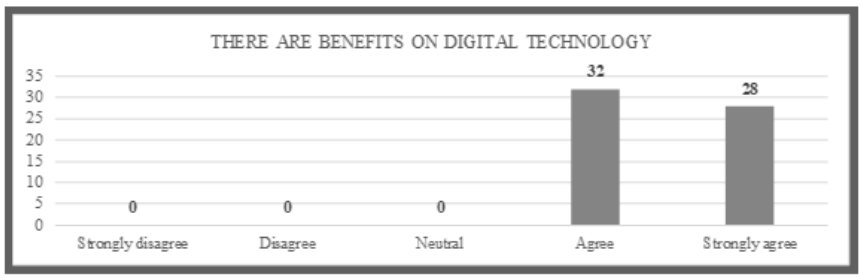

Figure 4.4.2: Benefits of Digital Technology

Digital Technology Figure 4.4.2 above illustrates that 32 of the respondents agreed that using digital technology yields postive benefits, and twenty-eight (28) of the respondents strongly agreed.

Kucukozer et al. (2009) examined the use of digital tools to teach basic astronomical concepts to learners aged 11–13 in Turkey. The study involved learners predicting phenomena, using computer-based models to visualise outcomes, and comparing their predictions with observations through group discussions and teacher-guided 3D demonstrations. The findings showed that integrating direct observation with computer modelling significantly enhanced learners' conceptual understanding and academic outcomes.

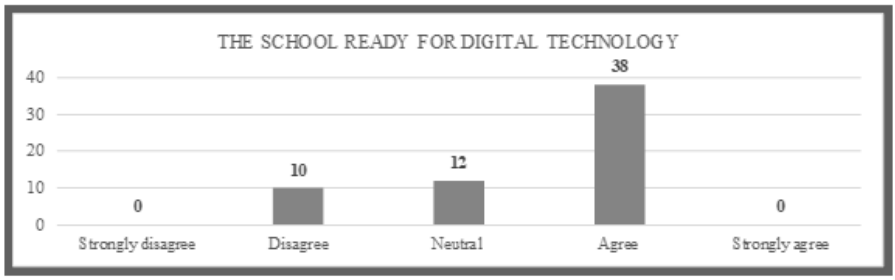

Figure 4.4.3: School Ready for Digital Technology

School Readiness Figure 4.4.3 above illustrates that thirty-eight respondents perceived the school as ready for digital technology integration. While positive, the presence of neutral and negative responses suggests room for institutional strengthening. As Gee (2003) argues, technology fosters engagement and sustained concentration when meaningfully embedded in learning processes.

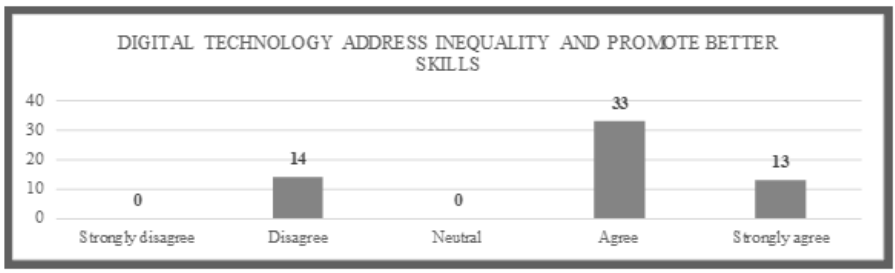

Figure 4.4.4: Digital Technology Addresses Inequality and Promotes Better Skills

Figure 4.4.4 shows that 33 respondents agreed and 13 strongly agreed that digital technology helps address inequality and promote skills, while 14 disagreed. De Bruyckere, Kirschner, and Hulshof (2016) found that 1:1 technology increases student engagement by enabling innovative teaching methods, interactive simulations, and diverse instructional programs. Such technology allows educators to e refine lesson planning, promote collaboration, and create a learning environment that is more engaging and participatory than traditional classrooms.

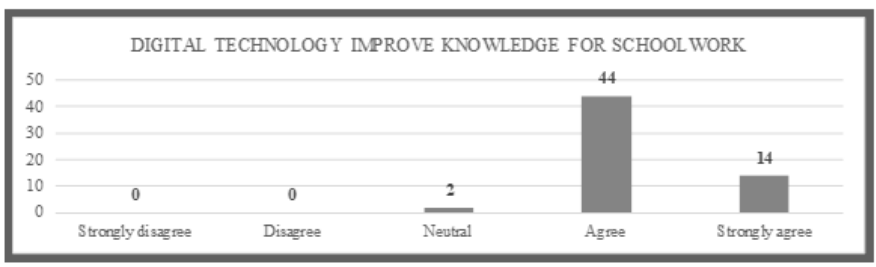

Figure 4.4.5: Digital Technology Improve Knowledge for Schoolwork

Figure 4.4.5 shows that 44 respondents agreed and 14 strongly agreed that digital technology improves knowledge for schoolwork, while two were neutral. Edyburn (2006) emphasises that effective technology use requires aligning tools with students' educational needs. Beyond its established function in providing accessibility for students with disabilities, technology now underpins essential classroom functions, ranging from organisational tasks and research to collaborative writing and assessment preparation.

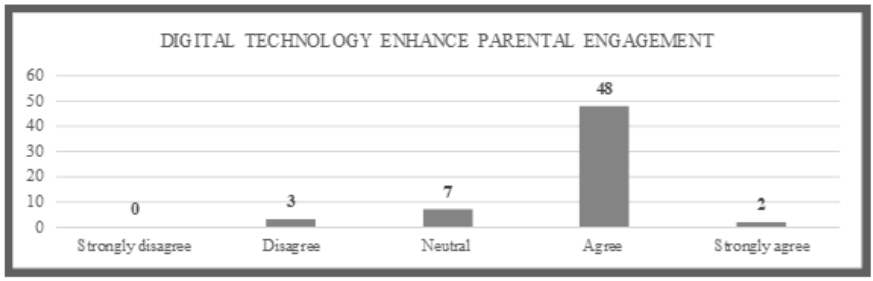

Figure 4.4.6: Digital Technology Enhancing Parental Engagement

Figure 4.4.6 shows that 48 respondents agreed, 2 strongly agreed, 7 were neutral, and 3 disagreed that digital technology enhances parental engagement. Evidence suggests that using digital tools to connect with parents can improve compliance with educational expectations regarding attendance, behaviour, and learning support. Effective implementation hinges on educators' proficiency with digital resources and the systematic adoption of platforms like virtual learning environments. School readiness involves both parents and educators and influences academic planning, particularly in foundational literacy skills such as vocabulary, print motivation, print awareness, letter knowledge (LK), phonological awareness (PA), and rapid automated naming, which contribute to reading fluency, accuracy, and comprehension.

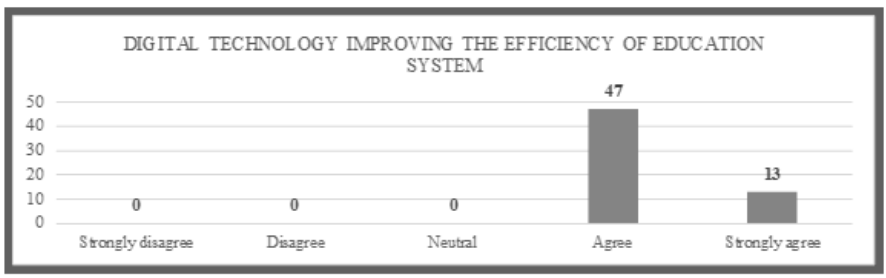

Figure 4.4.7: Digital Technology Improving the efficiency of the Education System

Figure 4.4.7 shows that 47 respondents agreed and 13 strongly agreed that digital technology improves the efficiency of the education system.

Evidence indicates that digital tools can enhance educators' efficiency in lesson preparation, teaching, assessment, and professional development.

ICT has profoundly reshaped societal structures, leading to a global trend where educational institutions are progressively integrating advanced technological frameworks. Research suggests that, when properly implemented with instructor support, technology as a teaching tool improves classroom learning, increases on-task behaviour, and promotes high learner engagement (Prensky, 2001).

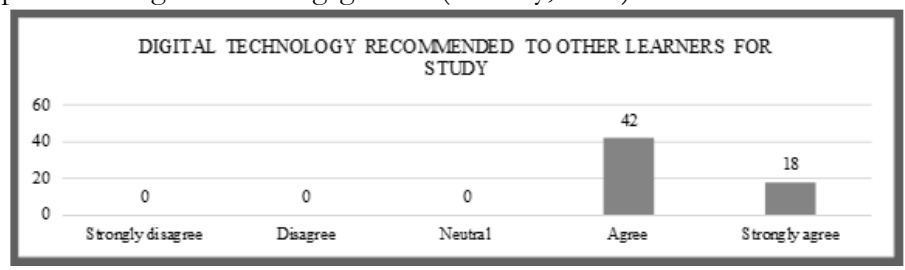

Figure 4.4.8: Digital Technology Recommended to Other Learners for Study

Figure 4.4.8 shows that 42 respondents agreed and 18 strongly agreed that digital technology should be recommended to other learners for study purposes. The findings suggest that the successful integration of digital technology depends not only on the availability of equipment and resources but also on comprehensive educator training, technical knowledge, and robust support networks. Equipping teachers with the necessary skills enables learners to understand the benefits and applications of digital technologies and to use them effectively. Puckett and O'Bannon (2012) note that, when appropriately implemented and accessible, technology can benefit all learners, support advanced language and literacy skills, and provide learning opportunities both at school and at home.

5. KEY FINDINGS OF THE STUDY

The study examined digital technology integration in a South African public primary school, focusing on learner perceptions, institutional readiness, policy alignment, and educational outcomes.

5.1. High Learner Awareness and Positive Attitudes

Most learners understand and value digital technology, with over 90% recognising its importance for schoolwork. This aligns with research showing that modern learners are accustomed to digital environments

(Prensky, 2001) and that positive attitudes influence technology adoption and engagement (Van Braak, Tondeur, & Valcke, 2004). Learners are receptive to digital transformation and see it as relevant to their future in the 4IR.

5.2. Improvement in Academic Knowledge and Learning Outcomes

Learners perceive digital technology as improving knowledge, understanding, and learning efficiency. This supports evidence that well-integrated ICT enhances conceptual understanding and performance (Cox et al., 2003; Edyburn, 2006) and promotes interactive learning (Kucukozer et al., 2009). Although based on perceptions, digital tools are viewed as meaningful pedagogical enhancers.

5.3. Moderate but Uneven Institutional Readiness

The school demonstrates general readiness through policies and available resources. However, inconsistencies in access and implementation persist. This reflects research indicating that policy does not guarantee effective practice (Hammond, 2014) and that infrastructure disparities can limit impact (Lindqvist, 2015; OECD, 2014; 2017).

5.4. Educator Preparedness as a Critical Determinant

While many educators are seen as capable, gaps in skills and the absence of a digital specialist affect implementation. This supports literature identifying teacher competence as key to ICT success (Harper & Wright, 2018; US Department of Education, 2017), with institutional factors shaping outcomes (Perrotta, 2013).

5.5. Contribution to Digital Equity and Skill Development

Digital technology is perceived to reduce inequality and build skills, particularly in a context of unequal access (Livingstone, 2012). Schools play a vital role in bridging the digital divide (OECD, 2015), while learners increasingly view technology as essential preparation for future societal participation, which aligns with 4IR curriculum reforms (Nagy, 2018; Rivette, 2019).

5.6. Enhancement of Parental Engagement and System Efficiency

Technology is viewed as improving parental engagement and system efficiency. This aligns with findings that digital platforms strengthen home–school communication and accountability (Seufert, Guggemos, & Sailer, 2021) and enhance administrative and instructional processes (Edyburn, 2006).

5.7. Strong Learner Endorsement

All learners support the use of digital technology for learning. However, sustained impact depends on continued access, support, and training (Puckett & O'Bannon, 2012). The integration of digital technology is viewed as a transformative force in education, credited with enriching student engagement and creating more balanced opportunities for success across different socio-economic backgrounds. While aligned with policy goals, its effectiveness depends on improving infrastructure, ensuring consistency, and strengthening educator capacity to sustain and scale benefits.

6. SIGNIFICANCE OF THE STUDY

This study examined the effects of digital technology at Park Senior Primary School in Johannesburg and found that learners widely perceive it as important and beneficial to their academic development. Most respondents indicated that digital technology enhances knowledge, improves parental engagement, increases system efficiency, and supports skills development for participation in the Fourth Industrial Revolution, highlighting its potential to strengthen teaching and learning.

However, the findings also reveal key implementation challenges. While policies and general readiness are in place, gaps remain in resource adequacy, operational procedures, and the availability of specialised educators. This indicates that policy alone is insufficient without consistent infrastructure, training, and clear implementation frameworks.

In the broader South African context, where inequalities in digital access persist, schools play a critical role in bridging the digital divide. For many learners, schools are the primary access point to digital tools, making effective integration essential for social inclusion, workforce readiness, and national development.

Despite focusing on the perspectives of learners instead of quantified academic performance, the study yields important findings regarding digital technology adoption in public primary schools. Future research should include measurable outcomes, longitudinal studies, and comparisons across schools to better assess impact.

Overall, while digital technology shows strong perceived benefits, its full potential depends on sustained investment in infrastructure, educator development, policy implementation, and equitable access to ensure meaningful and lasting educational transformation.

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