The influence of digital devices used by teachers on Grade 12 academic performance in Gauteng public schools

Applied Research Project Report

Submitted by

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SUPPLEMENTARY INFORMATION

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ABSTRACT

Technology in education has become a norm in today's teaching and learning environment. This has seen the Gauteng Department of Education allocating substantial budgets toward the e-Learning projects in the province. Since its implementation in 2015, limited research has been conducted to establish and link the extent of Information and Technology Communication (ICT) integration to academic performance. Grade 12 results are celebrated nationally and given that a greater part of the school funding is by the state, there is pressure from the public and media for policy-makers to demonstrate benefits and value for money. The research objective aimed to evaluate the extent of technology adoption, its impact on academic performance and further identify challenges in technology integration. This quantitative study evaluated the influence of digital devices used by teachers in Grade 12 academic performance in Gauteng public schools. The study is intended to influence a revision of policies and processes on the project to enable full effective roll out, while getting by in from stakeholders involved. 15 full ICT schools were purposefully selected and a sample of grade 12 teachers participated in the survey which was administered both manually and online. The results revealed that technology affects academic performance through the large extent of technology adoption in schools. Interestingly, challenges in integrating technology was not found to impact academic performance. In addition, historical data revealed that Grade 12 academic achievements prior and post technology were not consistent over the period. This suggests that other factors outside the scope of this study contribute to performance. Full integration of devices to allow online facilitation of lessons and assessments fell short which prevented teachers from using technology to its maximum. The Gauteng Department of Education should be prepared to modernise and integrate technology devices in order to align to new technological developments. In this regard, continuous upskilling of teachers will be critical as technology changes. There is a need for further research to explore the factors that have impact on academic achievements where technology exist.

Key words: Grade 12 Academic Achievements, Information and Technology Communication (ICT), eLearning, Technology Devices, Integration of Technology, Academic Performance.

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Wishing you all good things in life and God Bless.

DECLARATION

I declare that this applied research report is my unaided work. It is submitted for the degree of Masters in Business Administration at the Wits Business School, in Johannesburg. I declare that it has not been submitted before for any degree or examination at any other university.

X

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LIST OF ABBREVIATIONS

ABBREVIATIONS	DEFINITIONS
ANCOVA	Analysis of Covariance
AST	Adaptive Structuration Theory
DBE	Department of Basic Education
GDE	Gauteng Department of Education
GPG	Gauteng Provincial Government
ICT	Information, Communication and Technology
IS	Information System
IT	Information Technology
KBV	Knowledge Based View
NDP	National Development Plan
SA	South Africa
SITES	Second Information Technology in Education
STEM	Science, Technology, Engineering and Mathematics
STREM	Science, Technology, Robotics, Engineering and Mathematics
SPSS	Statistical Package for Social Sciences

CHAPTER 1. INTRODUCTION

1.1 BACKGROUND OF THE RESEARCH

Technology has become a norm in today's teaching and learning environment. Back in the days, a typical classroom setup comprised of a teacher with a green chalkboard and chalk to facilitate learning while learners had pens and papers on their desks to digest and partake in the learning process. Fast-forward to the 21st century, technological devices such as interactive boards, laptops, and tablets have been introduced to facilitate modern learning and teaching in schools to integrate technology into education.

To keep up with technological developments, the South African (SA) national government has made strides by ensuring clear foundations and guidelines on how South African education can transition and take advantage of technological advancements. In this regard, the White paper No. 7 on e-Education (1896/2004) by the government was the foundation upon which a framework for integrating technology into education was established to accelerate the achievement of national education goals. Since then national and provincial departments have implemented policies, frameworks and initiatives backed up by financial investments focusing on integrating technologies in schools. However, the debate on the impact of integrating technological tools in education continues owing to the challenges of technological use and its adoption in schools (Botha, Herselman, Rametse & Maremi, 2017; Lim, Zhao, Tondeur, Chai & Tsai, 2013, p. 64; Ramorola, 2010).

The South African Grade 12 results are celebrated nationally and regression in Grade 12 academics could bust the bubble of this celebratory occasion. Given this background, this study focused on evaluating the influence of digital devices used by teachers on Grade 12 academic performance in Gauteng public schools. This was achieved by assessing the level of technological adoption in public schools and comparing the Grade 12 results from a sample of schools that have fully implemented technological devices between 2018 and 2021 with their results before the implementation.

1.2 PURPOSE OF THE STUDY

Technology has become a helpful tool designed to help solve problems. The helpfulness is evident in daily activities as technology use increases creating a dependency to accomplish tasks. Furthermore, investments in technology are being recorded substantially across all fields. Lim *et al*., (2013) consented that worldwide school technology has grown more than a hundredfold in the past two decades. StatsSA (2017) reported that SA households spent R93 billion on information, communication and technology (ICT) products contributing 3% to the gross domestic product for 2014. Supported by Erman, Rojko and Lesjak (2022), worldwide information technology expenditure grew by $2 397 billion between 2006 and 2019. The technology expenditure was expected to increase due to the increased technology adoption caused by the COVID-19 pandemic.

In 2012 the SA government developed the National Development Plan (NDP) and clearly outlined proposals in areas that needed attention in basic education (National Planning Commission, n.d.). Infrastructure and ICT formed a crucial point in framing and guiding reforms in the basic education sector by exploring using mobile devices to distribute learning content. The government ensured that a high-speed network was available to support schools which would in turn encourage technological usage and enhance teaching in classrooms. In response to this strategic initiative, the Gauteng Department of Education (GDE) introduced an e-learning programme in 2015. This was aimed at encouraging the use of technology to improve education outcomes in particular learner achievement while enhancing teaching quality, providing access to learning material and improving learner engagement (GDE, n.d.).

The department has identified the implementation costs, sustainability and efficient usage of technology as three key elements that will determine the future of ICT as an effective tool for social and economic development (Department of Basic Education, 2004). According to Stepanyan, Littlejohn and Margaryan (2013), many e-learning projects have failed and were regarded as unsustainable owing to resource constraints thus degrading their impact. The failure is due to the reliance on state funding, which may be subject to austerity measures resulting in a lack of delivery of the technologies at schools (Stepanyan *et al*., 2013). In 2013, the assessment of e-learning reached an estimated value of R396.2 million, which encompassed the expenditure on project capital over a two-year period (SA Government, 2013). Tablets accounting for R289 million and network lease costs totalling R107.2 million (SA Government, 2013). The adoption of technology across industries prompted even more investments in information and technology (IT). This led to the allocation of R1.712 billion towards the e-Learning project in the adjusted budget for the 2020-21 financial year (Gauteng Provincial Government, 2022).

Lim *et al*. (2013) noted substantial investments in technology through spending on procuring devices, infrastructure preparation, hardware, software, network connectivity and training. These investments were likely to increase the costs of running schools. There was a likelihood that schools may not have reaped the benefits compared to other industries that had reported cost savings and improvement in business performance (Lim *et al*., 2013). According to Becta (as cited in Lim *et al*., 2013), technology cannot be studied in isolation when emphasising the relationship between the use of technology and academic achievement. However, given that a more significant part of school funding is by the state, there is pressure from the public and media for policy-makers to demonstrate benefits or return on investment in using technology in schools (Lim *et al*., 2013). Therefore, there is a need to evaluate whether implementing technology devices in public schools has yielded positive results affecting academic achievements as initially envisioned by GDE. This study has determined the influence of digital devices teachers use in Grade 12 academic performance.

1.3 PROBLEM STATEMENT

The Department of Basic Education's (DBE) strategy for e-Education was to ensure the implementation of the strategic objectives of the White Paper up to 2025 (DBE, 2004). This strategy equipped 16 102 schools with basic ICT facilities and services (Munje & Jita, 2020). However, there have been challenges associated with integrating ICT in SA schools. The e-Education strategy was tested at the peak of the COVID-19 outbreak whereby many schools came to a standstill due to the restriction of physical contact. The standstill increased the use of technology to facilitate learning (DBE, 2021). As a result, investments in technology in schools continued to rise.

Conversely, Grade 12 academic achievements in Gauteng over the last five (5) years (2016-2021) were at an average of 85% with a 2.28% improvement that was noted between 2017 and 2018 (DBE, 2021). The national Grade 12 pass average was 76.6% with a 3.1% improvement between 2018 and 2019 (DBE, 2021). Mathevula and Uwizeyimana (2014) observed no unanimous agreement in the literature on whether ICT positively or negatively impacts education. Researchers have explored the impact of technology in schools and concluded that there is a positive impact on academic achievements (Harris & Al-Bataineh, 2015; Vadachalam & Chimbo, 2017). However, the literature mainly focused on rural schools, teaching rather than learning, and performance aspects, and most of the studies were conducted outside of Gauteng. Although there was literature exploring the impact of ICT on learner performance, limited studies focused on the SA context with specific interest on grade 12 learners.

Moreover, the studies primarily centred around educators in certain situations. This highlight the necessity to make an effort in establishing and correlating the degree of ICT integration with academic performance. While there were attempts in extant literature to link the impact of usage and academic performance, the studies faced several shortcomings. This included shortcomings such as small sample sizes and limited focus on grade 12 results in the SA context which provided the basis for further studies. It is against this background that this study evaluated the extent to which schools have adopted the use of technology and how the adoption impacted Grade 12 academic achievement.

1.4 RESEARCH AIMS AND OBJECTIVES

The research addressed the following objectives:

i. To evaluate the extent to which teachers have adopted digital devices in Gauteng schools.
ii. To assess whether the quality of information on devices affects the adoption of digital devices in Gauteng schools.
iii. To evaluate the impact of digital device adoption on Grade 12 academic performance in Gauteng schools.
iv. To identify the challenges associated with digital devices in Gauteng schools.

1.5 RESEARCH QUESTIONS

The research questions answered are as follows:

i. To what extent have teachers adopted digital devices in Gauteng schools?
ii. Does the quality of information on devices affect the adoption of digital devices in Gauteng schools?
iii. How does the adoption of digital devices affect Grade 12 academic achievements?
iv. What challenges need to be addressed to improve the adoption of digital devices in Gauteng schools?

1.6 SIGNIFICANCE OF THE STUDY

Technology is increasingly driving efficiencies in our environment and learners will need to be tech-savvy to succeed in their future careers. Therefore, e-learning technology becomes a foundation for introducing technology in schools in preparation for the Fourth Industrial Revolution. This is a view shared by the former Gauteng Education MEC, Mr Panyaza Lesufi, who acknowledges that the department cannot overlook new technology's revolutionary potential as well as the need to provide learners with the ability to cope with a digital environment that will make them employable (Gauteng Provincial Government, 2021). The e-learning programme has become an essential component of school development programmes in Gauteng. However, an assessment still needs to be done to link technology implementation to academic achievements. Furthermore, research studies completed on this programme have revealed challenges with implementation and recommended action plans to ensure successful adoption and implementation. In the South African context, specifically within the Gauteng department of education, the study will assist the department in getting buy-in from school governing bodies, the South African Democratic Teachers' Union (SADTU), the private sector, parents and bodies such as Section 27. This will see the department fully rolling out an e-learning programme in the province or revising the programme to improve policies and processes. Furthermore, the DBE's goal of taking advantage of technological developments to improve academic achievements could be realised. This will provide an opportunity for the DBE to develop a framework to drive policy changes. This could also influence and increase public funding in terms of National Treasury Budget Allocation to drive the initiative at greater scale and possibly rolling it out to lower Grades.

1.7 DELIMITATIONS

Studies have limitations that researchers need to address. According to Creswell and Creswell (2017, p.180), research limitations assist in defining the parameters of the research study and further advance future research studies. As a result, the below limitation applies:

i. The study strictly focused on schools that received technologies during the study period.
ii. Only full ICT schools were covered as part of the study.
iii. The study did not assess the financial impacts of the project investment.
iv. Other non-technology teacher and leaner initiatives to improve performance should have been covered.
v. Other factors that influence academic performance.

1.8 SUMMARY OF THE INTRODUCTION

This chapter provides the background of the study, the purpose of the study and an overview of the research problem which is to evaluate the extent to which schools have adopted the use of technology and how the adoption impacts Grade 12 academic achievements particularly in Gauteng schools. The chapter further presents the research questions, the purpose of the study, the research question, the research objectives and the delimitations of the research. These will be explored more in the next chapters.

CHAPTER 2. LITERATURE REVIEW

2 INTRODUCTION

This chapter presents the current literature on integrating ICT into education. There is a review of studies on the adoption of ICT in schools, the challenges experienced during the implementation phase and the observed outcomes in terms of academic performance.

2.1 ADOPTION OF TECHNOLOGY IN EDUCATION

According to Dasgupta, Granger and McGarry (2002), ICT adoption has been studied by researchers in great detail. Adoption as a concept is defined by Dasgupta, *et al.*, (2002) as a decision to accept and invest in technology. Totolo (2007) asserts that many individuals are of the view that technology adoption will naturally follow after the procurement of the hardware and software. However, this has not been the case in the African context as evidenced by the considerable research undertaken in assessing factor that influence the success or failures of technology adoption, Totolo (2007). Like other nations worldwide, schools in South Africa are receiving technology devices as part of projects to assist them with teaching and improving their IT knowledge and abilities (Botha *et al*., 2017). In GDE context the adoption of ICT in education through the implementation of e-learning in schools aims to enhance teaching and learning.

Integrating technology devices is described as a digital classroom environment that covers six (6) elements (Liang, Liu, Wang, Chang, Deng, Yang & Chan, 2005). These elements include learner and teacher devices, network connectivity, a class-room shared screen, the classroom server containing online content and a device management system that enables teachers to control learner devices (Liang *et al*., 2005). The DBE has ensured that technology is integrated into schools collaboratively with non-government organisations, the private sector and parastatals (Dzansi & Amedzo, 2014). This aligns with Meyer and Gent (2016) who identified levels of role players that are required to integrate and coordinate their actions in ensuring the success of the implementation at provincial and national levels. These are at national; provincial; district and school level. A notion shared by Levin and Schrum, (2014) that collaborations with parents, communities as well as with businesses and industries provided a potential for financial support in a form of donations, expertise and support. In the context of the SA education sector, this has been achieved and backed up by progressive policy development such as the National Education Policy, the 2004 White Paper 7 on e-Education, the 2001 Strategy for Information Technology in Education and the 2015 Operation Phakisa ICT in Education policy document.

In a quest to identify factors that influence technology adoption in education, several theoretical and practical methods have been applied (Granić, 2022). In the articles reviewed, scholars explored e-learning technology adoption using TAM, UTAUT and the DeLone and McLean models. Granić (2022) found that perceived ease of use and perceived usefulness were two factors identified through the TAM model to foster users' adoption and acceptance of different technologies supporting the teaching and learning process. At the same time, Yakubu and Dasuki (2018) explored the adoption of e-learning technology at a university level in Nigeria by adopting the DeLone and McLean model. Although the impact part of the model was not covered, Yakubu and Dasuki (2018) found that information and system quality did not affect user intention to use the technology, which was not determined by user satisfaction. This result could be caused by a limitation on the method of study used, which was limited to quantitative, as it focused on mandatory usage and did not factor in instructors (Yakubu & Dasuki, 2018).

However, there were contrary findings by Prasetyo, *et al.*, (2021) in evaluating the factors influencing the acceptance of an online platform for high school learners in the Philippines. Prasetyo *et al.*, (2021) found that the level of adoption by learners regarded similar factors to impact learner intention to use the technology. The study in the Philippines fell short of further exploring the impact on the individual or organisation level (Granić, 2022; Yakubu & Dasuki, 2018). This study aims to close the knowledge gap by extending the DeLone and McLean theory in assessing whether the technology adoption impacts academic performance at the school level. Mathipa and Mukhari (2014) argue that the use and adoption of technology in schools to promote teaching and learning is dependent on teachers as they are change agents. In the same vein, teachers must employ technology in teaching digitally capable learners while acquiring new ways of teaching and learning in the new technological era (Botha, *et al.*, 2017; Ghavifekr &

Rosdy, 2015, as cited in Lekgothoane, 2021). The researchers Botha *et al*., (2017) and Ghavifekr & Rosdy, 2015 as cited in Lekgothoane (2021) alluded that the progression of technology over the years has made available an abundance of technologies. Consequently, maturity in learning has been visible with teachers firmly establishing themselves as the implementers of technology in the classroom (Botha *et al*., 2017; Ghavifekr & Rosdy, 2015 as cited in Lekgothoane, 2021).

In investigating teachers' adoption of IT technologies in rural schools for learning and teaching, Mwapwele, Marais, Dlamini and Van Biljon (2019) discovered that 94% of teachers confirmed to have received tablets in their schools. Mwapwele *et al*., (2019) assert that teachers were optimistic and innovative in the adopting of technology in the classroom. This is because they believed that tools such as tablets would positively change the approach to teaching and learning. This will encourage interactions and non-engaging learners in classrooms through technical support and the technology's suitability (Mwapwele *et al*., 2019). In agreement, Kotrlik and Redmann (2009) found that at the classroom level, teachers had adopted technology and encouraged learners to use technology as a tool for learning. However, the integration of devices fell short, which prevented teachers from using technology to its maximum (Kotrlik & Redmann, 2009).

In the same breath Botha *et al*., (2017) related this optimism to attitudes and beliefs, pointing out that teachers were eager to try tablets as a teaching aid in their classrooms as they used them productively for preparing and presenting lessons. According to Botha *et al*., (2017), teachers had previously expressed reservations about technology's potential to enhance classroom practice. However, they changed their minds due to their experiences, which starkly contrasted their earlier reservations and supported their expectations (Botha *et al*., 2017). Similarly, Groff and Mouza (2008) believed learners would impact how lessons are initiated, designed and presented in the classroom. Therefore it was logical to assume that learners identified to work with similar technologies in classrooms will impact the chances of such projects succeeding (Groff & Mouza, 2008). As a result, Groff and Mouza (2008) deemed learner background, beliefs and technological skills as characteristics that should be considered vital success factors in technology-based projects at schools. In addition, there is an emphasis that due to the complexity of integrating technology in learning and teaching, planning overall should be a key element to ensure improvement and adequate development (Ghavifekr & Rosdy, 2015, as cited by Lekgothoane, 2021).

2.2 IMPACT OF TECHNOLOGY ON ACADEMIC ACHIEVEMENTS

Meyer and Gent (2016) regards learning as progressive to enhance the education process if learners can remember, understand, apply, evaluate and create concepts. As a result, there is an argument that implementing technology alone does not necessarily translate into improved learning outcomes (Amory et al., 2015, as cited by Meyer & Gent, 2016). This is a view pointed out by Levin and Schrum (2014) in studying lessons learnt from school leaders who successfully used technology to improve their schools. Levin and Schrum (2014) found that leaders acknowledged that technology is only one of many components required for school reform and that much more must happen before positive improvements can occur. Although there is an argument for implementing technology, many policy-makers, community members and other stakeholders were expecting evidence of the effects of technology on student learning to support technology investments (Monserate, 2018). Many researchers have explored the impact of digital classrooms and technology, focusing on specific grades and subjects. For example, Wenglinsky (1998, as cited in Irving, 2006) studied the relationship between technology and learner achievement in mathematics, observed improved learner proficiency and attributed it to the efficient use of technology. However, Wenglinsky (1998, as cited by Irving, 2006) highlighted that the outcomes would be depended on how the technology is used within the school taking into account access to the technology among learners when looking at rural and urban areas. In a similar study of Grade 4 classes at Central Illinois in the US region, Harris and Al-Bataineh (2015) found that adopting technology in both learning and teaching could catalyse high academic results, mainly due to the technological shift faced by schools.

In support, Edwards (2012) illustrated a real case study of the Mooresville School in the United States where 6th Grade learners were enthusiastic and energised by the technology implementation, which translated to learners remaining engaged. Edwards (2012) suggested that the academic achievement at Mooresville can be linked to the curriculum changes adopted including learner performance goals aligned with strategic district plans, teacher level and specific learner plans. However, the authors also acknowledged that programmes were likely to yield results and the envisaged benefits when funds are available to cover expenditures relating to manpower, IT infrastructure and personnel development costs. In the same vein, Rahman et al. (2015 as cited in Al-Abdullatif and Gameil (2021) believe that the integration of technology in teaching and learning can be associated with improving the effectiveness of knowledge construction and dissemination efficacy as well as improved academic performance. According to Rahman et al. (2015) as cited in Al-Abdullatif and Gameil (2021), impact can be expected if technology integration is effectively and consistently implemented. However, the study of Wenglinsky (1998 as cited in Irving, 2006; Harris & Al-Bataineh, 2015) has been devastatingly critiqued by researchers (Meyer & Gent, 2016; Monserate, 2018). In studying the impact of technology on learners' academic achievement and teaching in the Philippines, Monserate (2018) found no significant association between teacher computer competency and teaching effectiveness even though learners from private schools had more access to technology than public school learners.

Voogt, Kneplompzek, Cox, Knezek and ten Brummelhuis (2013) acknowledge that technology was integrated into primary and secondary schools' curricula in many countries. However, the assessment frameworks usually remained unchanged (Voogt *et al*., (2013). At the same time, the DBE (2019) regards the introduction of technology as a complex area, especially with continuing technological developments. This is due to extensive stakeholders' involvement and the complexity of cost-benefit aspects (DBE, 2019). As a result, the DBE (2019) conceded that there was a need for the national strategy to clearly outline how technology can be aligned to enhance educational outcomes. A view shared by Aristovnik (2012) who noted that theoretical and empirical research faced difficulty in assessing the impact of technology on outcomes owing to the difficulty in observing learner performance. The Second Information Technology in Educational Study (SITES) samples teachers, principals and technology administrators in 26 countries including SA to explore the use of technology in teaching (Aristovnik, 2012). Although it does not examine learner achievement, the study examines how teachers view technological effects on learners (Pelgrum & Anderson, 1999; Kozma, 2003, as cited in

Aristovnik, 2012). The reliability results of Plomp, Pelgrum and Carstens (2009) study in evaluating the impact demonstrated that teachers perceived technology to impact teaching and learning. A similar conclusion was reached by Qaddumi, Bartram, & Qashmar (2021) in evaluating the impact of technology focusing on Palestinian learners and teachers. Notably, an experiment study by Jena (2013) evaluated the difference in the impact of technology on academic performance compared to when traditional methods are explicitly used specifically when teaching the science subject. The students were separated into those regarded as high performers against low performers. Interestingly, the results demonstrated that high and low student performers achieved better academic results when taught using technology (Jena, 2013). Similarly, a recent Zambian study evaluating the effect of COVID-19 on Grade 12 academics by Sintema (2020) found that Grade 12 academic results in percentages, specifically Science and Technology, Engineering and Mathematics (STEM), were likely to regress owing to COVID-19 distractions. This emphasis that technology can minimise the impact of school disruptions such as COVID-19, riots and protests where learners and teachers cannot access school premises.

On the contrary, Meyer and Gent (2016) believed that it could be detrimental to measure learner achievements by assessing the impact of technology on teaching and learning and heavily discouraged this notion. At the same time Monserate (2018) encouraged more studies in evaluating the relationship between learners and teachers, technology use and learners' academic achievement as this could assist the education department in evaluating the importance of technology in schools. Raja and Nagasubramani (2018) indicated that technology brings positive impacts such as improved teaching and learning, globalisation and non-geographic limitation with the potential to increase access to more educational resources. However, Raja and Nagasubramani (2018) also conceded that teachers' negative views might cause such projects to fail due to negative attitudes towards technology, which may be triggered by the continuous introductions of emerging technologies requiring teachers to train continuously. The varying views demonstrated by the authors necessitated a study to examine the phenomenon of technological impact on academic achievement concerning the SA context in Gauteng.

2.3 CHALLENGES OF IMPLEMENTING TECHNOLOGY IN EDUCATION

Integrating digital technology in schools brings about varying challenges. Many scholars outlined four (4) significant challenges that less developed countries may experience hindering a successful implementation and, therefore, not reaching its objectives (Wenglinsky, 1998 as cited in Irving 2006; Harris & Al-Bataineh, 2015; Donovan, Hartley & Strudler, 2007 as well as Rogers, 2003; Howkins, 2002; Tiene, 2004; Pelgrams, 2001; Rodrigo, 2005 as cited in Richardson, 2011). The four (4) challenges summarised by Richardson (2011) note that, firstly, in less developed countries, advances in digital technology in schools are specifically not focused on addressing the demands of the end user, i.e. learners and teachers. This frequently leads to inconsistencies in planning, implementation and long-term sustainability (Richardson, 2011). Matwadia (2018) studied the influence of digital media use in classrooms on teacher stress based on the initial implementation of the e-learning project in Gauteng schools. Matwadia (2018) revealed that teachers that were part of the roll-out did not form part of the decision-making process. This resulted in various challenges being experienced during the implementation phase (Matwadia, 2018). Some challenges that were cited by the teachers and needed consideration were time constraints, hardware and software issues, learner discipline and subject-specific obstacles (Matwadia, 2018).

Furthermore, teachers had challenges with new technologies as they were not experienced and learner safety was a concern as criminals targeted learners (Matwadia, 2018). Similarly, a study to investigating the levels of a digital classroom in Limpopo, Lekgothoane (2021) identified a need for more classroom technology, network connectivity and teacher training as critical challenges contributing to failing to transition to digital teaching. These challenges are consistent with findings from Harris and Al-Bataineh (2015) as well as Raja and Nagasubramani (2018). This is, however, notwithstanding that learner safety and subject-specific challenges being found to be unique to the Gauteng study (Matwadia, 2018). Secondly, digital technology in school programs in developing countries frequently need long-term funding; as a result, early accomplishments tend to fade away (Richardson, 2011). As a case in point, government mainly funded the GDE programme with limited resources that continue to diminish due to economic conditions. According to Groff and Mouza (2008), the costs of technologies, including hardware in schools were still extremely high. As a result, securing funding together with continuous maintenance might be difficult as, in some cases, hardware and software procurement accounted for 75% of the total technology costs (Groff & Mouza, 2008). Furthermore, Meyer and Gent (2016) cautioned against budgeting for technologies based on current requirements and costs against donated technologies not budgeted for as these may hinder sustainability due to cost escalations.

Thirdly, the roll-out of digital technology in schools necessitates a conceptual and pedagogical shift by learners and teachers and this tends to be a difficult transition to make (Richardson, 2011). As a result, projects in developing countries frequently overlook the importance of aligning academic outcomes with digital technology initiatives. Groff and Mouza (2008) argued that professional development in schools then falls short in this area and failing to address teacher development and new pedagogies represented in implementing technology in schools may prevent the success of such projects. Casey and Rakes (2002) in their analysis of the influence of technology training on teachers, found that in most cases trainers and administrators were more concerned with addressing learners with the technology and not necessarily equipping teachers with the new technological skills and teaching strategies. Casey and Rakes (2002) advocated effective teacher development on technologies focusing on development as a long-term plan. Casey and Rakes (2002) recommended that focus be targeted at individuals, not groups, the progressive adjustment of development and training; the structuring of development in a way that integrates the technologies into education curriculum; the assignment of adequate time; seeing teacher development as an investment to the schools and monitoring to cause change. In contrast, Halverson and Smith (2009) distinguish between technologies for learners and for learning. In contrasting their effect on learning and teaching, Halverson and Smith (2009) advocate for technologies that schools primarily support. These are regarded as structured and reliable to deliver and measure outcomes irrespective of the learner's situation or context (Halverson & Smith, 2009).

Fourthly, sustaining digital technology in schools has proven complex and challenging (Richardson, 2011). As suggested by Levin and Schrum (2014), key aspects must be addressed for leaders to drive their school development efforts ahead through technology.

These include clear vision and leadership, technology planning and support, curriculum and instructional techniques, school culture, funding, and collaborations amongst stakeholders. Additionally, a generalised study exploring sustaining the use of technology by communities by Lee and Passey (2019) concur with Mathipa and Mukhari (2014) in that skills and development are also vital in sustaining the use of technology. Furthermore, there is sustained use of technology where users have understood the importance of the technology, the potential benefits and how it will improve their lives as new technologies emerge (Lee & Passey, 2019). All these factors and challenges were well considered by the DBE during the conceptualisation of e-education and were well articulated in the White paper No. 7 on e-Education (1896/2004). A concern remains whether adequate interpretation and implementation by all role players were achieved and translated into improved academic achievements.

2.4 THEORETICAL FRAMEWORK

Bichler, Frank, Avison, Malaurent, Fettke, Hovorka and Thalheim (2016) suggested that the primary purpose of Information System (IS) research should be to craft robust theories that can inform researchers about their answers to research questions. This study aimed to answer the research question by evaluating whether the use of digital devices affects Grade 12 academic performance. In the same breath, Aktaruzzaman and Clement (2011) contend that the main reason for implementing technology in learning and teaching is to improve the quality of education. The research questions explored are concerned not only with understanding, explaining or possibly predicting a phenomenon but rather with shaping institutions governing the phenomena, ensuring some goals are achieved (North, 1991; Roth, 2002, as cited in Bichler *et al*., 2016). As a result, IS research typically adopts a theory-guided by an engineering approach. In analysing the theories that apply in IS studies, Halawi and McCarthy (2006) unpack, amongst others, seven (7) significant theories that apply. These include the "Adaptive Structuration Theory (AST), Knowledge-Based View (KBV) of the firm, DeLone and McLean Information Success Model, Diffusion of Innovation Theory (DIT), Task Technology Fit (TTF), Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT)".

2.5 CHOSEN THEORETICAL FRAMEWORK

The DeLone and McLean Information Success Model are considered the most comprehensive although more research is recommended. The model aims to address six (6) elements and present results in a success model urging that system and user satisfaction is directly impacted by system quality. At the same time the amount of usage can either positively or negatively affect user satisfaction (Bichler, *et al*., 2016). In turn, user satisfaction will impact individual and institutional performance (Bichler *et al*., 2016). A similar view is also shared by Cheng *et al*., (2013 as cited in Aldholay, Isaac, Abdullah, Abdulsalam and Al-Shibami, 2018). System quality is defined by Petter and McLean (2009 as cited in Aldholay *et al*., 2018) as the extent to which users believe systems will be easy to use. While the quality of information is concerned with accuracy, relevancy and up-to-date information (Halonen *et al*., 2009, as cited in Aldholay *et al*., 2018). In turn, both factors determine user satisfaction and actual usage where actual usage influences performance impact.

A study by Aldholay *et al*. (2018) in investigating whether user satisfaction and actual usage of an online learning platform predicted student performance concluded that both factors positively impacted performance which was also aligned with previous assertions in other studies (Hou, 2012; Islam, 2015; Kim *et al*., 2015 as cited in Aldholay *et al*., 2018). However, Aldholay *et al*., (2018) still cautioned researchers on the limitations that may exist. These may be presented by the sample selection and lack of information to conclude on performance impact (Aldholay *et al*., 2018). Researchers are encouraged to extend performance assessment at the institutional level rather than the individual while considering a technological change that may also impact usage (Aldholay *et al*., 2018). Based on the analysis of the different IS research theories, all theories focus on different factors surrounding the system development, use and impact. As a result, the scope of the research will determine the most applicable theory to be adopted. Furthermore, due to limitations on each and the complexity of IS research, no one theory or model can sufficiently explore a phenomenon. Therefore, this study is supported by the theory of DeLone and McLean by adopting the ten-year update of DeLone and McLean's Model of Information Systems Success Model. This study will evaluate whether using digital devices affects Grade 12 academic performance in Gauteng public schools. This will directly link to the value of the technologies introduced at schools while drawing insights from challenges cited by Matwadia (2018) and other studies on the outcome of the assessment of integration technology in the classroom.

Consequently, the below hypothesis (H) is proposed in this study, which will be underpinned by the extent of usage (adoption) of the technology devices and material provided at schools:

i. *H0: There is no difference in the Adoption of technology according to whether a teacher is using devices or not*
ii. *H1: There is a difference in the Adoption of technology according to whether a teacher is using devices or not*
iii. *H0a: Challenges in integrating technology have no impact on perceived academic performance.*
iv. *H0b: Technology Adoption has no impact on perceived academic performance.*
v. *H1a: Challenges in integrating technology have an impact on perceived academic performance.*
vi. *H1b: Technology Adoption has an impact on perceived academic performance.*

2.6 CONCEPTUAL FRAMEWORK

The conceptual framework (depicted in figure 1 below) will be adopted. The conceptual framework is driven by the theory of DeLone and McLean. Although this model has been widely used successfully in the e-commerce space, the model still assists in measuring the success and effectiveness of information systems which is critical in understanding the value and efficacy of management actions and investments in technology (DeLone & McLean, 2003). In the study context, the ***Technology*** domain addresses the digital devices provided to schools and related content and whether these meet the requirements to support adoption. The ***People*** domain represents the adoption of devices, i.e. usage by learners and teachers, while the ***Organisation*** domain involves the analysis of Grade 12 learners' academic achievements.

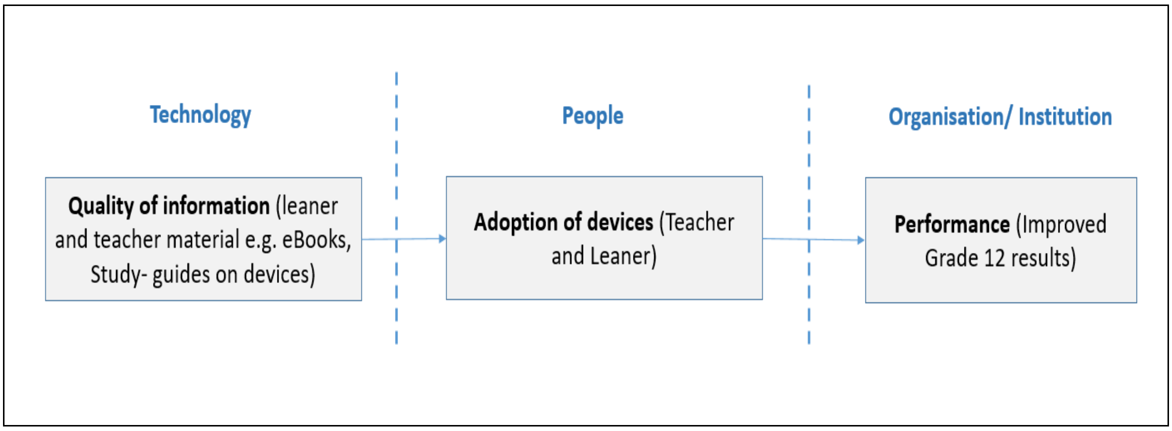

Figure 1: Proposed research model

Sources: DeLone and McLean (2003)

Drawing adapted from: *10-year IT update – DeLone McLean Model - JOHNSOHN.dk*

2.7 SUMMARY OF LITERATURE REVIEW

The literature review reveals clear benefits in the integration and adoption of technologies in schools by teachers and learners. However, there is still a debate on whether implementation will impact academic achievements due to challenges that became evident where there needs to be clearer leadership, guidance and collaboration from stakeholders at the school level.

CHAPTER 3. RESEARCH DESIGN AND METHODOLOGY

This chapter discusses the methods and procedures utilised in conducting the study. It includes the research design, location of the study, respondents of the study, population, sample size, the research instruments, data gathering procedures and the data treatment and analysis.

3 TYPE/ NATURE OF THE RESEARCH

A research approach can either be qualitative, quantitative, or mixed. In this study, a quantitative method design is adopted. Creswell and Creswell (2017, p.41) assert that a quantitative method allows a researcher to test objective theories by investigating the relationship between variables through the use of statistics. There are four advantages of quantitative method identified by Basias and Pollalis (2018). According to Basias and Pollalis (2018) the method allows for results to be presented numerical and will not be affected by personal feelings or opinions. Big data can be simplified, the method allows for easy comparison of data and for development of valuation indictors (Basias & Pollalis, 2018). Wenglinsky (1998, as cited in Irving, 2006) used a quantitative research method to reach greater audience to assess the relationship between technology and learner achievement in mathematics. This provided greater perspective on how technology improved learner proficiency. Comparably, in a recent study by Qaddumi *et al.*, (2021) the same method was successfully adopted to explore teachers' and students' perceptions of the impact of ICT on teaching and learning including the challenges they experienced. Similarly, in order to reach a larger audience and explore the adoption of technology, its impact on academics and problems in technology integration, this study used a quantitative method to primary data gathering and analysis.

The primary data emanates from a questionnaire survey sent to a sample of full ICT secondary schools in Gauteng. Full ICT schools are schools that have undergone a complete technological transformation. The transformation involves a total makeover of the classrooms. The classrooms have smart boards (LED TVs), tablets for every student, laptops for teachers, teacher training and other enablers such as security and network connectivity. Security covers physical and electronic security to the school and classrooms while network connectivity entails internet access for the schools. The aim is to promote technology-based teaching and learning by establishing a paperless classroom. Furthermore, secondary data containing Grade 12 results or statistics on academic achievement was utilised to support the outcomes from the questionnaire.

3.1 POPULATION, SAMPLES & SCOPE OF THE RESEARCH

The population comprised of all full ICT secondary schools irrespective of their quantile that, firstly, they are part of the e-Education program and secondly, they have been consistently allocated with digital devices in the last five (5) years (i.e. 2018-2022). Based on permission from GDE, a clustering approach in identifying the schools to participate in the study was followed. According to Creswell & Creswell (2017, p.212), clustering as a sampling design allows a researcher to select participants from a specific cluster identified. In this case, the schools were selected from the list of schools participating in the program. As advocated by Martin (2018), an appropriate representative sample from the population will be selected considering available resources; financial and time constraints to ensure data is not distorted. From the list provided by GDE, 604 schools participated in the program, and 49 of these were categorised as secondary full ICT schools meaning they had undergone the technological transformation. These 49 schools formed part of the population and were considered better placed to fulfil the research objectives and questions. According to Creswell and Creswell (2017, p. 262), this technique can be classified as a purposeful selection of participants. However it is mainly used in qualitative studies and is most effective in assisting a researcher in gathering more insights about the research question and problem. A sample of 10 schools was randomly selected from the population, with five schools subsequently added at a later stage due to low and inadequate responses to the survey. The schools that participated were across eight (8) out of 15 districts in Gauteng including Ekurhuleni North, Gauteng East, Johannesburg South, Ekurhuleni South, Johannesburg Central and Tshwane South. From each school in the sample, Grade 12 teachers were requested to participate in the questionnaire survey with a target of reaching ten respondents in each school. In total, 109 responses were received from the survey.

3.2 DATA COLLECTION TECHNIQUES

Primary data collection was executed using a questionnaire designed on the Qualtrics tool, shared with ICT coordinators in each school to distribute to Grade 12 teachers participating. In the first few schools visited, teachers opted for the electronic link, but due to slow response, a manual approach was subsequently adopted, which enabled more effective tracking. Each school was given 3-5 days to respond after the visit, and responses were collected upon confirmation by the in-house ICT coordinators at those schools. The school stamped all manually completed surveys to confirm the validity of the completed questionnaires, which was manually loaded into the tool. A Statistical Package for Social Science (SPSS) data file was exported from the Qualtrics tool and was used for analysis in chapter 4.

3.3 RESEARCH INSTRUMENT

The questionnaire used for collecting data was structured into five categories. Category 1 included data on teachers' years of experience, years of teaching using technology, devices used, internet connectivity options and programs used was collected. Category 2 covered an assessment of technology devices, including adoption and category 3 consisted of challenges of integrating technology with construct adopted from Kotrlik and Redmann (2009). Category 4 covered quality of information assessment with construct adopted from Prasetyo et al. (2021). While Category 5 included information gathered through open-ended questions on subjects migrated to devices, electronic content loaded and measures to improve technology. The structure of the three categories (2, 3 and 4) allowed participants to answer statements using 3 Likert scales being 1=Disagree, 2=Neutral, and 3= Agree. The detailed questionnaire is included in (Annexure A) below. Secondary data comprising Grade 12 results from 2014 to 2022 obtained from the DBE website for the selected schools was used to support the conclusions from the hypothesis testing.

3.4 TOOLS FOR DATA ANALYSIS

The SPSS version 28 tool was used to analyse the data collected. Descriptive analysis was performed to gather knowledge about years of experience for teachers, the devices, connectivity, number of years using devices, frequency of using the devices and content loaded, amongst others. At the same, the inferential analysis was used to evaluate the hypothesis. This also included a view of the mean, frequencies, percentages and standard deviation to assess the adoption of technology in schools, the challenges of integrating technology in teaching and learning and the quality of information loaded on devices. The results are presented in the tables, charts and graphs with narrations.

3.5 VALIDITY AND RELIABILITY

According to Kumar (2018, p. 340), researchers are tasked with ensuring that their research is of quality by ensuring the validity and reliability of the information presented. Validity is concerned with confirming the accuracy of the measure aimed at establishing whether the results from the study represent what the study meant to measure (Kumar, 2018, p. 340). While reliability is concerned with measuring consistency, i.e., determining whether the results produced can be replicated under the same condition or by another researcher (Kumar, 2018, pp. 345-346). In this study, primary data was collected from teachers using questionnaires. While secondary data is published officially by DBE, readily available on the website, validated by the department and forms part of communication to the public. Hudson and Miller (as cited in Martin, 2018, p. 277) suggest strategies for increasing reliability and quick response that researchers employing questionnaires should consider. According to Hudson and Miller (as cited in Martin, 2018, p. 277), these should include, amongst others, the following factors, which were adopted in this study to address data reliability:

- The design of the questionnaires was simplified, containing short questions, non-personal and non-sensitive and will consider time for completion.
- Where teachers opted to respond on manual copies, all questionnaires completed by teachers- were stamped by the school.
- The objective and importance of the questionnaire were explained to the head of schools and ICT co-coordinator before the distribution of the questionnaire.

- The data collected relating to technology adoption, quality of information and challenges that impact technology integration was assessed for reliability and validity using the SPSS tool. The results are presented below.

3.5.1 RELIABILITY ANALYSIS OF VARIABLES

Analysing the internal consistency reliability and validity for technology adoption, quality of information and challenges of integrating technology.

Table 1: Reliability Statistics

Scale	**Cronbach's Alpha**	**Number of Items**
Technology adoption	.826	14
Quality of information	.882	14
Challenges of integrating technology	.773	11

Table 1 demonstrates that all the scales comply with the inter-rater reliability. For this requirement to be satisfied, the Cronbach Alpha values must be at least .70 and above reflect as such. The quality of information scale indicates the greatest level of internal consistency of (α = .882, n = 14). As a result, the variables are computed using the mean of the responses for each scale.

3.5.2 VALIDITY ANALYSIS STATISTICS

In order for the construct validity to be sufficient, a Pearson's correlation analysis should reflect correlations and be statistically significant. The correlations noted on the technology adoption, quality of information and challenges of integrating technology variables demonstrated a positive correlation and were statistically significant. Table 6 in (Appendix A) shows that the technology adoption variable correlation is significant at the 0.05 level, Tables 7 and 8 in Appendix A demonstrate that the quality of information and challenges of integrating technology variables are both significant at the 0.01 level. Based on the results in Tables 6, 7 & 8, a majority of the items in the scale reflect a positive correlation (marked**); therefore, the scales satisfied the requirements for reliability and validity and the instruments used are reliable, and valid.

3.6 ETHICAL CONSIDERATION

There were no ethical issues experienced in this study. The following precautions were adhered to:

- Respondents' participation was voluntary and a consent letter declaring this was included in the questionnaire.
- Permission to conduct the study was granted by the GDE following process as guided by the research department.
- The ethical clearance was obtained from the Wits Business School following the processes of the school.
- The information gathered during the study will remain confidential. The physical papers will be destroyed after scanning.
- The electronic responses will be safely kept on a password-protected computer.

The relevant support documentation listed above is provided as supplementary information to this paper in (Annexures A, B, C & D)

CHAPTER 4. PRESENTATION OF RESULTS

This chapter presents the analysis and interpretation of the data collected during the study. Descriptive and inferential statistics were executed to answer the research questions and objectives including regression, correlation and an Analysis of Covariance (ANCOVA) tests. The results are presented on graphs, tables and figures with narrations and where applicable, reference to appendixes.

4.1 EXTENT OF TECHNOLOGY ADOPTION

This section presents findings on the extent of technology adoption in Gauteng schools.

4.1.1 Teachers' years of experience

Out of 104 responses, Figure 2 indicates that 30 teachers have been teaching for 15 years and above, 26 at 0-3 years, 20 at 3-5 years, and 15 at 5-8 years, while 13 fell within 10-15 years. This demonstrates that the spread varied amongst teachers with fewer years of experience and those with more years of teaching experience.

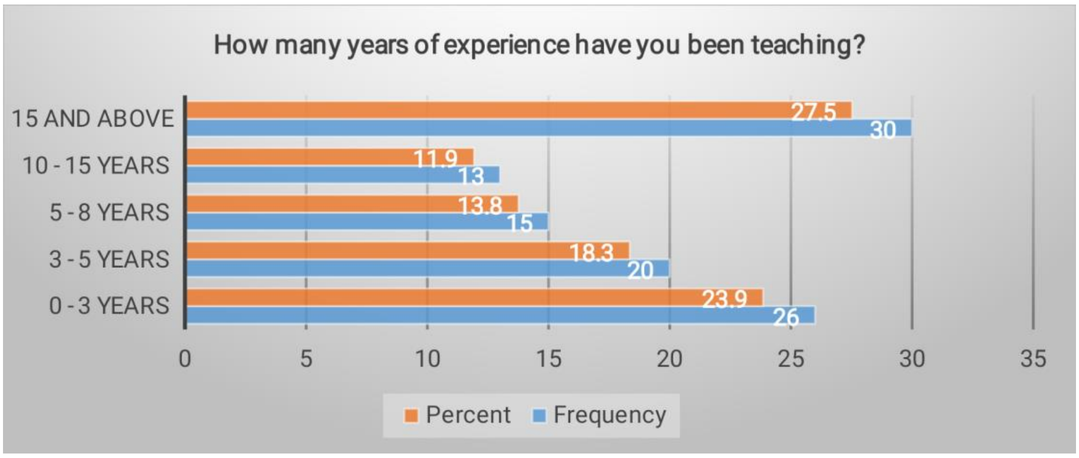

Figure 2: Years of experience

4.1.2 Number of years using technology for teaching

Figure 3 illustrates the number of years technology has been used in teaching and learning activities in Gauteng Schools. Findings indicate that 31% of teachers have been using technology for 3-5 years, 30% for 2-3 years, 22% for 5-8 years and 17% for 0-1 years. This data shows that the spread also varies amongst the teachers. Interestingly, a closer analysis demonstrated that 61% of teachers had used technology for 2-5 years and 22% for 5-8 years. This data implies a good representation of teachers using technology since the program's implementation.

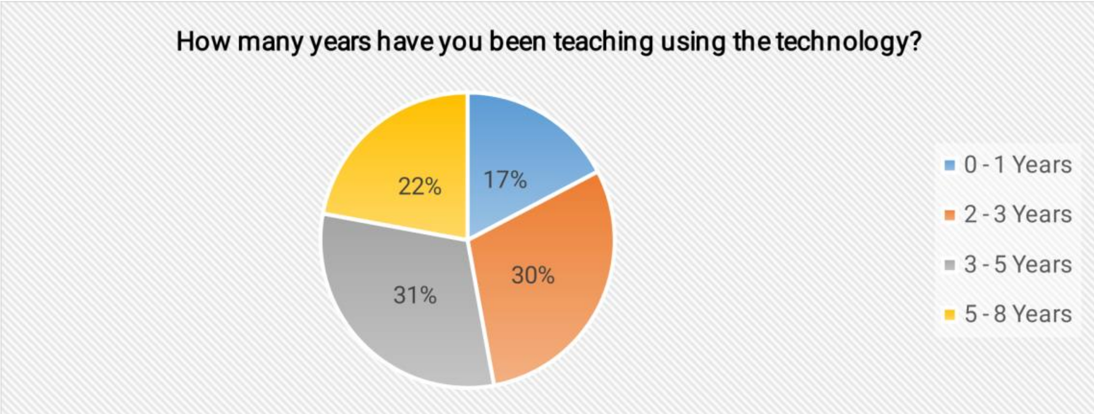

Figure 3: Years using technology for teaching

4.1.3 Devices used at various schools

As depicted in Figure 4, most of the teachers use technology devices in schools. Technology device usage varied from smartboards (30%), laptops (35%), tablets (26%), projectors (7%) and others (2%).

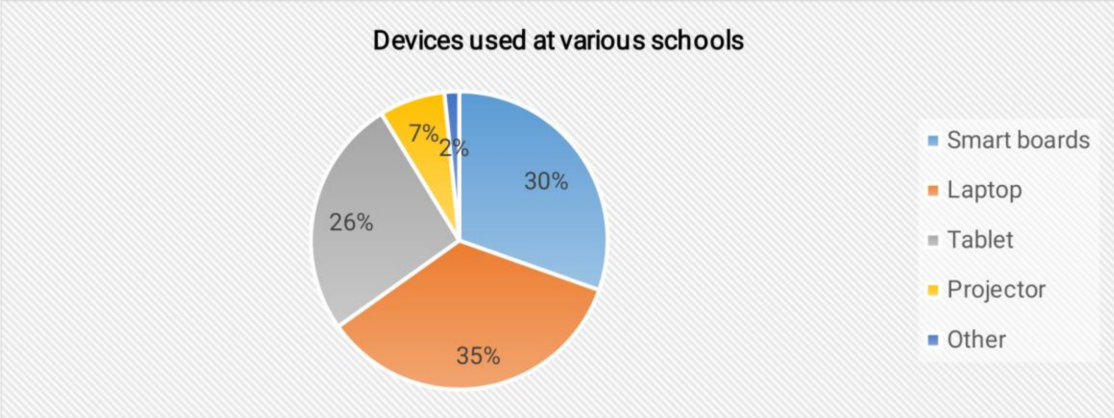

Figure 4: Devices used at schools

A univariate analysis was conducted to determine the extent to which teachers have adopted technology devices. Table 9 (Appendix A) demonstrates the pattern of responses on using technology devices at schools. Out of 109 participants, 88 teachers responded, with 85 indicating that technology devices are used at schools and only three indicated not to be using technology devices. This indicates a large extent of device usage at 77% based on the total number of participants. Furthermore, the item statistics in Table 10 show 83 teachers who responded to the adoption assessment. The top three scales were; 1) teachers confirmed to expect learners to use technology to enable self-direction; 2) confirmed to discuss how to use technology as a learning tool; 3) confirmed to encourage learners to share responsibility.

The means were (M = 2.86, SD = 387), (M = 2.84, SD = 366) and (M = 2.84, SD = 398) respectively. While the scales on incorporating technology to allow learner collaboration, teachers acting as facilitators and using technology to simulate lessons indicated low means M = 2.53, SD = 591), (M = 2.52, SD = 612) and (M = 2.13, SD = 745) respectively. The results indicate that when teachers encouraged learners to use technology as a learning tool, technology was adopted. However, integrating technology through simulation fell short implying that the devices were not used at the highest levels. This is supported by teachers' responses on incorporating technology to an extent where it becomes a norm with a mean of (M = 2.64, SD = 554).

4.1.4 Technology Adoption Hypothesis Testing

In assessing the hypothesis to determine whether there is a difference or not in technology adoption according to whether a teacher is using devices or not, an analysis of covariance (ANCOVA) was performed. The results are presented below.

Analysing whether or not there is a difference in technology adoption according to whether a teacher uses devices**.** In this section, an ANCOVA analysis to test the following hypothesis was executed:

- *H0: There is no difference in the adoption according to whether a teacher is using devices or not*
- *H1: There is a difference in the adoption according to whether a teacher is using devices or not*

The ANCOVA results in Table 11 on Appendix A show that teachers who answered Yes had the highest mean (M = 2.6716, SD = 27471) and the highest variance compared to those who answered No, with the dependent variable being adoption assessment. These results imply that adoption does differ based on whether a teacher is using or not using a device. Therefore the null hypothesis (*H0*) is rejected.

4.2 RESULTS ON QUALITY OF INFORMATION & ADOPTION

4.2.1 Connectivity options used

Figure 5 shows that 90% of teachers connected to the internet using school Wi-Fi while 3.7% and less than 1% used their data and GDE-allocated sim cards, respectively.

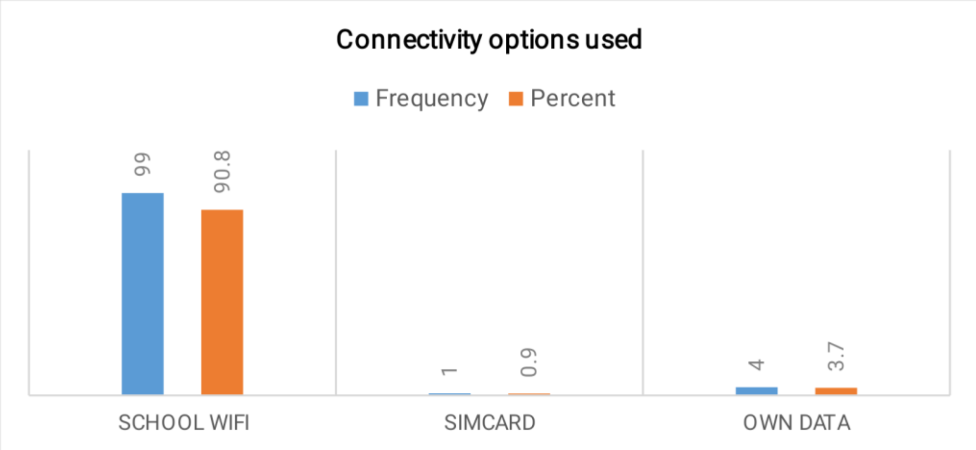

Figure 5: Connectivity options

4.2.2 Programs used on the devices

Figure 6 shows that out of the 97 responses, 60 teachers (55%) confirmed that to use e-books, 14 at 12.8% were using the internet, 10 at 9.2% using PowerPoint, 9 at 8.3% used a teacher's guide and 4 at 3.7% were using the Microsoft Word and Excel programs from the devices. As depicted in figure 6, content in the form of e-books and study guides were some of the items used by teachers.

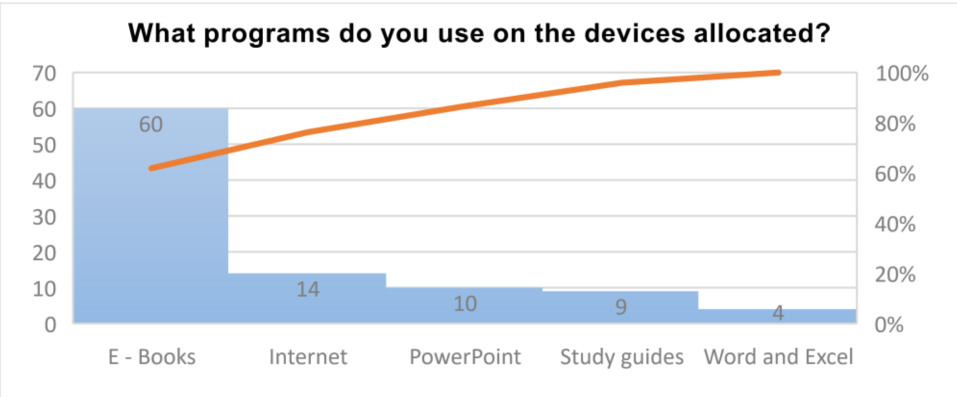

Figure 6: Program used on the devices

4.2.3 Quality of Information Inferential Analysis

ANCOVA analysis was used to assess whether the quality of information on devices affects the adoption of digital devices. This assessment was done to adjust the sample for the quality of information variable as this could affect the dependent variable. The results are depicted in Table 11 (Appendix A). Technology adoption has been stated as the dependent variable while a question concerning the utility of teachers using the devices in their environment has been noted as a fixed factor (independent variable). The quality of information assessment variable has been stated as the covariate. Based on the results in Table 9, it can be concluded that quality of information assessment does significantly adjust the association between whether teachers are using the devices in school as well as the adoption thereof, which is represented by ($F(1) = 62.217$, $p < .01$). Furthermore, at a confidence level of 95%, the results show that there is a significant difference between teachers that are using the devices as well as those who do not ($F(2, 87) = 4.334$, $p = .040$). Additionally, observations demonstrate a change in the means after adjustment. The results are depicted in Table 12 in Appendix A.

4.2.4 Quality of information Hypothesis Testing

Table 13 on Appendix A indicates that the teachers that answered No saw an increase in the mean (*M* = 2.414, *SE* = .121), while those that answered Yes saw a decrease in their means after adjusting for quality of information assessment (*M* = 2.670, *SE = .023).* Based on these results, the null hypothesis (*H0*) is rejected. It is concluded that technology adoption differs based on whether teachers use the devices within their environments, even after adjusting the sample for the quality of information assessment variable.

4.2.5 List of subjects migrated to technology devices

Table 2 illustrates the different subjects that migrated to technology. The subjects which have the highest migration include Languages (18%), Mathematics (12%), and CAT/Technology (12%). The subjects with the least migration to ICT are Creative arts and Tourism which had 1%, and Consumer Science, which had 2%. Notably, some teachers (8%) responded that all the subjects had migrated to ICT.

4.3 RESULTS OF TECHNOLOGY ADOPTION & PERFORMANCE

4.3.1 Trends in academic performance

Secondary data for the selected Gauteng schools was obtained from the DBE website and arranged in excel to analyse the movement between 2014 and 2022. The results are depicted in Table 2. The period from 2014 to 2017 (prior technology) indicates an average increase of 8.6% in 2015, 3.53% in 2016, and a decrease of 1.29% in 2017. The period from 2018 to 2022 (with technology) shows an average increase of 1.68%, 0.15%, -4.70%, 1.53% and 0.73%, respectively, over the years. The results do not demonstrate a consistent decrease or increase but fluctuate between the period where technology was used and the period without technology. Notably, a significant decrease of 4.70% in academic performance in 2020 was observed. The decrease could be explained by the disruption of schools in 2020 due to the COVID-19 shutdown. In addition, from the 15 schools sampled, it was observed that only four (4) schools either maintained or saw an increase in academic performance in the same year. These results are depicted in Table 19 (Appendix A). Based on the analysis, the secondary data does support the statistical analysis in that other factors impact academic achievements.

Table 2: Historical Grade 12 academic results in averages

Year	Yearly Average	Change
2014	77,65	-
2015	85,71	8,06
2016	89,23	3,53
2017	87,94	-1,29
2018	89,62	1,68
2019	89,77	0,15
2020	85,07	-4,70
2021	86,61	1,53
2022	87,33	0,73

Sources: (DBE, 2016, 2018, 2021, 2022)

4.3.2 Normality test

Findings from a normality test on the perceived performance variable indicate that it is not normally distributed. However, in multiple linear regression, normality does not significantly impact the results (Figure 8). Especially since the data are cross-sectional, even so, the homoscedasticity assumptions, which require the residual plot to fall below the value of three for both the standardised residual and the predicted value, are met, as presented in (Figure 9) on perceived performance below. Homoscedasticity refers to whether the residuals concerning our dependent variables are equally distributed. In this case, the assumption has been met.

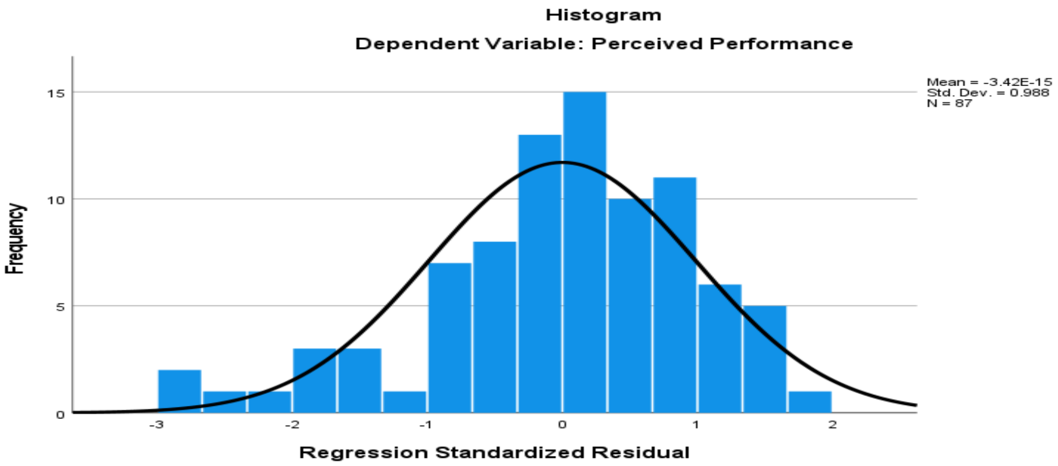

Figure 7: Histogram Perceived Performance

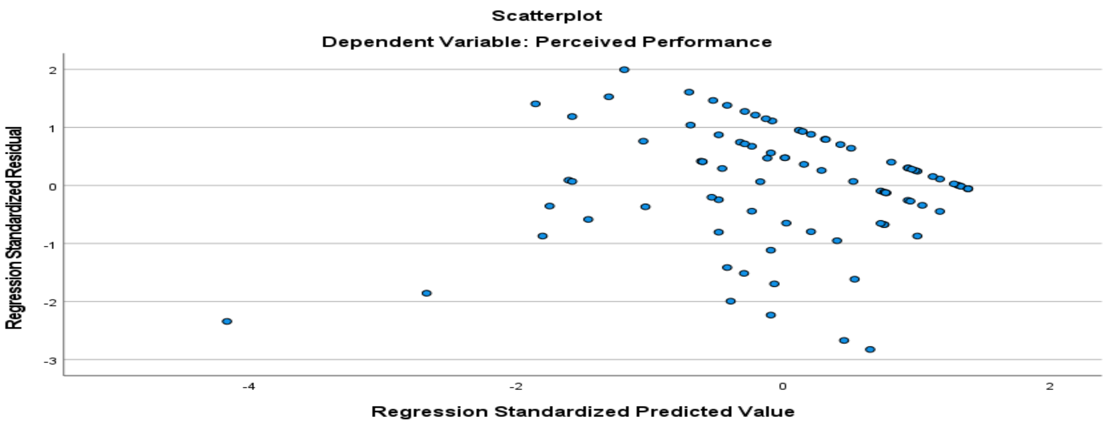

Figure 8: Homoscedasticity Perceived Performance

4.3.3 Factors that influence academic performance

Multiple linear regression was conducted to test whether the independent variables (Technology Adoption and Challenges in integrating Technology) impact the dependent variable (Perceived academic performance). The null and alternative hypotheses are identified as follows:

- *H0a: Challenges in integrating technology have no impact on perceived academic performance.*
- *H0b: Technology Adoption Assessment has no impact on perceived academic performance.*
- *H1a: Challenges in integrating technology have an impact on perceived academic performance.*
- *H1b: Technology Adoption Assessment has an impact on perceived academic performance.*

To evaluate whether perceived challenges, as well as technology adoption assessment, impact or influence on perceived academic performance. A perceived academic performance assessment variable was computed via a factor analysis. The results from the factor analysis showing patterns amongst components are presented in Table 14. The results from component two were computed into a perceived academic performance variable. Since a factor analysis was used, the variable complies with construct validity. This is further supported by a Cronbach's alpha test that confirms the reliability of the variable performed. The result in Table 15 (Appendix A) indicates a reliable result where (α = .810, n = 6). Furthermore, an analysis of the means and standard deviation of the three variables was performed. Results are displayed in Table 16 and demonstrate that perceived academic performance had the highest mean (M = 2.6874, SD = 3.7840), while challenges of integrating technology showed the highest variance.

4.3.4 Impact on Perceived Performance Hypothesis testing

Table 17 (Appendix A) shows results from the MLR at a 95% confidence interval (F (2, 84) = 27.261, p <.01, R2 = .379). The Adjusted R Square of .379 means the independent variables can explain 37.9% of the variance in perceived academic performance, which is considered as significant in social research. These results, therefore, demonstrate other factors which will impact perceived academic performance that does not form part of this study. Moreover, a coefficient of regression analysis was performed. The results in Table 18 (Appendix A) indicate that adoption was the most significant contributor in terms of predicting perceived academic performance ($\beta = .825$, $t = 7.036$, $p<.01$). Challenges in integration technology predicted performance ($\beta = .069$, $t = 884$, $p=.379$). This implies that on average, for every one (1) increase in adoption assessment, perceived academic performance increased by 82.5%. Challenges of integrating technology proved to be statistically insignificant, although it still explained that on average, for every one (1) challenge in integration addressed, perceived performance increased by 69%. Therefore, based on these results above, it can be concluded that the null hypothesis (*H0a*) is accepted and the null hypothesis (*H0b*) is rejected. Consequently, the technology adoption assessment does have an impact concerning perceived academic performance.

4.4 CHALLENGES IN TECHNOLOGY INTEGRATION

The following section presents a narrative of the challenges associated with technology integration in Gauteng schools.

4.4.1 Inferential analysis of Challenges in Technology Integration

A ranking scale on the identified challenges variable was performed to identify the most significant challenges associated with integrating technology devices in schools, (Table 3). 11 challenges were identified. The top three (3) challenges for integrating technology which reflected the highest means were; devices not used for the intended purpose ($M = 2.42$, $SD = .756$), theft of devices ($M = 2.36$, $SD = .730$) and availability of effective instructional software ($M = 2.32$, $SD = .668$). Insufficient training/lack of training and ability to integrate technology in teaching and learning were the challenges rated low by the respondents with means at ($M = 1.98$, $SD = .758$) and ($M = 2.22$, $SD = .791$), respectively. These are challenges perceived by teachers to impact the integration of technology negatively.

Table 3: Challenges in integrating technology

	Mean	Std. Deviation	N	Ranking
C1 - Availability of technology for teaching and learning in the classroom.	2.23	.810	81	7
C2 - Availability of technical support to effectively use instructional technology in the teaching/ learning process.	2.23	.810	81	7
C3 - Enough time to develop lessons that use technology.	2.25	.783	81	6
C4 - Scheduling enough time for learners to use the Internet, computers, or other technology in the teaching/learning process.	2.27	.775	81	5
C5 - Internet availability / Network connectivity	2.28	.794	81	4
C6 - Availability of effective instructional software for the courses I teach.	2.32	.668	81	3
C7 - My ability to integrate technology in the teaching/learning process.	2.22	.791	81	8
C8 - Administrative support for integration of technology in the teaching/learning process.	2.23	.779	81	7
C9 - Insufficient / Lack of training	1.98	.758	81	9
C10 - Theft of devices	2.36	.730	81	2
C11 - Devices not used for intended purpose	2.42	.756	81	1

4.4.2 Measures to improve academics

An analysis of the measures that can be implemented to continuously improve academics through technology integration in schools indicated training (30%) as one of the key measures (Figure 7). A closer analysis of the responses indicated that keywords “continuous training or more training” were used in the statements. Other measures which were suggested include the provision of technical support at (10%), improvement of internet speed at (9%) and increasing device availability at (9%) amongst other factors. It is also important to note that 19% of the respondents did not suggest any measures for improving academic performance through technology.

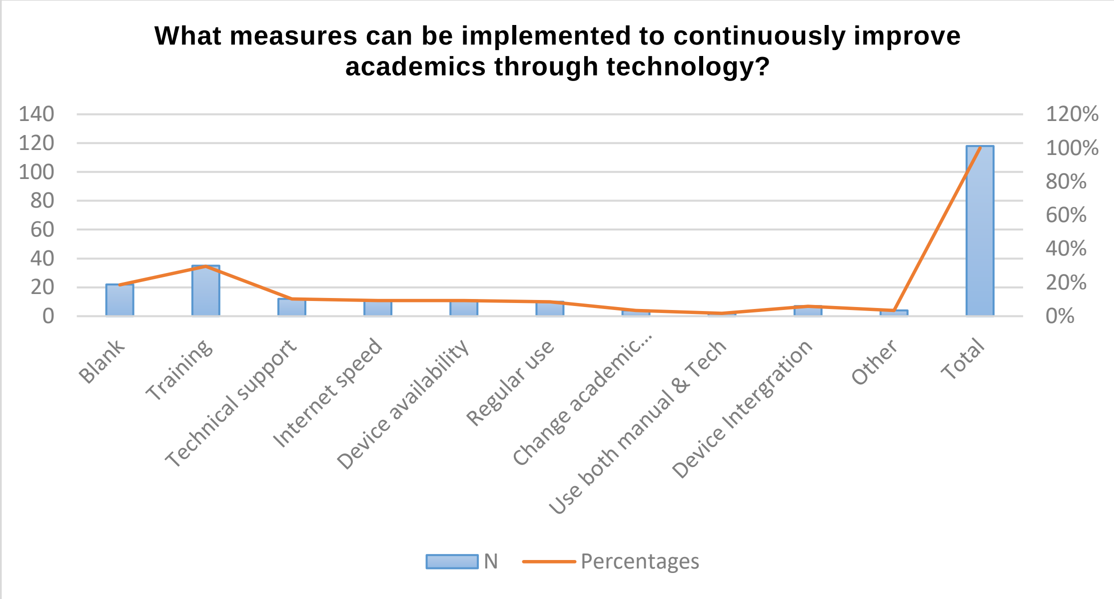

Figure 7: Measures to improve academics

4.5 SUMMARY OF STATISTICAL RESULTS

The purpose of this chapter was to analyse the findings derived from the data collection instrument. Firstly, the required reliability and correlation tests to confirm validity presented in chapter 3 were performed. All the variables complied with inter-rater reliability, and most items in the scales were valid. Secondly, when addressing the first set of hypotheses, it was found that technology adoption assessment differed based on whether a teacher used technology devices in their setting. The results also illustrated that the quality of information assessment proved to have a significant influence in this regard. The outcome of the hypotheses tests is summarised in Table 4.

Furthermore, it was confirmed through the analysis that there was a causal relationship between technology adoption assessment and the challenges concerning technology integration on perceived academic performance. The result indicated that only the technology adoption assessment significantly influenced perceived academic performance. While the historical Grade 12 results demonstrated inconsistencies, the outcome was consistent with the statistics results supporting the notion that other factors may impact performance. The results will now be used as part of the discussion in the next chapter.

Table 4: Summary of hypothesis testing

Research Question Number #	Research Question	Hypothesis Reference	Hypothesis	Outcome of Hypothesis
i)	To what extent have teachers adopted digital devices in Gauteng schools?	*H0*	*There is no difference in the Adoption of technology according to whether a teacher is using devices or not*	Rejected
		H1	*There is a difference in the Adoption of technology according to whether a teacher is using devices or not*	Accepted
ii)	Does the quality of information on devices affect the adoption of digital devices in Gauteng schools?	*H0*	*There is no difference in the Adoption of technology according to whether a teacher is using devices or not*	Rejected
		H1	*There is a difference in the Adoption of technology according to whether a teacher is using devices or not*	Accepted
iii)	How does the adoption of digital devices affect Grade 12 academic achievements?	*H0b*	*Technology Adoption has no impact on perceived academic performance.*	Rejected
		H1b	*Technology Adoption has an impact on perceived academic performance.*	Accepted
iv)	What challenges need to be addressed to improve adoption of digital devices in Gauteng schools?	*H0a*	*Challenges in integrating technology have no impact on perceived academic performance.*	Accepted

CHAPTER 5. DISCUSSION OF RESULTS AND FINDINGS

This chapter contains a discussion of the research. The purpose of the study is to evaluate the effect of digital devices used by teachers on Grade 12 academic achievements in Gauteng public schools. The results discussed are presented in the context of this study supported by literature and findings from chapters 2 and 4.

5 INTRODUCTION

The DeLone and McLean Model was adopted in this study. This model suggests that the quality of information influences user adoption of the technology, consequently impacting positively organisational performance. In this study, the technology devices and the related content loaded on devices such as e-Books, teachers' guides, previous papers and memos are understood to be the quality of information. Teachers represent people adopting the technology in their environment. Adoption will impact organisation performance, measured by the Grade 12 academic results. The analysis from the technology adoption assessment, quality of information assessment, and challenges of adoption assessment were used to respond to the research questions while aligning with the model adopted.

Furthermore, since academic results were secondary data and did not form part of the research questionnaire distributed, a perceived academic performance variable was constructed considering the components relating to the quality of information variable. As a result, historical Grade 12 academic results for sample schools support the statistical results reported. The discussion is structured in line with the research questions.

5.1 DISCUSSION ON TECHNOLOGY ADOPTION

The Gauteng province can be regarded as a modern province due to its composition of urban areas compared to other provinces that may have schools in rural areas. It is then assumed that schools in Gauteng would have moved with the times and embraced technology in teaching and learning. In that breadth, the first research question evaluates the extent to which teachers have adopted digital devices in Gauteng schools.

The results indicated that many teachers (77%) were using technology devices in schools and this suggests that the GDE has allocated various schools devices to facilitate teaching and learning. This aligns with an observation that states that as technology progresses, more technology is made available (Botha *et al*., 2017; Ghavifekr & Rosdy, 2015, as cited in Lekgothoane, 2021). Comparably Mwapwele *et al*. (2019) found that 94% of teachers and learners in 24 rural schools had received tablets. This is consistent with findings by Botha *et al*. (2017), contending that teachers had become implementers of technology in classrooms.

Similarly, Liang *et al*. (2005) assertion is confirmed as sampled schools met the six (6) prescripts of the digital classroom environment. The schools used smartboards, laptops and tablets, with 90% of teachers connecting using school Wi-Fi. Although in some schools, teachers cited the need to install smartboards in all classrooms, the frequencies on devices and network connectivity were favourable. This is in line with findings by Kotrlik and Redmann (2009) that teachers had adopted technology and encouraged learners to use technology as a tool for learning.

Concerningly, the integration of devices fell short, which prevented teachers from using technology to its maximum (Kotrlik & Redmann, 2009), in evaluating the hypotheses that states that *there is or there is no difference in Adoption according to whether a teacher is using devices or not*. The study confirmed a difference in technology adoption according to whether a teacher uses devices. This aligns with Mathipa and Mukhari (2014) arguing that the use and adoption of technology for teaching and learning depend on teachers, who are regarded as change agents. Moreover, the scholars reflect a general view of the high technology uptake in schools. However, the study of (Granić, 2022; Yakubu & Dasuk, 2018) suggests that the impact of adopting technology on academics should be explored, especially at an organisational level. This is also underpinned by the DeLone and McLean model adopted.

5.2 DISCUSSION ON QUALITY OF INFORMATION & ADOPTION

The results demonstrate that the quality of information assessment significantly adjusts when determining whether a teacher uses a device. This could be attributed to the notion that teachers who have adopted devices are already use technology in their environment. Transparent processes exist to resolve quality of information issues, as a result, adoption may not be affected. In essence, the quality of information loaded on devices may not affect teachers not using devices; hence this will not affect adoption. Yakubu and Dasuk (2018) used the DeLone and McLean model to assess technology user intention and user satisfaction. However, the impact part of the model has not covered the results yielded a complimentary conclusions. Granić (2022) further supported this even though a different model was used. Both studies confirmed that ease of use and system quality did not affect technology adoption. According to Meyer & Gent (2016), this is a consistent result as they assert that several factors should be considered when evaluating technology adoption. In this study, it can be concluded that technology adoption differs based on whether teachers use the devices within their environments. This is observed when factoring in the quality of information variable.

5.3 DISCUSSION ON ADOPTION & IMPACT ON PERFORMANCE

In Gauteng schools, technologies have been introduced to encourage the use of technology to improve education outcomes, particularly academic achievement (GDE, n.d.). Through the DeLone and McLean Model, there is an assumption that where teachers have adopted technology in schools, there is a chance for a positive impact on academic achievements. Although this is the case, it is also clear that technology's impacts on academics cannot be studied in isolation. As a result, it is understood that several factors contribute to teaching and learning in the classroom. This aligns with studies by (Royer *et al*., 1994; Salerno, 1995; Brush, 1997; Hecht *et al*., 1995; Farrell, 1996; Shyu, 1999; as cited in Li & Ma, 2010) that explored the impact of technology adoption, specifically on mathematics from lower grades to Grade 12. The findings revealed that the effect of technology on teaching and learning could be impacted by more factors such as learners' gender, teaching methods, learner ability and leaner group composition (Royer *et al*., 1994; Salerno, 1995; Brush, 1997; Hecht *et al*., 1995; Farrell, 1996; Shyu, 1999; as cited in Li & Ma, 2010). The results in answering whether or not technology adoption has an impact on perceived academic performance reveal that technology adoption has an impact on perceived academic performance. This supports the DeLone and McLean model view that where users adopt technology, there is a positive impact on the institution (Bichler *et al*., 2016). There is however a difference in that the quality of information impact technology adoption. While in this study, the element that teachers had already embraced technology in the respective institutions helps to explain the viewpoint. The historical averages of Grade 12 results assessed demonstrate no consistent increase or decrease in performance percentages.

Contrary to the study of Li and Ma (2010), when evaluating the effect of technology using the meta-analysis technique, learners using technology achieved better than those not using technology in mathematics, asserting that technology adoption impacts performance. The sharp decrease in 2020 could have been attributed to the devastating COVID-19 pandemic that affected the regular school calendar and brought all schools to a standstill. The introduction of technology in Gauteng schools was meant to replace chalkboards and hard-copy books. However, as findings from this study have demonstrated the integration of devices fell short, preventing teachers from using technology to its maximum. This suggests that teachers were still expected to facilitate the technology devices in classrooms, almost like using chalkboards and hard-copy books.

The shortages of technology, coupled with the disruption and abrupt shutdown faced by schools during the COVID-19 pandemic, resulted in Grade 12 academic results regressing, Sintema (2020) suggested. According to DBE (2021), there was an increase in the use of online technologies during the COVID-19 lockdown, which suggests that without the available technology, the decrease in performance could have been worse. The increase in technology adoption through online resources and technology devices cushioned further decline in performance as some teaching and learning were salvaged.

5.4 DISCUSSION ON CHALLENGES OF INTEGRATING TECHNOLOGY

The last research question aimed at identifying the challenges associated with digital devices in Gauteng schools; the top three (3) challenges for integrating technology were; devices not used for the intended purpose, theft of devices and availability of effective instructional software. The challenges rated low by participants are need for more training/lack of training, and the ability to integrate technology in teaching and learning. This aligns with findings from Matwadia (2018), who identified devices not used for the intended purpose, theft of devices and availability of effective instructional software as challenges in a similar study. Learner discipline where devices are not used for their intended will require attention. Theft of devices will render the project unsustainable due to high replacement costs. At the same time, failure to introduce effective instructional software will impact the overall technology integration.

Lekgothoane (2021) study identified the training of teachers as one of the top challenges that affected technology integration in schools. This contrasts the findings in this study that indicate insufficient training/lack of training as the least rated challenge. Teachers cited requiring “continuous training or more training”, and this demonstrates that training was offered, but more can still be done. As Buckenmeyer (2010) suggested in addressing teachers’ professional development, training can be less formal to allow teachers to adopt a trial-and-error approach. The Gauteng province exhibits evidence of maturity compared to the challenges stated by Lekgothoane (2021) in Limpopo. The fundamental challenges of technology accessibility and network connectivity were no longer seen as problems. The statistics results of challenges on integration technology impacting perceived performance were not significant when compared with technology adoption. However, addressing challenges in integration was likely to contribute to perceived performance. This supports the findings by scholars (Wenglinsky, 1998 as cited in Irving 2006; Harris & Al-Bataineh, 2015; Donovan, Hartley & Strudler, 2007; Rogers, 2003; Howkins, 2002; Tiene, 2004; Pelgrams, 2001; Rodrigo, 2005 as cited in Richardson, 2011) that challenges in integration technology may hamper the implementation and objectives of roll out of technology in schools.

5.5 CONCLUSION ON DISCUSSION OF RESULTS AND FINDINGS

This chapter aimed to discuss the results and findings reported in chapter four (4) concerning the research questions and hypothesis. Findings from this study have to align with the DeLone and McLean Model and findings from other similar research studies. Technology has been adopted mainly in Gauteng schools; however, integrating of devices for maximum benefit remains a concern. When evaluating the result on performance, it can be concluded that technology adoption impacts perceived academic performance. However, if challenges are left unresolved, adoption could negatively impact academic performance.

CHAPTER 6. CONCLUSION AND RECOMMENDATIONS

6 INTRODUCTION

The study focused on evaluating the influence of digital devices used by teachers on Grade 12 learners' academic achievements in Gauteng public schools. This was triggered by continuous significant investment in technology by the Gauteng government. Technology in schools was introduced in 2015 to enhance teaching quality and improve education outcomes, particularly academic achievements (GDE, n.d.). In addition, grade 12 results are generally celebrated nationally. Therefore there was a need to evaluate whether the technology implementation yielded positive results impacting academic achievements initially envisioned by GDE. Teachers provided their insights on each school's technology devices, connectivity, programs and content. Teachers' feedback included the number of years devices have been used, perception of the level of technology adoption, the quality of information on devices and the challenges experienced in utilising technology devices. This chapter summarises of the findings (conclusions) relating to the research question and hypothesis set out in this study. The chapter ends with a presentation of the recommendations, research implications and suggestions for future research.

6.1 CONCLUSIONS

The following section presents a narrative and conclusions of the significant findings.

6.1.1 IMPORTANCE OF TECHNOLOGY ADOPTION

Technology in education can be regarded as an essential component of school development. The Gauteng province has intentionally responded to the DBE's E-education initiative. The massive investments over the years are a testament. Technology devices such as smartboards, laptops, and tablets are primarily used at schools, and all schools devices are loaded with content based on teachers' and learners' subject choices. The observations are consistent with conclusions reached by other researchers.

In conclusion, the result of the analysis is supported by the extent of technology adoption was further accelerated by the COVID-19 adoption across many industries. Teachers have primarily adopted technology devices in Gauteng schools, and over 96% of teachers are confirmed to be using devices. However, the integration of devices fell short, which prevented teachers from using technology to its maximum. The lack of technology integration could reduce the impact technology adoption may present on academic performance.

6.1.2 SIGNIFICANCE OF QUALITY OF INFORMATION ON ADOPTION

The quality of the information in this study represents the related content loaded on devices such as e-books, teacher's guides, previous papers and memos, amongst others. Quality of information was assessed, considering whether teachers are using devices or not to determine the impact on adoption. Observations revealed that the quality of information assessment proved to have a significant influence on technology adoption; however this did not influence adoption for teachers already using devices. In conclusion, technology adoption differs based on whether teachers use the devices within their environments, even after adjusting the sample for the quality of information assessment variable. This confirms the notion by scholars in similar studies that the quality of information determines the actual usage of technology.

6.1.3 IMPACT OF TECHNOLOGY ON ACADEMIC ACHIEVEMENTS

In line with the initial objective of the GDE, the adoption of technology in schools is meant to impact academic achievements positively. There is an agreement among researchers that many factors should be considered to assess the impact of technology adoption on academic achievements. The observations in this study suggest a similar notion. The statistics results affirm DeLone and McLean's model that where users adopt technology, there is a positive impact on the institution. Although historical Grade 12 results reveal an erratic movement in academic achievement, the decrease in academic performance for 2020 affected by COVID-19 demonstrates that more factors contribute to academic performance. In conclusion, teachers at schools have adopted technology and technology adoption proved to improve performance in academics significantly. Correcting technology integration to facilitate online lessons and assessments will likely to provide a more significant impact.

6.1.4 ASSESSING THE CHALLENGES IN TECHNOLOGY ADOPTION

Adopting and integrating technology in teaching and learning brings about varying challenges. These challenges can interfere with the objectives set by GDE of improving academic results, enhancing teaching quality, providing access to learning material and improving learner engagement.

The challenges identified in similar studies covered:

1) Failure to prioritise users' needs by excluding teachers
2) Funding for ensuring continuous implementation
3) Alignment of academic outcome to technology implementation initiatives
4) Sustaining the integration of technology.

Other challenges experienced at ground level by teachers and learners were managing theft of the devices, ensuring devices are used for the intended purpose, availability of effective instructional software and ensuring internet availability or network connectivity.

The need for more training/lack of training and the ability to integrate technology in teaching and learning were the challenges rated low by the teachers. This is inconsistent with observations in other studies, although teachers still highlight continuous training as an area of improvement, this explains that the GDE has successfully addressed basic device training needs for teachers. Interestingly, the observations demonstrate that challenges in integrating technology have not impacted perceived academic performance. However, these remain important and should be addressed. The first 2 challenges impact the GDE financially as the replacement of devices will be more frequent; this could threaten the program's sustainability. The availability of effective instructional software could enhance the integration of devices, improving the quality of teaching.

6.2 LIMITATIONS OF THE STUDY

The limitations of this research are as follows;

i. School selection was limited to those within the proximity of the researcher due to time and resource constraints. However, the majority of the districts were covered in the sample.
ii. Teacher participation was limited to Grade 12 teachers to gather specific insights.
iii. Academic performance was strictly assessed at the school level and did not evaluate individual learner performance.

6.3 RECOMMENDATIONS

Technology as a tool should improve the way of doing things irrespective of the industry the said technology is being implemented. In the context of GDE, its aim will be centred around enhancing quality of teaching and improving education outcomes. Huge investments by GDE towards the integration of technology in schools are notable. To successfully realise the impact, the department should develop a framework to assess the impact on technology integration. There is a greater need for policymakers to develop a framework that will consider key factors that influence academic performance. Technology adoption is visible as confirmed by the number of teachers using technology in schools. The goal should be to move from utilising technology to replacing the chalkboard and physical textbooks to full integration that enables teacher and learner devices to integrate and allow online facilitation of lessons and assessments.

The top three challenges in integrating technology that require immediate attention are: devices not used for the intended purposes, theft of devices and availability of effective instructional software. Through the introduction of tools (e.g. instructional software), the department can enable the integrations in this regard. Success will be evident when teachers and learners use technology daily to create lessons and assignments and complete classwork demonstrating deep understanding and comprehension of the subject or lesson. This further calls for a change in the assessment framework to clearly outline how technology can be aligned enhance academic achievements.

Sustaining device usage in schools can be achieved through continuous training of teachers on the use of devices as technology changes. To ensure devices are used for intended purposes, the department should restrict content to only educational resources and have monitoring tools to detect non-compliance for correction. Technology continuously changes every aspect of different industries and the education sector cannot be immune. COVID-19, as a test, demonstrates that a paradigm shift has occurred, which will require adopting new technologies at a much faster pace. The department should be prepared to modernize technology devices in this regard in order to align with new technological developments.

6.4 IMPLICATIONS OF THE RESEARCH

The findings in this study revealed the possible impact of technology adoption in Gauteng schools. The results indicate that teachers are open to using technology to a large extent. In addition, technology integration emerges as a barrier that could affect the GDE’s course of enhancing teaching quality. This will derail the national goal of taking advantage of technological developments to improve academic achievements. In that breath, the following recommendations are provided:

i. At institutions of high learning, the emphasis should be on training the teacher of the future. The e-learning technology should be formally integrated into the teacher training and development programme at institutions of high learning. This will prepare new teachers to use technology before joining the school environment.

ii. In line with the e-Education strategies defined in White paper No. 7 on e-Education (1896/2004) the DBE and GDE should clearly outline how technology can be aligned to enhance academic achievements. This will inform a change in assessment frameworks and outline other factors that impact academic performance. Voogt *et al.* (2013) state that many countries ignored changing curricula. Although monitoring the impact of ICT on learner achievement was defined in the White paper, it is not clear how the department has been tracking and monitoring implementation.

iii. To aid technology integration, the focus could be on human and social sciences subjects that offer the kind of perspective required to embrace technological advancements such as science, technology, robotics, engineering and mathematics (STREM). This will enforce integration, eliminating a mere replacement of the chalkboard and hard-copy text books. Although teachers used the technology, the results lacked full integration.

iv. There should be capacity building through the provision of sufficient technological equipment and training of teachers. Continuously upskilling teachers already in the education system as new technologies are introduced with refresher training to keep teachers updated with the latest technologies.

6.5 SUGGESTIONS FOR FURTHER RESEARCH

Technology advancements are accelerating as everyday life or tasks involve technology. The GDE, through its continued massive investment in technology at schools, demonstrate the intent of staying abreast with technological advancements. Similarly, education policies and practices cannot remain the same, especially when technology is introduced to improve academic performance. This brings about new research to be explored and uncovered by this study.

Possible proposals are as follows:

i. To explore the factors that impact academic achievements where technology exists. This could direct the development of the framework outlining how technology can be aligned to enhance academic achievements.

ii. An experimental study compared performance in a smaller group of high-performing learners using devices and those not in Gauteng schools.

iii. Further research on the impact on financials uncovering the project's benefits concerning investments.

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APPENDIX A

Table 5: List of subjects migrated to technology devices

List applicable subject	N	Percentages (%)
CAT / Technology	24	12%
Physical sciences	15	8%
Natural sciences	6	3%
Mathematics	24	12%
Languages	32	16%
Life sciences	16	8%
Geography	12	6%
History	7	4%
Business studies	13	7%
Accounting	10	5%
Economics	5	3%
Creative arts	1	1%
Consumer studies	4	2%
Life orientation	13	7%
Tourism	2	1%
All subjects	15	8%
Total	**199**	**100%**

Table 6: Correlations - Technology Adoption (TA) Assessment

Correlations																
Technology Adoption (TA) Assessment			**TA1**	**TA2**	**TA3**	**TA4**	**TA5**	**TA6**	**TA7**	**TA8**	**TA9**	**TA10**	**TA11**	**TA12**	**TA13**	**TA14**
Spearman's rho	I have made physical changes to accommodate technology in my classroom.	Correlation Coefficient	1,000	0,181	.260*	0,062	0,162	.218*	.226*	.223*	.273**	.329**	0,183	0,083	0,186	0,127
		Sig. (2-tailed)		0,088	0,012	0,562	0,123	0,040	0,032	0,037	0,010	0,002	0,085	0,443	0,081	0,235
		N	92	90	92	91	92	89	91	88	89	90	90	88	89	89
	I emphasise the use of technology as a learning tool in my classroom.	Correlation Coefficient	0,181	1,000	.267*	.491**	.349**	.456**	0,191	0,110	0,164	.305**	.274**	.357**	.265*	.212*
		Sig. (2-tailed)	0,088		0,011	0,000	0,001	0,000	0,071	0,306	0,127	0,003	0,009	0,001	0,013	0,046
		N	90	91	91	91	91	89	90	88	88	90	89	88	88	89
	I expect my learners to use technology so they can take on new challenges beyond traditional assignments and activities.	Correlation Coefficient	.260*	.267*	1,000	0,163	0,135	.333**	0,019	.318**	.273**	.348**	0,142	0,060	.340**	.240*
		Sig. (2-tailed)	0,012	0,011		0,120	0,198	0,001	0,856	0,002	0,009	0,001	0,181	0,579	0,001	0,023
		N	92	91	93	92	93	90	92	89	90	91	91	89	90	90
	I expect my learners to fully understand the unique role that technology plays in their education.	Correlation Coefficient	0,062	.491**	0,163	1,000	.426**	.400**	0,063	-0,024	-0,041	0,154	.336**	.450**	0,165	-0,039
		Sig. (2-tailed)	0,562	0,000	0,120		0,000	0,000	0,554	0,820	0,703	0,146	0,001	0,000	0,123	0,716
		N	91	91	92	92	92	90	91	89	89	91	90	89	89	90
	I discuss with learners how they can use technology as a learning tool.	Correlation Coefficient	0,162	.349**	0,135	.426**	1,000	.409**	0,132	0,168	0,064	.209*	0,129	.379**	.331**	0,193
		Sig. (2-tailed)	0,123	0,001	0,198	0,000		0,000	0,210	0,116	0,549	0,047	0,223	0,000	0,001	0,069
		N	92	91	93	92	93	90	92	89	90	91	91	89	90	90
	I expect my learners to use technology to enable them to be self-directed (take own initiative in learning) learners	Correlation Coefficient	.218*	.456**	.333**	.400**	.409**	1,000	0,071	.233*	0,152	.320**	0,163	.310**	.236*	0,019
		Sig. (2-tailed)	0,040	0,000	0,001	0,000	0,000		0,507	0,029	0,158	0,002	0,126	0,003	0,027	0,863
		N	89	89	90	90	90	90	90	88	88	90	89	88	88	89
	I design learning activities that result in my learners being comfortable using technology in their learning.	Correlation Coefficient	.226*	0,191	0,019	0,063	0,132	0,071	1,000	.211*	.397**	.302**	0,092	0,188	.236*	0,166
		Sig. (2-tailed)	0,032	0,071	0,856	0,554	0,210	0,507		0,048	0,000	0,004	0,385	0,078	0,025	0,118
		N	91	90	92	91	92	90	92	89	90	91	91	89	90	90
	I expect learners to use technology to such an extent that they develop projects that are of a higher quality level than would be possible without them using technology.	Correlation Coefficient	.223*	0,110	.318**	-0,024	0,168	.233*	.211*	1,000	.345**	0,140	0,020	0,121	.390**	.333**
		Sig. (2-tailed)	0,037	0,306	0,002	0,820	0,116	0,029	0,048		0,001	0,190	0,853	0,260	0,000	0,002
		N	88	88	89	89	89	88	89	89	88	89	89	89	88	88
	I regularly pursue innovative ways to incorporate technology into the learning process for my learners.	Correlation Coefficient	.273**	0,164	.273**	-0,041	0,064	0,152	.397**	.345**	1,000	.389**	.255*	0,104	.367**	.347**
		Sig. (2-tailed)	0,010	0,127	0,009	0,703	0,549	0,158	0,000	0,001		0,000	0,015	0,336	0,000	0,001
		N	89	88	90	89	90	88	90	88	90	89	90	88	88	88
	I incorporate technology in my teaching to such an extent that it has become a standard learning tool for my learners.	Correlation Coefficient	.329**	.305**	.348**	0,154	.209*	.320**	.302**	0,140	.389**	1,000	.255*	.281**	.421**	0,163
		Sig. (2-tailed)	0,002	0,003	0,001	0,146	0,047	0,002	0,004	0,190	0,000		0,015	0,008	0,000	0,126
		N	90	90	91	91	91	90	91	89	89	91	90	89	89	90
	I am more of a facilitator of learning than the source of all information because my learners use technology.	Correlation Coefficient	0,183	.274**	0,142	.336**	0,129	0,163	0,092	0,020	.255*	.255*	1,000	.399**	0,161	0,150
		Sig. (2-tailed)	0,085	0,009	0,181	0,001	0,223	0,126	0,385	0,853	0,015	0,015		0,000	0,133	0,162
		N	90	89	91	90	91	89	91	89	90	90	91	89	89	89
	I use technology to encourage learners to share the responsibility for their own learning.	Correlation Coefficient	0,083	.357**	0,060	.450**	.379**	.310**	0,188	0,121	0,104	.281**	.399**	1,000	.210*	0,051
		Sig. (2-tailed)	0,443	0,001	0,579	0,000	0,000	0,003	0,078	0,260	0,336	0,008	0,000		0,049	0,639
		N	88	88	89	89	89	88	89	89	88	89	89	89	88	88
	I incorporate technology in my teaching to such an extent that my learners use technology to collaborate with other learners in class during the learning process.	Correlation Coefficient	0,186	.265*	.340**	0,165	.331**	.236*	.236*	.390**	.367**	.421**	0,161	.210*	1,000	.472**
		Sig. (2-tailed)	0,081	0,013	0,001	0,123	0,001	0,027	0,025	0,000	0,000	0,000	0,133	0,049		0,000
		N	89	88	90	89	90	88	90	88	88	89	89	88	90	88
	I use technology-based games or simulations on a regular basis in my classroom.	Correlation Coefficient	0,127	.212*	.240*	-0,039	0,193	0,019	0,166	.333**	.347**	0,163	0,150	0,051	.472**	1,000
		Sig. (2-tailed)	0,235	0,046	0,023	0,716	0,069	0,863	0,118	0,002	0,001	0,126	0,162	0,639	0,000	
		N	89	89	90	90	90	89	90	88	88	90	89	88	88	90

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7: Correlations - Quality of Information (QI) Assessment

Correlations

Quality of Information (QI) Assessment			QI1	QI2	QI3	QI4	QI5	QI6	QI7	QI8	QI9	QI10	QI11	QI12	QI13	QI14
Spearman's rho	The allocated devices are easy to use for both teaching and learning.	Correlation Coefficient	1,000	.530**	0,144	.301**	.368**	.313**	.370**	.372**	.211*	.268*	0,206	.361**	.399**	.322**
		Sig. (2-tailed)		0,000	0,179	0,005	0,000	0,003	0,000	0,000	0,049	0,011	0,056	0,001	0,000	0,002
		N	89	88	89	87	88	89	88	88	88	89	87	89	88	89
	The devices allocated are flexible to integrate with other devices in the classroom.	Correlation Coefficient	.530**	1,000	.217*	.351**	.341**	.446**	.398**	.479**	.212*	.401**	0,212	.275**	.300**	0,115
		Sig. (2-tailed)	0,000		0,042	0,001	0,001	0,000	0,000	0,000	0,049	0,000	0,050	0,009	0,004	0,287
		N	88	88	88	86	87	88	87	87	87	88	86	88	88	88
	My learners have a clear and understandable interaction with the device.	Correlation Coefficient	0,144	.217*	1,000	.388**	.439**	.307**	.221*	.271*	0,201	0,204	0,027	.331**	.318**	0,177
		Sig. (2-tailed)	0,179	0,042		0,000	0,000	0,003	0,038	0,011	0,061	0,055	0,806	0,002	0,003	0,098
		N	89	88	89	87	88	89	88	88	88	89	87	89	88	89
	I have a clear and understandable interaction with the device.	Correlation Coefficient	.301**	.351**	.388**	1,000	0,192	.553**	0,152	.401**	.289**	.252*	0,162	.390**	.308**	.233*
		Sig. (2-tailed)	0,005	0,001	0,000		0,076	0,000	0,163	0,000	0,007	0,019	0,140	0,000	0,004	0,030
		N	87	86	87	87	86	87	86	86	86	87	85	87	86	87
	My learners are comfortable using the device services and functionalities.	Correlation Coefficient	.368**	.341**	.439**	0,192	1,000	.323**	.403**	.461**	.366**	.418**	.350**	.368**	.396**	.339**
		Sig. (2-tailed)	0,000	0,001	0,000	0,076		0,002	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001
		N	88	87	88	86	88	88	88	87	87	88	86	88	87	88
	I am comfortable using the device services and functionalities.	Correlation Coefficient	.313**	.446**	.307**	.553**	.323**	1,000	.446**	.504**	.319**	.399**	.296**	.459**	.583**	.363**
		Sig. (2-tailed)	0,003	0,000	0,003	0,000	0,002		0,000	0,000	0,002	0,000	0,005	0,000	0,000	0,000
		N	89	88	89	87	88	89	88	88	88	89	87	89	88	89
	The devices allocated deliver useful information for teaching and learning.	Correlation Coefficient	.370**	.398**	.221*	0,152	.403**	.446**	1,000	.364**	.380**	.452**	.238*	.384**	.484**	.302**
		Sig. (2-tailed)	0,000	0,000	0,038	0,163	0,000	0,000		0,001	0,000	0,000	0,027	0,000	0,000	0,004
		N	88	87	88	86	88	88	88	87	87	88	86	88	87	88
	The devices allocated offer exactly the knowledge required for teaching and learning.	Correlation Coefficient	.372**	.479**	.271*	.401**	.461**	.504**	.364**	1,000	.429**	.480**	.271*	.333**	.309**	0,085
		Sig. (2-tailed)	0,000	0,000	0,011	0,000	0,000	0,000	0,001		0,000	0,000	0,012	0,002	0,004	0,432
		N	88	87	88	86	87	88	87	88	87	88	86	88	87	88
	The devices allocated contain relevant and organised content for teaching and learning.	Correlation Coefficient	.211*	.212*	0,201	.289**	.366**	.319**	.380**	.429**	1,000	.606**	.420**	.260*	.251*	0,135
		Sig. (2-tailed)	0,049	0,049	0,061	0,007	0,000	0,002	0,000	0,000		0,000	0,000	0,014	0,019	0,210

	N	88	87	88	86	87	88	87	87	88	88	86	88	87	88
The devices allocated provide up-to-date information and content for teaching and learning.	Correlation Coefficient	.268*	.401**	0,204	.252*	.418**	.399**	.452**	.480**	.606**	1,000	.473**	.317**	.289**	.212*
	Sig. (2-tailed)	0,011	0,000	0,055	0,019	0,000	0,000	0,000	0,000	0,000		0,000	0,002	0,006	0,046
	N	89	88	89	87	88	89	88	88	88	89	87	89	88	89
The devices allocated accurate information for teaching and learning.	Correlation Coefficient	0,206	0,212	0,027	0,162	.350**	.296**	.238*	.271*	.420**	.473**	1,000	.423**	.396**	0,200
	Sig. (2-tailed)	0,056	0,050	0,806	0,140	0,001	0,005	0,027	0,012	0,000	0,000		0,000	0,000	0,063
	N	87	86	87	85	86	87	86	86	86	87	87	87	86	87
The integration of technology has improved my teaching.	Correlation Coefficient	.361**	.275**	.331**	.390**	.368**	.459**	.384**	.333**	.260*	.317**	.423**	1,000	.802**	.386**
	Sig. (2-tailed)	0,001	0,009	0,002	0,000	0,000	0,000	0,000	0,002	0,014	0,002	0,000		0,000	0,000
	N	89	88	89	87	88	89	88	88	88	89	87	89	88	89
The integration of technology has improved my learning for my students.	Correlation Coefficient	.399**	.300**	.318**	.308**	.396**	.583**	.484**	.309**	.251*	.289**	.396**	.802**	1,000	.475**
	Sig. (2-tailed)	0,000	0,004	0,003	0,004	0,000	0,000	0,000	0,004	0,019	0,006	0,000	0,000		0,000
	N	88	88	88	86	87	88	87	87	87	88	86	88	88	88
I have seen improvement in academics (learner results) because of integrating technology.	Correlation Coefficient	.322**	0,115	0,177	.233*	.339**	.363**	.302**	0,085	0,135	.212*	0,200	.386**	.475**	1,000
	Sig. (2-tailed)	0,002	0,287	0,098	0,030	0,001	0,000	0,004	0,432	0,210	0,046	0,063	0,000	0,000	
	N	89	88	89	87	88	89	88	88	88	89	87	89	88	89

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 8: Correlations - Challenges (C) of integration technology

Correlations													
Challenges (C) of integration technology in teaching and learning			**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**
Spearman's rho	Availability of technology for teaching and learning in the classroom.	Correlation Coefficient	1,000	.515**	.502**	.340**	.427**	.366**	.474**	.492**	0,012	-0,077	-0,005
		Sig. (2-tailed)		0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,913	0,486	0,961
		N	87	86	87	86	86	87	86	86	86	85	86
	Availability of technical support to effectively use instructional technology in the teaching/ learning process.	Correlation Coefficient	.515**	1,000	.400**	.445**	.211*	.249*	.340**	.378**	-0,097	0,033	-0,074
		Sig. (2-tailed)	0,000		0,000	0,000	0,048	0,018	0,001	0,000	0,363	0,762	0,491
		N	86	90	89	89	88	90	88	89	89	87	88
	Enough time to develop lessons that use technology.	Correlation Coefficient	.502**	.400**	1,000	.600**	.419**	.536**	.464**	.423**	0,045	0,113	-0,089
		Sig. (2-tailed)	0,000	0,000		0,000	0,000	0,000	0,000	0,000	0,674	0,294	0,408
		N	87	89	90	89	89	90	89	89	89	88	89
	Scheduling enough time for learners to use the Internet, computers, or other technology in the teaching/learning process.	Correlation Coefficient	.340**	.445**	.600**	1,000	.492**	.435**	.476**	.409**	0,017	-0,110	-0,178
		Sig. (2-tailed)	0,001	0,000	0,000		0,000	0,000	0,000	0,000	0,872	0,312	0,096
		N	86	89	89	90	88	90	89	89	88	87	88
	Internet availability / Network connectivity	Correlation Coefficient	.427**	.211*	.419**	.492**	1,000	.521**	.596**	.533**	-0,037	-0,177	-.235*
		Sig. (2-tailed)	0,000	0,048	0,000	0,000		0,000	0,000	0,000	0,732	0,100	0,028
		N	86	88	89	88	89	89	88	88	88	87	88
	Availability of effective instructional software for the courses I teach.	Correlation Coefficient	.366**	.249*	.536**	.435**	.521**	1,000	.430**	.434**	0,082	0,048	0,021
		Sig. (2-tailed)	0,000	0,018	0,000	0,000	0,000		0,000	0,000	0,444	0,657	0,846
		N	87	90	90	90	89	91	89	90	89	88	89
	My ability to integrate technology in the teaching/learning process.	Correlation Coefficient	.474**	.340**	.464**	.476**	.596**	.430**	1,000	.647**	-0,049	-0,005	-0,030
		Sig. (2-tailed)	0,000	0,001	0,000	0,000	0,000	0,000		0,000	0,649	0,960	0,781
		N	86	88	89	89	88	89	89	88	88	87	88
	Administrative support for integration of technology in the teaching/learning process.	Correlation Coefficient	.492**	.378**	.423**	.409**	.533**	.434**	.647**	1,000	-0,047	0,085	0,033
		Sig. (2-tailed)	0,000	0,000	0,000	0,000	0,000	0,000	0,000		0,664	0,432	0,758
		N	86	89	89	89	88	90	88	90	88	87	88
	Insufficient / Lack of training	Correlation Coefficient	0,012	-0,097	0,045	0,017	-0,037	0,082	-0,049	-0,047	1,000	0,196	.236*
		Sig. (2-tailed)	0,913	0,363	0,674	0,872	0,732	0,444	0,649	0,664		0,068	0,027
		N	86	89	89	88	88	89	88	88	89	87	88
	Select 1 appropriate option to each statement - Theft of devices	Correlation Coefficient	-0,077	0,033	0,113	-0,110	-0,177	0,048	-0,005	0,085	0,196	1,000	.468**
		Sig. (2-tailed)	0,486	0,762	0,294	0,312	0,100	0,657	0,960	0,432	0,068		0,000
		N	85	87	88	87	87	88	87	87	87	88	88
	Devices not used for intended purpose	Correlation Coefficient	-0,005	-0,074	-0,089	-0,178	-.235*	0,021	-0,030	0,033	.236*	.468**	1,000
		Sig. (2-tailed)	0,961	0,491	0,408	0,096	0,028	0,846	0,781	0,758	0,027	0,000	
		N	86	88	89	88	88	89	88	88	88	88	89

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 9: Univariate test on usage of technology devices at schools

Between-Subjects Factors

		Value Label	N
Are you and your learners using the technology devices in school?	1	No	3
	2	Yes	85

Table 10: Technology adoption

Item Statistics

	Mean	Std. Deviation	N
I expect my learners to use technology to enable them to be self-directed (take own initiative in learning) learners	2,86	0,387	83
I discuss with learners how they can use technology as a learning tool.	2,84	0,366	83
I use technology to encourage learners to share the responsibility for their own learning.	2,84	0,398	83
I emphasise the use of technology as a learning tool in my classroom.	2,77	0,477	83
I expect my learners to use technology so they can take on new challenges beyond traditional assignments and activities.	2,77	0,451	83
I expect my learners to fully understand the unique role that technology plays in their education.	2,76	0,508	83
I have made physical changes to accommodate technology in my classroom.	2,73	0,520	83
I design learning activities that result in my learners being comfortable using technology in their learning.	2,71	0,482	83
I regularly pursue innovative ways to incorporate technology into the learning process for my learners.	2,67	0,497	83
I incorporate technology in my teaching to such an extent that it has become a standard learning tool for my learners.	2,64	0,554	83
I expect learners to use technology to such an extent that they develop projects that are of a higher quality level than would be possible without them using technology.	2,60	0,583	83
I incorporate technology in my teaching to such an extent that my learners use technology to collaborate with other learners in class during the learning process.	2,53	0,591	83
I am more of a facilitator of learning than the source of all information because my learners use technology.	2,52	0,612	83
I use technology-based games or simulations on a regular basis in my classroom.	2,13	0,745	83

Table 11: ANCOVA statistics

Dependent Variable: Adoption Assessment

Are you and your learners using the technology devices in school?	Mean	Std. Deviation	N
No	2.3810	.25085	3
Yes	2.6716	.27471	85
Total	2.6617	.27771	88

Table 12: Tests of Between Subject effects

Dependent Variable: Adoption Assessment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.977[a]	2	1.489	33.895	<,001	.444
Intercept	2.016	1	2.016	45.898	<,001	.351
Quality information assessment	2.732	1	2.732	62.217	<,001	.423
Are you and your learners using the technology devices in school?	.190	1	.190	4.334	.040	.049
Error	3.733	85	.044			
Total	630.136	88				
Corrected Total	6.710	87				

a. R Squared = .444 (Adjusted R Squared = .431)

Table 13: Adoption Assessment (Change)

Dependent Variable

Are you and your learners using the technology devices in school?	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
No	2.414[a]	.121	2.173	2.655
Yes	2.670[a]	.023	2.625	2.716

a. Covariates appearing in the model are evaluated at the following values: Quality of Information Assessment = 2.6610.

Table 14: Factor Analysis Pattern Matrix

Pattern Matrix [a]		
	Component	
	1	2
QA1 - The allocated devices are easy to use for both teaching and learning.	.652	
QA2 - The devices allocated are flexible to integrate with other devices in the classroom.	.866	
Q3 - My learners have a clear and understandable interaction with the device.		.514
QA4 - I have a clear and understandable interaction with the device.		.506
QA5 - My learners are comfortable using the device services and functionalities.		
Q6 - I am comfortable using the device services and functionalities.		.486
QA7 - The devices allocated deliver useful information for teaching and learning.	.455	
QA8 - The devices allocated offer exactly the knowledge required for teaching and learning.	.663	
QA9 - The devices allocated contain relevant and organised content for teaching and learning.		
QA10 - The devices allocated provide up-to-date information and content for teaching and learning.		
QA11 - The devices allocated accurate information for teaching and learning.		
QA12- The integration of technology has improved my teaching.		.805
QA13 - The integration of technology has improved my learning for my students.		.843
QA14 - I have seen improvement in academics (learner results) because of integrating technology.		.696

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalisation.

a. Rotation converged in 15 iterations.

Table 15: Perceived Performance reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.810	.816	6

Table 16: Statistics Items (Adoption, Performance and Challenges)

Technology Adoption Assessment, Perceived Academic Performance and Challenges of integrating technology

	Mean	Std. Deviation	N
Perceived Academic Performance	2.6874	.37840	87
Technology Adoption Assessment	2.6610	.27926	87
Challenges of Integrating Technology	2.2764	.41977	87

Table 17: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.627[a]	.394	.379	.29815

a. Predictors: (Constant), Challenges of Integrating Technology, Adoption Assessment

b. Dependent Variable: Perceived Performance

Table 18: Coefficients Table for independent variables

Model		Unstandardised Coefficients B	Unstandardised Coefficients Std. Error	Standardised Coefficients Beta	t
1	(Constant)	.336	.330		1.018
	Technology Adoption Assessment	.825	.117	.609	7.036
	Challenges of Integrating Technology	.069	.078	.076	.884

a. Dependent Variable: Perceived Performance

Table 19: Historical Grade 12 academic results

Sampled schools	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Sample school 1	83,3	89,1	92	86,2	85,3	90,9	87,1	84,1	87,6
Sample school 2	83,1	81	70,6	66,7	80,5	77,4	**88**	75,8	80
Sample school 3	80,3	70,9	85,5	86,8	94,3	87,9	82,2	83,9	74,3
Sample school 4	54,7	94,6	95,4	100	100	100	**100**	98,7	98,4
Sample school 5	83	85,8	95,5	89,2	88,9	88,3	62,2	89,9	76,8
Sample school 6	0	100	100	100	98	99,1	**99**	98,2	93,9
Sample school 7	65,3	65,7	74,6	79,3	82,4	82,9	74	71,9	82,2
Sample school 8	100	95,4	87,7	76,1	86,6	93,7	91,3	83,7	90,6
Sample school 9	91,9	85,8	81,3	80,1	76,9	97,3	86,4	85,4	81,3

Sample school 10	63,2	44,4	100	92,6	94,9	100	82,9	93,5	96,7
Sample school 11	87,2	91,1	97,6	87,1	85,4	70	76	72,3	87,6
Sample school 12	94	98,6	80,7	98,8	95,9	90,4	89,3	92,8	95,9
Sample school 13	94,7	95,9	97,5	100	100	88,6	**94**	95	91
Sample school 14	97	96,3	91,4	96	98	97,5	93,9	97,7	96,3
Sample school 15	87	91	88,7	80,2	77,2	82,6	69,8	76,2	77,4

Sources: (DBE, 2016, 2018, 2021, 2022)

ANNEXURE A: RESEARCH INSTRUMENT INCLUDING CONSENT

Wits Business School

Sculpting global leaders

LETTER OF CONSENT:

You are kindly requested to participate in a research study. The purpose of my study is to evaluate the influence of digital devices used by teachers on Grade 12 academic performance (results) in Gauteng public schools. By doing so, I wish to learn more about the extent of technology/ device usage in your day-to-day school activities (teaching or learning). You have been selected to participate in this research study based on your involvement in the integration of technology devices in the school.

Information regarding completing the survey:

- There are no personal identifiers or personal information that will be collected, therefore your identity will be anonymous. The data collected will be kept confidentially and only used for the purposes of this research study.
- It should take approximately 15 to 20 minutes to complete the questions on the survey.
- Completion of the survey is voluntary.

Your participation in the survey indicates your agreement for the data to be used for research purposes and this will serve as a declaration of your consent to indicate that you participate in this study willingly.

Yes – I Consent

☐

No – I do not Consent

☐

Please start completing below or follow the link to access the electronic survey:

Page 1 of 7

Note- To open double click on the document

ANNEXURE B: GDE PERMISSION FORM

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

For admin. Use only:
Ref. no.:
Enquiries: 011 3550775/1379
Gumani Mukatuni/ Busi Mchunu

2021/2022 GDE RESEARCH REQUEST FORM

REQUEST TO CONDUCT RESEARCH IN INSTITUTIONS AND/OR OFFICES OF THE GAUTENG DEPARTMENT OF EDUCATION

1. PARTICULARS OF THE RESEARCHER

1.1	**Details of the Researcher**
a) Surname and Initials:	Masiya P.N
b) First Name/s:	Precious Nomthandazo
c) Title (Prof/Dr/Mr/Mrs/Ms):	Mrs
d) Student Number:	0716598N
e) SA ID Number:	810306 0573 080
f) Work permit no. (If not SA citizen)	Not applicable

1.2	**Private Contact Details**
a. Home Address	***c. Postal Address (if different)***
59 Klipview street	Same as home addressess
Liefde En Vrede	
Glenvista	
Johannesburg	
b. Postal Code: 2091	***d. Postal Code:***
e. Tel: 076 4012410	***f. Cell:*** 076 401 2410
g. Fax:	***h. E-mail:*** Nomthandazo.mokwena@gmail.com

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ANNEXURE C: GDE PERMISSION LETTER TO VISIT SCHOOL

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**07 February 2023**
Validity of Research Approval:	**08 February 2023– 30 September 2023** **2022/474AA**
Name of Researcher:	**Masiya PN**
Address of Researcher:	**59 Klipview Street**
	Liefde En Vrede
	Glenvista
Telephone Number:	**076 401 2410**
Email address:	**Nomthandazo.mokwena@gmail.com**
Research Topic:	**The influence of digital devices used by teachers on Grade 12 academic performance in Guteng public schools**
Type of qualification	**MBA**
Number and type of schools:	**15 Secodnary Schools**
District/s/HO	**Ekurhuleni North,Gauteng East,Johannesburg East,Ekurhuleni South,Johannesburg North,Tshwane South,Johannebsurg Central,Johannesburg South**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

09/02/2023

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below are met. Approval may be withdrawn should any of the conditions listed below be flouted:

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

ANNEXURE D: ETHICS CLEARANCE CERTIFICATE

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/BA0716598n/101

This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

This certificate is only valid if accompanied by formal permission from the relevant stakeholder(s).

Project title	The influence of digital devices used by teachers on Grade 12 academic performance in Gauteng public schools
Investigator / Researcher	Ms Precious Masiya
Nature of Project	MBA (Research Article)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed confidentialty.
Issue Date of Certificate	25 09 2022
Expiry date	Date of submission of the project / research report
Chairperson	Prof Anthony Stacey +27 11 717 3587 +27 82 880 4531 anthony.stacey@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature — 26 September 2022 Date:

ANNEXURE E: SUPERVISOR'S EVALUATION FORM AND CHECK LIST

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

WITS FACULTY OF COMMERCE, LAW & MANAGEMENT

THESIS/DISSERTATION/RESEARCH REPORT – FIRST SUBMISSION CHECKLIST FORM *(for Examination)*

Name of Candidate:	Precious Nomthandazo Masiya	
Person/Student Number:	0716598N	
Qualification:	MBA	
Title:	The influence of digital devices used by teachers on Grade 12 academic performance in Gauteng public schools	
Supervisor(s):	Dr Keratiloe Mogotsi	
Contact Details:	Cell number(s): 076 401 2410	Email: Nomthandazo.mokwena@gmail.com

FIRST SUBMISSION CHECKLIST *(for Examination)*

Supervisor to send:	Full Turn-it-in Report signed by Supervisor	✓
	Confirmation of Ethics *(Clearance/Waiver certificate or declaration)*	✓
	Overall Supervisor Evaluation form *(MBA candidates ONLY)*	✓
	University Clearance Certificate (Supervisor to complete and send directly to Faculty)	✓
	Supervisor's Report (Supervisor to complete and send directly to Faculty)	✓
Faculty to check on:	Approved title and supervisor(s)	
	Approved examiners	
	Registration status *(students must be registered during the examination period)*	

Kindly email your submission to the relevant email address

- MBA: #fac-MBAsubmissions@wits.ac.za
- MM (WBS and WSG): #Fac-MMsubmissions@wits.ac.za
- PhD and Full Research Masters students belonging to WBS: Veli.Mongwe@wits.ac.za
- PhD and Full Research Masters students belonging to WSG: Nasreen.Abdulla@wits.ac.za

Please Note:

- *Outstanding fees must be cleared to enable Awaiting Examiner's registration.*
- *Incomplete submissions will NOT be prioritised.*

There may be a delay in the examination process where the research has been accepted by Faculty without approved examiners