



Comparing the status of ICT in the school education systems of South Africa and New Zealand during Covid-19

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DECLARATION

I, Catharina Maria Swanepoel, the undersigned, hereby declare that the work contained in this dissertation, titled “Comparing the status of ICT in the school education systems of South Africa and New Zealand during Covid-19”, is my own original work and that I have not previously, in its entirety or in part, submitted it at any university for a degree.

Signature:

Signed at BOTHAVILLE on the of 2022

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DEDICATION

I believe in the saying “it takes a village to raise a child”. This research felt like my child because it started with a problem I encountered as a teacher in South Africa and a parent interested in exploring the future of my children. I could not have managed to complete this research without my “village” of support. I want to thank God who gave me the strength and encouragement to not give up and also the capability to do this, as I doubted myself in the beginning. Thanks to Dr Louw de Beer, who was my mentor since the start of my research journey. He encouraged me and gave me the necessary tools to grow. Thanks to Lariza Hoffman for assisting me with the language aspect of my research.

I have so much gratitude toward my husband, Danie, my parents and my in-laws for every weekend, late night and holiday when you took over my duties and responsibilities and supported me through the whole journey. Special thanks to my mother, Tinka Kruger, for assisting me with my resources. To my children, Gurrard and Rouxné, I hope you have learnt a lesson by always watching Mum working and realising that accomplishments are earned through hard work and not just received.

Thanks to the North-West University who has been with me through my tertiary education since 2008 and now completing my master’s degree. I will always recommend this institution, as it has shaped me into the teacher and academic scholar that I am today.

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I hereby confirm that I have edited and proofread the following dissertation, including the references.

Title of dissertation

Comparing the status of ICT in the school education systems of South Africa and New Zealand during Covid-19

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ABSTRACT

Digital tools and school-building design in the 21st century differ from the traditional blackboard teaching method. The situation is further complicated by the estimation that new professions that do not even exist currently will emerge for approximately 65% of learners who are now starting their school careers. These learners will be part of the fourth industrial revolution. Equipping them for fourth industrial teaching makes numerous policymakers focus on modern learning, innovative learning and modern teaching so that learners are effectively equipped with skills to thrive in the fourth industrial revolution. “Information and communication technology” or ICT is the blanket term for all the technologies and services involved in the provision of telecommunication, data management, computing and the internet. The United Nations member states have adopted Agenda 2030 for Sustainable Development Goals, of which the implementation of ICT infrastructure forms a big part.

The World Economic Forum indicates that the Covid-19 pandemic has increased the inequalities in the labour market and businesses had to change their way of operating, which triggered the use of fourth industrial revolution technologies. According to the United Nations, two billion students across the world had their learning disrupted during the Covid-19 pandemic. Schools had to close and apply other forms of teaching and learning by utilising information and communication technologies. This comparative study focused on school education in New Zealand and South Africa. The differences and similarities between these countries will be insightful to compare the status of ICT in education during the Covid-19 pandemic. Good practices and strategies to implement for improving education technology were identified in the study.

Keywords: Covid-19 pandemic, education, ICT, South African education system, New Zealand education system.

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LIST OF ACRONYMS

3D	Three-dimensional
CAPS	Curriculum Assessment Policy Statement
Covid-19	Coronavirus disease 2019
DBE	Department of Basic Education
ICT	Information and communication technology
NZCER	New Zealand Council for Educational Research
OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
SA-SAMS	South African School Administration and Management System
TIMMS	Trends in International Mathematics and Science Study
Unesco	United Nations Educational, Scientific and Cultural Organisation
Unicef	United Nations International Children's Emergency Fund
Wi-fi	Wireless fidelity

CHAPTER 1 INTRODUCTION AND BACKGROUND

1.1 Introduction

Education is a deliberate and thoroughly planned process during which learners receive systematic instruction from teachers to gain the knowledge, expertise, skills and attitudes to fulfil the various responsibilities they will encounter in their lives (Steyn *et al.*, 2017). To survive in a rapidly changing globalised and digital society, 21st-century learners need skills associated with technology and communication, as well as more flexible approaches to knowledge for which traditional blackboard teaching and learning methods and school building designs may not be sufficient (Benade, 2017). The situation is further complicated by matters such as the estimation that new professions that do not even exist currently will emerge for approximately 65% of learners who are now starting their school careers (World Economic Forum, 2016). These learners will be part of the fourth industrial revolution. The World Economic Forum (2020) states that the coronavirus pandemic of 2019 (Covid-19) increased the inequalities in the labour market and businesses had to change their way of operating, which triggered the use of fourth industrial revolution technologies.

The fourth industrial revolution involves manufacturing processes that are more digitalised through self-learning, machine-like artificial intelligence, automation and robots (Mulyani *et al.*, 2021). This revolution uses wireless connectivity and sensors that are connected to a system that monitors decision making and production without human assistance (Mulyani *et al.*, 2021). Davis (2016) explains that the fourth industrial revolution is the occurrence of cyber-physical structures entailing completely new intelligence for individuals and devices. Current learners will be part of the fourth industrial revolution, which is characterised by a combination of digital, biological and physical worlds, as well as the growing utilisation of new information and communication technologies (ICTs), such as artificial intelligence, cloud computing, robotics, three-dimensional (3D) printing, the Internet of Things and advanced wireless technologies. However, the following question arises: Are the current education systems equipped to prepare learners to thrive in the fourth industrial revolution where they will have to assume professions that do not even exist currently and which will change rapidly?

To answer the question of whether current education systems are sufficiently equipped to prepare learners to live in the world of the fourth industrial revolution, numerous policymakers focus on modern and innovative learning (Benade, 2017) so that learners are effectively equipped with technical skills to thrive in the fourth industrial revolution. The United Nations Educational, Scientific and Cultural Organisation (Unesco, 2015) declares that ICT will benefit education

systems by increasing learner skills as it extends to learners in rural areas, enhances teacher training and reduces the costs of traditional teaching. Due to these benefits, many countries have already started to incorporate ICT in their national development plans. Dele-Ajayi *et al.* (2021), define ICT as technologies that allow the production, storage and control of information and facilitate different forms of communication between people and electronic systems and between electronic systems in digital binary language. Furthermore, Brown (2020) indicates that “ICT” is a blanket term for all the technologies and services involved in the provision of telecommunication, data management, computing and the internet.

Many external determinants influence education systems, and since 2020, there has been a specific challenge on the rise, namely the Covid-19 pandemic. This pandemic, which started in 2019, involves a virus, the coronavirus, that spreads from one infected person to another. Covid-19 is associated with a cold with fever, tiredness and a dry cough. Individuals with other medical problems are probable to develop a serious illness if positive for Covid-19. The National Department of Health (2021) indicates that 2% of individuals with the disease have died from it. In 2020, when the Covid-19 pandemic affected almost all countries and more than 50 million people worldwide (Organisation for Economic Co-operation and Development [OECD], 2020b), it became clear that not all countries were ready for the challenges that this pandemic entailed. Among other things, many schools were closed and numerous institutions had to consider using the fourth industrial revolution tools (Mhlanga & Moloji, 2020), as remote learning was opted due to the distance required among individuals and the spread of the Covid-19 virus made it impossible to attend traditional schools.

As a comparative study, this study focuses on school education in New Zealand and South Africa. These two countries differ to a great extent when it comes to the economy, as South Africa is a developing country and New Zealand a developed country. In addition, researcher is planning to immigrate from South Africa to New Zealand. A developed country has a mature and experienced economy with a high gross domestic product, whereas a developing country has a low gross domestic product and depends mostly on agriculture. In New Zealand, 51,2% of the population lives in large urban areas, and 16,3% lives in rural areas (Environmental Health Indicators New Zealand, 2018), while in South Africa, 33,14% of the population lives in rural areas (Trading Economic, 2021). National Geographic (2021) states that rural areas have a low population density and open lands, with fewer homes, businesses, people and schools. There is also the digital divide that each country experiences. With these differences between the two countries, it will be insightful to compare the status of ICT during the Covid-19 pandemic in schools in these countries. This comparison will give a clear indication of best practices and strategies to implement for improving ICT in schools.

1.2 Problem statement

Due to the Covid-19 pandemic, globally, more than 160 countries temporarily closed schools, which meant that learning came to a halt (Mhlanga & Moloi, 2020). The World Bank (2020) indicates that 1,6 billion children were not in school during the Covid-19 pandemic. Because of the spread of this virus, governments globally made use of distance learning. Bhula and Floretta (2020) indicate that attainable and economical technology, such as short message service or SMS, the radio and phone calls, was used to communicate information to learners and parents. For many parents, teachers and learners, the use of ICTs in learning is unknown, as they have not been exposed to different ICTs yet. In addition, assessment had to be done online, which was unusual for many learners and teachers. Low-income areas worldwide found it especially difficult to adapt to online learning, as people living in these areas do not have the financial means to have wireless fidelity (wi-fi) internet access or buy computers (Bangani, 2020). As this situation was not a short-term matter, the pandemic could had major effects on the delivery of quality education on an equal basis to all learners (Burgess & Sievertsen, 2020). By comparing the ICTs used in the school education systems of South Africa and New Zealand during the Covid-19 pandemic, stakeholders such as governments, schools, teachers and learners can acquire more knowledge pertaining to ICT, as the use thereof has changed during the pandemic.

1.3 Research question

1.3.1 Main research question

What was the status of ICT in the school education systems of South Africa and New Zealand during the Covid-19 pandemic?

1.3.2 Secondary research questions

The following secondary research questions were formulated:

- What were the differences regarding the status of ICT in the schooling system of South Africa and New Zealand during the Covid-19 pandemic?
- What were the similarities regarding the status of ICT in the schooling system of South Africa and New Zealand during the Covid-19 pandemic?
- What are the best practices that can be identified regarding ICT in the schooling systems of South Africa and New Zealand?

1.4 Research aims

1.4.1 Main research aim

The main research aim was to determine the status of ICT in the school education systems of South Africa and New Zealand during the Covid-19 pandemic.

1.4.2 Secondary research aims

The secondary research aims were:

- to determine the differences regarding the status of ICT in the schooling systems of South Africa and New Zealand during the Covid-19 pandemic;
- to determine the similarities regarding the status of ICT in the schooling systems of South Africa and New Zealand during the Covid-19 pandemic; and
- to identify the best practices that can be identified regarding ICT in the schooling systems of South Africa and New Zealand.

1.5 Conceptual framework

1.5.1 ICT

Pratt (2019) defines “information and communication technology” or ICT as all devices, networking components, applications and systems that together enable people and organisations to communicate in the digital world. Dele-Ajayi *et al.* (2021) define ICT as technologies that allow for the production, storage and control of information and facilitate different forms of communication between people and electronic systems and among electronic systems in digital binary language. According to Brown (2020), “ICT” is the blanket term for all the technologies and services involved in telecommunications provision, data management, computing and the internet.

ICTs are tools that deal with the handling, production, storage and dissemination of information (Kaur, 2021). There are various ICT tools and they continue to grow. They consist of old and new tools. The radio, television and telephone are old tools, whereas smartphones, digital televisions, robots, computers, interactive whiteboards, e-readers, tablets, satellites, the internet and wireless technology are new tools (Kaur, 2021). However, ICT is more than just these tools. Artificial intelligence is a technology that is part of the fourth industrial revolution (Pratt, 2019).

Brown (2020) points out that ICT provides schools with the opportunity where learners can engage with self-paced methods of learning, increase independence in their learning, increase their involvement in the learning process and expand their digital and computer skills. Not only is ICT effective for teaching and learning, but it also assists administrators in using software and digital tools to automate various tasks, the management of systems, research and general documentation. Moreover, ICT limits the need for paper-based documentation, which will also save schools money. Other aspects of ICT include digital learning, e-learning, mobile learning, online learning, distance learning, smart classrooms, blended learning and educational robotics.

1.5.2 Theories of ICT

The Merriam-Webster Dictionary (2020) defines a theory as an idea or set of ideas that is intended to explain facts or events. Thus, a theory can be defined as something or an idea that can be explained. Gardner (2020) indicates that various theories occur in education. According to Gardner (2020), a diverse perspective on education theory is essential when online learning is being used. Online education considers the optimal means to produce quality and successful learning.

Teachers make use of mainly three theories in education, namely behaviourism, the cognitive theory and constructivism. Behaviourism refers to an outside stimulant that has an impact on learning behaviour (Ronghua & Stanley, 2014). According to Rützmänn (2019), behaviourism supplies design and learning outcomes and expands demands, regulation, time limits, differentiation and teaching to solve problems with science, technology, engineering and mathematics and support practices and execution. The cognitive theory describes learning as a mental process through problem-solving strategies (Ronghua & Stanley, 2014). The constructivist theory deduces learning as a procedure where individuals construct new knowledge based on their previous knowledge (Ratheeswari, 2018). The constructivist paradigm is found in ICT, as the learner makes use of a computer or the internet to construct new or build on previous knowledge, skills, attitudes and beliefs (Ratheeswari, 2018). Furthermore, Ratheeswari (2018) identifies three crucial conditions for ICT: first, there has to be sufficient access to digital technologies and the internet for teachers and learners; second, digital content must be meaningful and of high quality; and third, teachers need to have the necessary skills and knowledge to be able to use digital tools.

1.5.3 Education technology

The term “education technology” has various definitions. Lee (2019) defines education technology as the observation and moral procedure of assisting learning to advance performance by generating, implementing and managing suitable technological procedures and resources. In other words, education technology makes use of ICTs in education to improve learning.

1.5.4 Education system

Steyn *et al.* (2017:14) define an education system as a “framework, consisting of different components and elements for effective education to provide for the education need of the target group”. An education system is unique to a country and consists of education policy, education administration and a structure for teaching and support services.

1.5.5 South African education system

In the education system of South Africa, education is compulsory up to Grade 9, as promulgated in Section 3(1) of the *South African Schools Act* 84 of 1996. The education system has three levels, namely elementary, secondary and tertiary education. The Department of Basic Education (DBE) supervises primary and secondary education, while the Department of Higher Education and Training supervises post-secondary education (Macha, 2017). The South African education system has to accommodate 12 917 075 children in primary and secondary schools (Unesco, 2020). There are both public and private schools in South Africa (Mhlanga & Moloi, 2020). According to Macha (2017), there is a difference in the education resources and infrastructure available depending on the location of a school. Some schools in rural areas do not have electricity, books or water. Although South Africa has 11 official languages, education is mainly provided through the medium of English or Afrikaans. Technical and vocational training as a strategy has been implemented by the DBE since 2015 (Macha, 2017). The DBE is divided into nine provinces and 86 districts that administer schools within the legal framework presented by the *National Education Policy Act* of 1996. There is a Minister of Education, with a Deputy Minister, who administers education in South Africa. In line with the *South African Schools Act* of 1996, each school has a school governing body responsible for the governance of schools.

1.5.6 New Zealand education system

The New Zealand education system consists of three levels, namely early childhood education, primary and secondary education, and further education. Primary and secondary education is for children from age five to 19. In New Zealand, schooling is compulsory from the age of six to 16.

The majority of the schools in New Zealand, in which 85% of learners are enrolled, are owned and financed by the state. These state schools follow a national curriculum reflecting the national aims, values and philosophy of the country (Ministry of Education, 2021a). Education in New Zealand is managed by the Ministry of Education, which governs the policy development and standard setting for state schools, state-integrated schools and private schools. The Ministry of Education has four regional offices and 16 district offices. Each school has a school board that is responsible for the functioning of the school (National Center on Education and the Economy, 2020). The languages of instruction that are used in New Zealand are Māori and English (Ministry of Education, 2021a).

1.5.7 Covid-19 pandemic

Covid-19 was first discovered in Wuhan, China, in 2019 (Mhlanga & Moloji, 2020). On 11 March 2020, the World Health Organisation announced Covid-19 as a global pandemic. The virus spreads by the respiratory droplets of an infected person, and therefore, physical contact among individuals has to be minimised. The seriousness of the pandemic became obvious when statistics of cumulative positive cases and deaths in different countries were published on media platforms (Ramrathan, 2020). The pandemic also damaged the economy and led to job losses. Therefore, numerous countries shut down their schools to prevent the spread of the disease, and schools had to make use of online learning and home-schooling to ensure that learning could continue (OECDa, 2020).

1.5.8 Covid-19 in South Africa

South Africa recorded its first Covid-19 case on 5 March 2020 (Mhlanga & Moloji, 2020). President Cyril Ramaphosa declared the Covid-19 pandemic a state of disaster on 15 March 2020. On 23 March 2020, the president issued a national lockdown, which meant that schools had to close for 21 days. On 9 April 2020, the lockdown was extended by 14 days, after which it was extended again. On 31 May, the country was put on lockdown Level 4 of the Covid-19 pandemic strategy (South African Government, 2020a). The lockdown level was reduced to Level 3 on 1 June 2020, which meant that 33% of learners were allowed back at school. On 18 August 2020, the country was put on lockdown Level 2, which meant that 66% of learners could return to school (South African Government, 2020b). On 9 December 2020, Health Minister Doctor Zweli Mkhize reported that South Africa was entering a second wave of the Covid-19 pandemic due to a rise in Covid-19 cases and deaths (South Africa Coronavirus Online Resource & News Portal, 2020). Because of this second wave, the opening of school after the summer holiday was postponed to 15 February 2021.

The pandemic has affected South African schooling drastically, as normal vocational training could not be done effectively. According to the South Africa Coronavirus Online Resource and News Portal (2020), by 5 August 2021, there have been 2 511 178 cases of infection and 74 352 deaths in total in South Africa due to the Covid-19 pandemic.

1.5.9 Covid-19 in New Zealand

New Zealand was one of the first countries that implemented a strategy against the Covid-19 pandemic. In February 2020, preparations for hospitals and border control started. On 26 February, the first case of Covid-19 was detected in New Zealand. One month later, the government initiated a national lockdown on Level 4. The country had seven weeks of national lockdown. On 8 June 2020, the country moved to a Level 1 lockdown, which meant that there were only 103 days of lockdown (Kunzmann, 2020). The Ministry of Health (2021a) reports that on 5 August 2021, there have been 2 880 cases of infection and 26 deaths in New Zealand due to the Covid-19 pandemic.

1.6 Research design and methodology

Research is a structured activity of gathering and logically analysing data to solve a specific problem (McMillian & Schumacher, 2010). The research design and methods identified to assist in reaching the research aims are discussed next.

1.6.1 Research design and methodology

Research methodology can be defined as the research design, methods, approaches and procedures that will be used to gather information to solve a particular problem (Kivunja & Kuyini, 2017). Collis and Hussey (2009) define research methodology as the comprehensive approach of a research study, including the strategies to gather data. In this study, a qualitative research design was used. A research design can be defined as the process of research that starts with the beliefs, worldviews or paradigms of the researcher that will affect the manner in which the research will be conducted (Creswell, 2007). Kaufan and Kaufan (2005) refer to a research design as the different processes of how the research can be done. In this study, a qualitative approach with an interpretive design was used. A qualitative approach stresses the participants' views on the topic. Many different sources of data are used in a qualitative approach to expand the given event (Kobakhidze, 2018). According to Kobakhidze (2018), qualitative research allows for giving a more comprehensive explanation of an event. The constructivist and interpretivist worldviews are used as a basis for qualitative research. The qualitative approach begins with a paradigm, which is used to view the event to solve a problem (Creswell, 2007).

1.6.2 Research paradigm or worldview

A worldview can be defined as the structure of ideas and points of view about life and the world from a personal perspective (Rusbult, 2019). Maree (2020) defines a paradigm as the beliefs and assumptions that contribute to a specific worldview. A paradigm includes epistemology, ontology and methodologies. Epistemology refers to the knowledge and the connection thereof to the individual who knows, while ontology refers to the characteristics of reality. The interpretivist paradigm was used for this research study. The aim of an interpretivist paradigm is an investigation to understand a particular event (Tybey *et al.*, 2015). A non-numerical data analysis technique is used in the interpretive paradigm (Tybey *et al.*, 2015).

1.6.3 Comparative method

The comparative method of research entails items and proposals being analysed and compared (Bukhari, 2011). Bukhari (2011) further indicates that a comparative study identifies the similarities and differences between two or more items. According to Milošević and Maksimović (2020), comparative research in education emphasises different cultures, countries or education systems. The comparative method has become possible because of globalisation and access to information technologies. Particular features are focused on when comparing different items to conclude events for current and future possibilities.

1.6.4 Data collection

For this comparative research study, document analysis was used to gather information. Document analysis is a process to evaluate documents to have knowledge and understanding of a phenomenon. With document analysis, researchers evaluate existing literature and use the information gathered from it to answer a specific research problem.

Documents relevant to education technologies in South Africa and New Zealand were extracted from various resources such as journals, agendas, legislation, Google Scholar and published papers. The World Bank, Unesco, Statistics South Africa, the World Economic Forum, the OECD, government websites and the Hallon Foundation provide reliable information to researchers.

1.6.5 Data analysis

Bowen (2009) defines data analysis as a systematic procedure for reviewing documents. According to Maree (2020), inductive data analysis is favoured by researchers in the

interpretivism paradigm. It is important to elaborate on how data will be presented in data analysis.

The following topics were used in the data analysis for this study regarding South Africa and New Zealand:

- Legislation and funding of ICT before and during Covid-19.
- Preparedness and infrastructure of schools regarding ICT before and during Covid-19.
- Execution of effective ICT before and during Covid-19.
- Barriers that influence ICT implementation before and during Covid-19.
- Future prospects of ICT in education.

Through these topics, the similarities and differences of the status of ICT in the school education systems of South Africa and New Zealand were identified.

1.6.6 Participating countries

The researcher used South Africa and New Zealand as participants in the study. South Africa and New Zealand have many differences in terms of economics, education and politics. These differences make it possible to between these countries towards ICT in their school education systems.

1.6.7 Trustworthiness or credibility

A document analysis strategy was used; therefore, only documents that were regarded as trustworthy and available to the public were used. Particular topics (as stated earlier) guided the research to ensure that the research would not be biased and to ensure the integrity of the conclusions of the study.

1.6.8 Ethical considerations

The North-West University (2020) has a code of conduct regarding research. There are four crucial principles for research that a researcher must adhere to (North-West University, 2020):

- Honesty throughout the whole research.
- Responsibility in performing the research.
- Professional respect and integrity in working with others.
- Good management of research on behalf of others.

As the researcher employed document analysis as a data-gathering method, no confidential information was used, as the documents were all freely available to the public. In analysing the documents, the researcher paid special attention to the correct analysis of the data to ensure reliability and validity in reporting the findings.

1.7 Contribution of the study

Many external determinants have an impact on education. In this study, the status of ICT and its prospects in the education systems of South Africa and New Zealand were determined. This study focused on ICT in schools in both of these countries. With the urban-rural divide in both countries, it is necessary for each country to develop its infrastructure, especially in rural areas, to be able to use ICT in education. Technology can be very beneficial to especially rural schools by providing teachers and learners with access to information wherever they are. ICT is a fast-growing industry. Policymakers and schools need to be aware of how technologies play a role in education for future sustainability after the Covid-19 pandemic. They also need to know what is necessary to implement for learners and teachers to use education technology in the future.

1.8 Chapter layout

Chapter 1: Introduction and background

Chapter 2: Literature review

Chapter 3: Research design and methodology

Chapter 4: Data analysis

Chapter 5: Findings, recommendations and conclusion

1.9 Summary

This study compared the status of ICT in the South African and New Zealand school education systems during the Covid-19 pandemic. The main contribution of this study will be to the education community of South Africa and New Zealand. Furthermore, from this comparative study, other countries can comprehend the process that each country went through to make the use of education technology effective.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

A literature review is supportive in clarifying the research question and making the researcher aware of the results of similar studies (Fraenkel *et al.*, 2015). The intention of a literature review is straightforward – it is there to inform the reader about the topic before forming a justification (Arshed & Danson, 2015). When a researcher reviews literature, it suggests that summaries, books, journals and indexed publications on the topic are located (Creswell & Guetterman, 2020). The literature is chosen selectively to include work that concerns the specific research problem and research questions.

This literature review will clarify the following concepts: education and the education system; the education systems of South Africa and New Zealand; the concept of ICT, which includes several other concepts; the concept of Covid-19; the concept of Covid-19 in South Africa and New Zealand; and the concept of sustainable development. The focus of these topics will be on the clarification and characteristics thereof, as well as the theoretical framework and findings in the literature.

2.2 Concept clarification

2.2.1 Education and the education system

Le Grange (2020) describes education as a moral enterprise. Schools offer more than just knowledge that is provided by a curriculum. Steyn *et al.* (2017) define education as a deliberate, worked-out activity where learners are assisted by teachers to gain knowledge, expertise and attitudes to uphold the responsibilities in the various aspects of their lives. The OECD (2016) states that education is seen as the most traditional social system. However, learners and teachers in history differ from learners and teachers in the 21st century. Learners in the 21st century belong to the Millennial Generation and Generation Z who are exposed to digital platforms from birth (Lamanauskas, 2019). These learners do not like to feel that they are being taught and prefer to construct knowledge when they are in control of the situation. Kirschner and De Bruyckere (2017) state that this generation of learners can cognitively process multiple sources of information at the same time. This indicates that the way of constructing knowledge before the 21st century will have to change to satisfy the educational needs of learners in the 21st century. It is, therefore, important to look at what an education system is and how it contributes to the learning needs of the learners in a country. Information is key in education, but school libraries

offer mostly printed information that can be out of date. Moreover, knowledge is developing fast. Therefore, schools need to rely on not only printed information, and this is where the technologies that are available now will assist to ensure that more relevant, new information is available (Wright, 2018).

Steyn *et al.* (2017:14) define an education system as “the framework, consisting of different components and elements for effective education to provide for the real educational needs of the target group”. Sudhir (2015) declares that the objective of any education system is to guarantee that the earmarked population attain the expected literacy and numerical skills, higher-order thinking and reasoning abilities, life skills and values for the development and advancement of the country. Adding to Sudhir’s statement, Chauhan and Angra (2019) point out that an education system must be adaptable to supply an applicable high-quality education for a substantial number of people. Steyn *et al.* (2017) identify different types of education systems, namely the national education, the mini-education system and the mini-training system. Further types of education are formal education, non-formal education and informal education. The national education system refers to the framework for effective education to provide for the educational needs of all the inhabitants in a particular country as the target group (Steyn *et al.*, 2017). In general, the national education system refers to public schooling (Great Schools Partnership, 2013). It is important to note that the target group of each country varies, which implies that the education systems of different countries will vary. Private schools form part of the mini-education system, where the educational needs of a target group are provided for, for example Curro schools or Catholic schools. The mini-training system is a system that refers to the training of the target group for specific knowledge, skills and attitudes to be able to be responsible for a specific role (Steyn *et al.*, 2011). Formal education takes place in a formal system, such as schools, while non-formal education consists of training for a specific skill, such as in a particular sport or training for a trade skill. Informal education is part of unplanned activities where a learner acquires a specific skill.

Steyn *et al.* (2008) refer to the components of an education system as education system policy, education system administration, the structure of teaching and support service. Each of these components has different elements in an education system. The education system policy refers to the process of how the educational needs of the target group will be provided for. The elements of education system policy are the vision, mission, aims and objectives, as well as the format of the education system policy. The education administration refers to the organisational structure of the functions in the education system. The elements of education administration are organisational functions, the communication lines between the system and the target group, and the financing of the system (Steyn *et al.*, 2008).

There are three types of control in an education system, namely centralised control, decentralised control and mixed educational control (Nurakhir, 2016). Centralised control is when the formulation and implementation of the education policy are centralised in one person or structure and where the involvement of bottom-level individuals is limited. Decentralised control is when the formulation and implementation of the education policy are decentralised to various persons or structures. Mixed educational control is where the formulation and implementation of the policy of a country are centralised, and implementation and further formulation are decentralised (Nurakhir, 2016). The structure of the education system has the following elements: education levels, educational institutions, curricula and differentiation, the teachers, the learners, the medium of instruction and physical facilities. The support services component of the education system is referred to as those services that are not educational that are given to learners, teachers and teaching activities (Steyn *et al.*, 2017).

The different components and elements affect one another. Various contextual determinants influence an education system. There are two types of determinants, namely internal and external determinants. Internal determinants are contextual factors within the system, such as the history of a system, elements and components within the system that affect one another, and the effect of educational principles on the functioning of the education system. External determinants refer to tendencies outside the education system that have an effect on the system, namely the demography, geography and climate, economic and scientific technology, social and political factors, the language of the target group, juridical and institutional tendency and philosophy (Steyn *et al.*, 2017). This study focuses on two external determinants, namely technology and Covid-19, in the education systems of South Africa and New Zealand.

As discussed in Chapter 1, the online Merriam-Webster Dictionary (2020) defines a theory as an idea or set of ideas that is intended to explain facts or events. Ronghua and Stanley (2014) explain that an educational technology theory is directed by different theories. These theories include behaviourism, the cognitive theory and multiple intelligence. Gardner (2020) indicates that numerous teachers make use of three theories in education, namely behaviourism, the cognitive theory and constructivism. According to Gardner (2020), a diverse perspective on education theory is essential when online learning is used. Online education considers the optimal means to produce quality and successful learning. Behaviourism refers to an outside stimulant that has an impact on learning behaviour (Ronghua & Stanley, 2014). According to Rütman (2015), behaviourism supplies design and learning outcomes, expands demands and involves regulation, time limits, differentiation, teaching to solve problems with science, technology, engineering and mathematics, support practices and execution. The cognitive theory can be described as a mental process through problem-solving strategies (Ronghua & Stanley, 2014). Multiple intelligence

refers to the idea that each individual has a distinctive intellect. Constructivists make use of technology for teaching, which is different from behaviourism (Rüütman, 2015).

In conclusion, the theory of education technology can be seen as the effective use of technology as an external stimulant to allow individuals to create knowledge and do problem solving.

2.2.2 Education system of South Africa

South Africa has a population of 60 127 232 (Woldometer, 2021a). The National Department of Education is responsible for the education system that is guided by legislation. The DBE supervises primary and secondary education, and the Department of Higher Education and Training supervises post-secondary education (Macha, 2017). There is a Minister of Education who, together with the deputy minister, administers education in South Africa. Education policy is regulated by the *National Education Policy Act 27 of 1996*. The general administration is done by each of the nine provinces, which each has a Member of the Executive Council who has the highest education jurisdiction in a specific province with the responsibility to implement policy and legislation. The Head of the Department assists the Member of the Executive Council. There are 86 districts that administer the schools through the education policy. Education in South Africa is compulsory up to Grade 9 (Nuffic, 2020). The system has three levels: elementary, secondary and tertiary. The education system of South Africa is divided into undergraduate and postgraduate. The undergraduate education system consists of the Foundation Phase (primary education, Grades R-3), the Intermediate Phase (Grades 4-6), the Senior Phase (Grades 7-9) and Further Education and Training (Grades 10-12, to receive a National Senior Certificate). The postgraduate education system consists of a bachelor's degree, a bachelor honours degree, a master's degree and a doctoral degree. There is also an option for a learner to exit the education system in Grade 9 and attend vocational education to receive a National Certificate, then a Higher Certificate and then a National Professional Diploma to join the postgraduate education system (Nuffic, 2020).

There are 28 universities in South Africa that delivers higher education to the nation (Department of Education, 2019). The National Qualifications Framework is a system that classifies all education systems in South Africa. Umalusi, the Council of Higher Education and the Quality Council for Trade and Occupations are councils that oversee the monitoring of quality in education. The South African education system has to accommodate 12 917 075 children in primary and secondary schools (Unesco, 2020). There are public and private schools that add up to 97% of schools in South Africa (Mhlanga & Moloi, 2020). According to Macha (2017), there is a difference in the education resources and infrastructure depending on the location of a school.

There are schools in rural areas that do not have electricity, books or water. According to Unesco (2020), 33% of the South African population lives in rural areas. Of the approximately 25 000 schools, 11 252 are located in rural areas, the majority of which are in KwaZulu-Natal and Limpopo (Gina & Kubsyi, 2016). In addition, Ellis (2020) indicates that some South Africans do not have easy access to water in their residence. English and Afrikaans are used as the language of instruction, although South Africa has 11 official languages. Technical and vocational training is a strategy of the Department of Education from 2015 to 2019 (Macha, 2017). Le Grange (2020) indicates that schools in South Africa have more functions than the transmission of knowledge, as school is a safe place for learners and gives nine million learners two meals per day as part of the National School Nutrition Programme.

South Africa is “a middle income, emerging market with an abundant supply of natural resources, well-developed financial, legal, communications, energy, and transport sectors; and a stock exchange that is Africa’s largest and among the top 20 in the world” (Macha, 2017: online). In 2019, the gross domestic product of South Africa increased to 3,1% (Statistics South Africa, 2019). The Department of Education (2019) budgeted R246 billion for education, which is 16,7% of the total government spending in 2018/19 in South Africa. Wolhuter *et al.* (2017) point out that extreme poverty, elevated unemployment, a lack of skills and training and shortfalls of proper housing, water and electricity all have an effect on the development of the economy in South Africa.

The *White Paper on Education and Training* was published in 1995 by the Department of Education to supply a fundamental policy framework. The *National Education Policy Act 27* of 1996 regulates the responsibilities of the Minister of Education. The *South African Schools Act 84* of 1996 provides legislation for compulsory education. The *Adult Basic Education and Training Act 52* of 2000 provides guidelines on the establishment, governance and funding of public adult learning centres. The *Employment of Educators Act 76* of 1998 regulates the professional and ethical responsibilities of teachers.

School curricula in South Africa have changed over the years after 1994. In 2012, the *National Curriculum Assessment and Policy Statement (CAPS)* was introduced to replace the previous outcomes-based curriculum (Maddock & Maroun, 2018). CAPS is a single, comprehensive incisive policy document for school subjects from Grades R to 12. The aim of the South African curriculum, as stated in the CAPS document (DBE, 2012), is:

- to equip learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment and meaningful participation in society as citizens of a free country;

- to provide access to higher education;
- to facilitate the transition of learners from educational institutions to the workplace; and
- to provide employers with a sufficient profile of a learner's competencies.

South Africa has a National Development Plan 2030 (South African Government, 2020a). According to the Department of Education (South African Government, 2020a), it continues to focus on the following to contribute to the National Development Plan:

- Supplying and improving school infrastructure.
- Intensifying teaching and learning by securing access to high-quality learner and teacher support materials.
- Enhancing Grade 12 achievement.
- Supplying educational opportunities to learners with intellectual disabilities.
- Supplying quality teachers.
- Monitoring execution
- Providing meals for learners through the National School Nutrition Programme.

The Network Readiness Index 2019 reported by the Portland Institute (in Dutta & Lanvin, 2019) is a study that analyses 121 economies across the globe within 62 variables (different aspects of network readiness) to determine digital technologies according to the following basic aspects: technology, people, governance and impact. According to the Network Readiness Index 2019, South Africa was ranked 72nd, with a score of 47,38% (Dutta & Lanvin, 2019). Furthermore, the study had specific findings on South Africa, as stated in Dutta and Lanvin (2019). According to aspects that were inspected in the study, South Africa ranked 58th for technology, 79th for people, 47th for governance and 99th for impact. Within technology, it was found that South Africa was 69th when it came to access to technology, 54th for the content of technology and 53rd for future technologies. The study also found the following in South Africa: households with internet access scored 5,95%; mobile application development scored 34,40%; the availability of the latest technologies scored 41,51%; computer software spending scored 9,09%; government procurement of advanced technology scored 56,87%; and company investment in emerging technology scored 36,96% (Dutta & Lanvin, 2019).

Technology education was a new subject in the South African education system when the outcomes-based curriculum was introduced (Ankiewicz, 2020). The DBE initiated a plan to give Funza Lusaka Bursaries to education students with mathematics, science and technology as subjects (DBE, 2019). The DBE further aimed to provide ICT equipment, laboratories and related apparatus, workshops, teacher development and learner and teacher support materials to 1 000 schools (Ankiewicz, 2020).

2.2.3 Education system of New Zealand

New Zealand has a population of almost five million people (Hendrickson, 2020). The New Zealand education system consists of three levels, namely early childhood education, primary and secondary education, and further education. Primary and secondary education is for children from age five to 17 years. In New Zealand, schooling is compulsory from the age of six to 16. The education system has 13 year levels. Year Levels 1 to 8 level are for children aged five to 12 years in primary education, and Year Levels nine to 13 level are for children aged 13 to 17 years in secondary education.

At the end of secondary school, a learner receives the National Certificate of Educational Achievement. In 2020, New Zealand had 2 536 schools from primary to secondary education, including state, state-integrated and private schools, and 62 630 regular teachers - (Education Counts, 2021a). State schools accommodate 85% of learners in New Zealand, where the national curriculum is non-religious. There are also state-integrated schools, which are funded by the government and follow the national curriculum but have their own sets of values and religion. Lastly, private schools are mainly funded by school fees, although the government does assist with some funds. Private schools do not follow the national curriculum. The majority of the schools in New Zealand are owned and financed by the state and follow a national curriculum with national aims, values and a specific philosophy (Ministry of Education, 2021a). About 300 999 of the population live in the rural areas of New Zealand (Education Counts, 2021b).

Education in New Zealand is managed by the Ministry of Education, which governs the policy development and standard setting for state schools, state-integrated schools and private schools. The role of the Ministry of Education is to advise the government regarding early childhood education, primary and secondary education and tertiary and international education to ensure the long-term performance of the education system, support the sector leaders to obtain achievement and ensure that the education system adheres to the Treaty of Waitangi. The Ministry of Education has four regional offices and 16 district offices (Ministry of Education, 2021a). Each school has a school board that is responsible for the functioning of the school (National Center on Education and the Economy, 2020). The languages of instruction that are used in New Zealand are Māori and English (Ministry of Education, 2021a).

The Ministry of Education is responsible for funding the education system and delivering infrastructure, ICT and other services (Ministry of Education, 2016). One of the priorities of the Ministry of Education is information management and technology. The Ministry supplies funding by financing the salaries of teachers, school property and operational costs. The operational costs

include the day-to-day costs that are needed to run the school. The school property financing includes the maintenance and expansion of the property (Education Counts, 2021c). Through the Education Renewal Programme, \$1,14 billion is invested into energy-efficient buildings and learning spaces that are flexible for the needs of today's learners. In the 2016 budget, the government invested \$882 million in the infrastructure of schools (Ministry of Education, 2016). The Ministry of Education is in control of \$23,5 billion in school estate properties, including ICT infrastructure.

The education system in New Zealand has been provided with a legal framework – the *Education and Training Act of 2020* (formerly the *Education Act of 1989*) that determines the roles, responsibilities and powers of the Crown entities and private statutory bodies in the education sector (Ministry of Education, 2016). The previous Minister of Education, Hon Hekia Patra, declared that in the transition to a knowledge economy, it was important to provide learners with education for a future where there would be careers that did not even exist yet (Ministry of Education, 2016). In 2014, the Ministry of Education indicated that from 2014 to 2018, a digital education strategy for schools and teachers would be developed and implemented to make use of technologies so that learners would be equipped with 21st-century skills. The New Zealand Curriculum 2007 highlights the significance of ICT and e-learning (Ministry of Education, 2016).

The New Zealand government aimed to have ultra-fast broadband in 98% of schools by 2016 (Twining *et al.*, 2015). Ultra-fast broadband makes use of fibre optic with satellite to reach remote areas, even the high country and offshore islands. As mentioned earlier, the Network Readiness Index 2019, reported by the Portland Institute, is a study that analyses 121 economies around the globe within 62 variables to determine digital technologies according to the following basic aspects: technology, people, governance and impact (Dutta & Lanvin, 2019). According to the Network Readiness Index 2019, New Zealand was ranked 16th with a score of 73,97% and was ranked first regarding inclusion (Dutta & Lanvin, 2019). According to aspects that were inspected in the study, New Zealand was ranked as follows (Dutta & Lanvin, 2019): 17th for technology, 18th for people, 2nd for governance and 24th for impact. Within technology, New Zealand was ranked 16th when it came to access to technology, 10th in the content of technology and 28th in future technologies. The study also found the following in New Zealand: fixed broadband internet subscriptions scored 99,03%; households with internet access scored 86,99%; mobile application development scored 85,05%; the availability of the latest technologies scored 85,53%; computer software spending scored 27,37%; robot density scored 14,42%; government procurement of advanced technology scored 54,36%; and company investment in emerging technology scored 65,84%.

According to Bolstad (2016), most schools in New Zealand have consistent network access, although the use of digital technology in the classroom is an ongoing process. Teachers are sometimes unsure how to best use devices for effective teaching (Network for Learning, 2018). In New Zealand, there is a virtual learning network primary school, with a network of small rural schools collaborating online. This virtual learning network advances opportunities for the professional development of teachers, student learning support, technical support and the logistical coordination of online classes in New Zealand.

2.2.4 ICT

ICT can be defined as all devices, networking components, applications and systems that together enable people and organisations to communicate in the digital world (Pratt, 2019). Furthermore, Dele-Ajayi *et al.* (2021) define ICT as technologies that allow the production, storage and control of information and facilitate different forms of communication between people and electronic systems and among electronic systems in digital binary language. Brown (2020) states that “ICT” is a blanket term for all the technologies and services involved in the provision of telecommunication, data management, computing and the internet.

ICT consists of different components, namely hardware, software, cloud computing, internet access, data, communications technology and transactions (Pratt, 2019). Hardware refers to the physical components of a device (Brown *et al.*, 2019) and can be internal or external. Examples of internal hardware are the motherboard, power supply and central processing unit, while the monitor, keyboard, speakers, printer, external hard drive, projector, headphones and mouse are external hardware (Goodman, 2022). Software refers to programs that control the hardware system; in other words, the hardware follows the instructions that the software gives. Software is portable, easily adjustable and moveable, while hardware carries out the instructions contained in the software (Duncan-Williams, 2017).

Kaur (2021) identifies access, equity and quality as the three challenges that individuals experience in using ICT. Venkatesha (2016) lists the following benefits of ICT: ICT assists with changing teaching methods, makes active learning in and outside a classroom possible, brings the outside world into the classroom and improves exploring, experimenting, thinking creatively and achieving excellence; moreover, learning becomes less abstract and more relevant, and learners are more engaged in learning with ICT, as previously, learners had to make use of memorising-based learning. Kaur (2021) indicates that advances in higher-order thinking and reasoning skills are other benefits of ICT.

There are, however, also challenges regarding ICT, such as the high cost of quality content, devices and infrastructure. Furthermore, the deficiency of internet connectivity in small towns and rural areas can be a problem, while the training of teachers and their attitudes towards ICT can be challenging. Moreover, with the overload of information available on the internet, learners get confused as to what information is correct (Chitale & Thakar, 2015). Pratt (2019) also points out that the expansion of high-speed internet and the growing global network have led to new levels of crime, such as illegally gaining access to systems to steal money, private information and intellectual property and taking control of critical infrastructure. There is also the problem of robots and automation replacing workers who do not have the skills for new positions. In addition, human interaction has decreased, as people are limiting their interaction with others. Pratt (2019) also indicates that ICT capabilities are not being distributed evenly across countries, as richer countries and individuals have more access to ICT, which leads, in turn, to their having more advantages and opportunities that come with ICT. As technology is changing rapidly, it is important to train teachers to provide them with the necessary skills and knowledge to implement it. Brown *et al.* (2019) list the following as emerging technologies: artificial intelligence, vision enhancement, robotics, quantum cryptography, 3D and holographic imaging and virtual reality.

The following topics are discussed in this section under ICT: education technology, distance and online learning, mobile learning, SMART classrooms, blended learning, educational robotics, cloud computing, virtual reality and augmented reality, 3D and holographic imaging and artificial intelligence.

2.2.4.1 Education technology

Humans have five senses – smell, sight, touch, taste and hearing. Learners use these senses to connect to their real-world surroundings. Education technology stimulates these senses by creating a digital user experience that enables the learner to understand the information being conveyed (Cunningham & Weinel, 2016). Collaboration between teachers and technologists assists education in various ways, such as speeding up the innovation process in education, reviving new teaching ideas and improving learners' learning experience (Sung *et al.*, 2020).

La Shun (2017) defines technology as a structure, produced by people, that utilises knowledge and coordination to create devices and methods to achieve a particular objective. Education technology includes the instructional technology that is used by teachers in teaching and the knowledge technologies that are used by learners to achieve particular learning goals. According to Cedere *et al.* (2019), learners need to be active in their learning and receive feedback straight away. For this need, technology can be used as a program that can respond immediately to a

learner's answer. Through education technology, learning takes place beyond the conventional classroom and makes it possible for learners who are located far from one another to join forces in their learning. Education technology also assists schools when data are captured so that the administration and management can function smoothly. Teachers use education technologies, not only for the learners but also for their own professional development (Yamaguchi & Hall, 2017).

Cai and King (2020) state that online learning is remarkably increased among teachers, administrators and policymakers. The learning process is improved by technology through different devices. As the 21st-century society is more technology-driven and learners learn differently than before, it is important for teachers and learners to incorporate technology into teaching and learning (Lorenzo, 2017). Education technology is moving from being pedagogical tools to providing access to knowledge for individualised learning through learner devices (Kwet & Prinsloo, 2020). Baker (2021) identifies the following technologies that are part of educational technologies: computer tutors, digital learning games, simulations, virtual reality and educational robotics. These technologies increase personalised learning and self-regulated learning.

2.2.4.2 Distance and online learning

Distance learning is defined as learning and teaching that are planned where the teaching occurs in a different place for the teacher and learners by means of using technology (Heng & Sol, 2020). Therefore, distance learning is distinguished by the separation between the teacher and learners where distance and time are concerned (Whalley & Barbour, 2019). Learners have the flexibility to study at any time and any place. In 1840, Sir Isaac Pitman had the idea of creating professional shorthand writing courses by correspondence; this was the first time distance learning took place. Thereafter, distance learning has gradually grown because of its flexibility for individuals who cannot attend educational institutions because of distance or a lack of time (Pereira *et al.*, 2018). There is a concern that in distance learning, interaction between teachers and learners is insufficient (Aotaibi, 2021). In distance learning, there are tutors in the learning process instead of teachers (Pereira *et al.*, 2018). In addition, distance learning is an educational practice that successfully uses an extensive range of technologies and tools to enhance the learning experience and facilitate communication between learners and learning institutions (Mensah *et al.*, 2020). Nowadays, distance learning is also known as distance education, e-learning, mobile learning or online learning.

According to Mensah *et al.* (2020), the minimum technological essentials for effective distance learning include hardware, such as a computer, laptop, mobile device and webcam, a form of a

listening device, video conference application and stable internet connections with a speed of at least 56k.

Pereira *et al.* (2018) point out the following problems regarding distance learning: the quality of the education, concealed costs, the fact that often not all costs are classified correctly, which may lead to future problems, technology can be misused, teachers' attitudes, teachers not being able to adapt to what is required to teach in distance education, students' attitudes and the fact that they have to be more committed than traditional students. Apart from these problems, Pereira *et al.* (2018) mention specific disadvantages and advantages for both students and educational institutions when it comes to distance learning. The advantages of distance learning for students include the flexibility of anytime, anywhere learning, content availability and low costs. The disadvantages of distance learning for students include the fact that they need self-discipline and are not able to get answers to questions immediately as they arise. The advantages of distance learning for educational institutions are that there is no need for physical space, lower costs and the fact that more students can be reached, as traditional classes can only have a specific number of students, while a single video lesson can be distributed to several classes. The disadvantages of distance learning for educational institutions are that the educational institution may lose its quality, feedback to students takes longer, teachers have been trained for traditional classes, which means that distance teaching may be difficult for teachers, and the misconception that distance learning is not as effective as traditional classroom courses.

Distance learning has the same structure as online learning (Heng & Sol, 2020). Online learning is defined as a modern education approach where advanced information technology is used via the internet (Mansingh *et al.*, 2020) or simply as learning that is directed through the internet (Saikat, 2021). East (2016) defines online learning as education through technology, with no direct social interaction. Online learning takes place through applications, virtual study portals and social media, provided that students or learners have the necessary hardware and software (Mansingh *et al.*, 2020). The students submit their work and receive feedback online. Interaction is not just between teachers and learners, but learners can also interact with one another online (Heng & Sol, 2020).

The benefits of online learning are that the geographical location is of no concern, reduced financial implications, learning can take place any time or any place and information is available at any time or any place as long there is an internet connection (Aotaibi, 2021). Cai and King (2020) summarise the benefits of online learning as feasible, flexible and accessible. Other benefits of online learning for educational institutions include profitability, educational benefits, extension of the institution and plentiful feedback and evaluation (Cai & King, 2020). The

downside of online learning is that there are inequalities in countries when it comes to access to the internet and technological resources. The high cost of internet access in some countries makes it difficult for students to participate (Aotaibi, 2021). Therefore, the digital divide is extended. Challenges to online learning are the technological infrastructure, lack of internet access, lack of digital competence, lack of supervision of assessment, socio-economic factors, insufficient training of teachers using technology and teachers' heavy workload (Heng & Sol, 2020). There are also limitations to online learning, which include the insufficiency of online start-up capital, the preparedness of the organisation, team development having differing stages, the fact that feedback is limited and the absence of recognising information during the assessment and referral process. Online classes also entail security risks (Cai & King, 2020).

Online learning has led to the development of massive open online courses. These courses are attainable to many people online. Zoom, Skype for Business, Panapoto, Google Meet, Voiceover in PowerPoint, massive open online courses and videoed lectures are all contemporary tools that are used to facilitate online classes, as they are easy to use anywhere with an internet connection (Cai & King, 2020). In some countries, Zoom has been banned from being used in companies, government sectors and schools due to privacy and security concerns. The external aspect, software aspect and company aspect are problems in utilising Zoom. However, Zoom is still a favoured online learning platform (Cai & King, 2020).

With online learning, there is also the aspect of online assessment. Online assessment involves different methods of assessment, such as multiple-choice questions, essays, case studies, e-portfolios, projects and presentations (Cai & King, 2020). The advantages of online assessment are that there is less cheating and more fairness, health benefits of avoiding gatherings in class and time is saved by learners not having to commute to the classroom. The disadvantages of online assessment are that the assessment software is expensive, a stable network connection is required, and the inefficacy of human supervisors (Cia & King, 2020). To authenticate the learner when online assessment is done, two categories of technology are used, namely the biometric approach and the technology approach. The biometric approach has subcategories, namely biological biometrics and behavioural biometrics. These technologies comprise face recognition, fingerprint recognition, knuckle scan, iris scan, keystroke recognition and voice recognition. The technology approach entails lockdown of the browser, mouse dynamics and examination analytics (Cai & King, 2020).

2.2.4.3 Mobile learning

Mobile learning, according to Hawamdeh and Soykan (2021), is the most cooperative tool in ICT. Gasparini (2018) defines mobile learning as the process when teaching and learning take place through the use of devices such as tablets, laptops and smartphones. According to Saikat *et al.* (2021), mobile learning has the potential to be a successful objective for education if the defects are resolved. Mobile learning can happen any place as long as learners have their mobile devices (Dabbagh *et al.*, 2016). The mobility of technology, mobility of the teacher and mobility of learners are three important bases of mobile learning (Dabbagh *et al.*, 2016). Mobile learning can be regarded as a subdivision of online learning (Saikat *et al.*, 2021) and has developed significantly globally, as it is a crucial supplier of learning for any age (Hawamdeh & Soykan, 2021). According to Hawamdeh and Soykan (2021), the traditional method of teaching has been changed by smartphones.

Gafni *et al.* (2017) list the following advantages of mobile devices: these devices are portable, readily available and flexible, provide easy access to information, material and feedback, and self-testing is possible. Shadiev *et al.* (2017) have found that smartphones and mobile phones are the most used mobile technologies. Mobile phones have also made learning second languages easier, and the outcomes are positive (Hawamdeh & Soykan, 2021).

Mobile phones have enabled individuals to have information, entertainment and communication worldwide at their fingertips (Brown, 2020). A mobile device is attractive to users as instant access to e-mail, voice and video calls, social media, mobile applications and online resources is available. Smartphones use the internet to communicate through wi-fi or 3G, 4G or 5G mobile networks. Smartphones have the following advantages: the battery life of smartphones is longer than that of laptops; numerous applications are available for smartphones; they can work almost anywhere where there is a mobile phone network or wi-fi; they can be used on the move; and they are small and easy to carry around (Brown *et al.*, 2019). The disadvantages of smartphones are as follows: the small screen makes it difficult to read; web browsing drains the battery quickly; it is easy to lose smartphones because of their small size; mobile phone networks are slower wi-fi; not all website features work on smartphones; and the memory size of smartphones is small (Brown *et al.*, 2019). The mobile application WhatsApp has been identified in a study as the most popular mobile application among students (Hawamdeh & Soykan, 2021).

Saikat *et al.* (2021) identified challenges of mobile learning, such as unreliable access to internet and electricity, the inability to respond immediately, the lack of skills of teachers regarding mobile learning and issues with regard to assessment and examination. The advantages of mobile

learning include access anywhere and anytime, covering a wide distance, a variety of information available and being there to test one's knowledge. The disadvantages of mobile learning are software problems, hardware issues, distractions as there are social media websites available, misuse and the lack of electricity or internet connection (Thomes, 2019). Mobile security should also be considered when utilising mobile learning. Mobile security includes implementation and preventative measures (Powers, 2021).

Insorio (2021) states that teachers have a key role in implementing mobile learning, as teachers, enthusiasm and readiness play a part in the implementation process. It is important that proper planning, preparation and training are done before mobile learning is implemented. There are different factors of readiness that need to be contemplated, such as technological readiness and operational readiness. Technical readiness refers to teachers' and learners' access to mobile devices, applications and tools. These applications need to have access to connectivity that costs money. Moreover, some applications are not free. Operation readiness covers the skills that are necessary to operate the mobile device, the realisation of mobile learning and teachers' and learners' attitudes regarding mobile learning. Therefore, before mobile learning can be implemented, the readiness of all stakeholders must be determined, most importantly, that of the teachers, as they are the deliverers of the curriculum to the learners (Insorio, 2021). Insorio (2021) has found that teachers are ready for mobile learning where accessibility and affordability are concerned, although they do need training and support.

2.2.4.4 Smart classrooms

Smart classrooms can be defined as classrooms that utilise digital equipment to enhance learning and teaching, such as laptops, screens and projectors that are connected through wi-fi (Western Cape Government, 2019). A smart classroom is a traditional classroom that includes multiple technologies and media systems to provide for teaching and learning needs (Li *et al.*, 2016). Smart classrooms are also known as intelligent classrooms. Smart classrooms include ICTs as web-based technologies, wireless, mobile technologies, whiteboard technologies and audio and video recognition technologies (Li *et al.*, 2016), as well as 3D animated models, instructional material, modules and videos to assist learners to attain understanding (Das, 2020). According to Hastings (2018), interactive flat panels have replaced the blackboard in a smart classroom. An interactive flat panel can be used by more than one user and has a touch screen and software to access and share resources with other devices. In a smart classroom, it is possible to record and stream class presentations. With this, if a learner cannot attend a class, the lesson can be sent to the learner. Online and offline classes are offered in smart classrooms (Kwet & Prinsloo, 2020). Smart classrooms offer new forms of data with considerable variation and quickness. Sensors

and cameras are used to transform the learning environment and change the pedagogical strategies employed.

Das (2020) remarks that smart classrooms make it possible for learners to understand concepts faster than verbal or written notes. Visual concepts make it easier for learners to understand the concepts clearly. Das (2020) notes seven concepts of a smart classroom, namely comfort, adaptability, connectivity, the Internet of Things, multiplicity, openness and personalisation. Learners in the 21st century use computers, laptops and smartphones, and as smart classrooms also include activities such as reading, writing, watching videos and playing music, these classrooms offer a comfortable learning experience. All the arrangements and tools in the classroom should be flexible or adaptable for varying settings and different learners. Smart classrooms make it possible for learners to be creative, use critical thinking and use various learning styles in the learning process. Learning takes place beyond the limited classroom space as visual and physical learning takes place.

Das (2020) identifies the main focus of smart classrooms as visual learning (animated multimedia lessons), fast and mesmerising learning, continuous advancement in learner education, the expectance of general high performance, learner assessment and evaluation and report cards. The hardware used in a smart classroom include an interactive smart board, projector, computer, uninterruptible power supply, speakers and teaching software.

The advantages of smart learning are as follows: the teaching and learning process is innovative and interactive; a flexible learning environment is set with audio-visual software; all learner needs are catered for; smart learning grabs the attention of the learners and they are focused on the learning; learners are easily assessed by teachers; modern and unique learning principles are incorporated; learning can be anytime and anywhere; and it is a creative and unique process of learning (Das, 2020). However, the following limitations of smart classrooms are indicated: teachers have to be familiar with new software and technologies; it is expensive to provide new technologies and implement them; smart technologies are not yet equalised in the education system; in remote areas, technical infrastructure is not adequate; many places do not have adequate teaching materials; the learning process may be hampered by insufficient technical knowledge; health problems can occur because of constant exposure to computers or mobile technologies; and many teachers are not clear about the smart class concept.

2.2.4.5 Blended learning

The European Commission (2020) defines blended learning as a flexible model to reinforce a course of study without requiring the teacher and learner to be in the same physical space at a specific time. According to Lorenzo (2017), blended learning is a precise education programme where a learner learns through both the online delivery of information and face-to-face instruction of information at a specific location. Blended learning is practical when it is not possible to attend school at a specific time, such as during the Covid-19 pandemic when schools were closed down. By using blended learning, learners could continue with their learning (European Commission, 2020). A blended learning method gives learners the opportunity to absorb concepts on their own time (Young *et al.*, 2017). Blended learning incorporates utilising web applications, multimedia presentations and video lessons, which creates an opportunity for learners to learn hands-on, which improves critical thinking. Open educational resources can be used in the online portion of blended learning, as these are free resources for educational purposes (Senanayake & Senanayake, 2021). The teaching and learning process of blended learning involves various factors, such as the learning environment, competence development process, affective domain and people (European Commission, 2020). Ruckdeschel (2018) points out that blended learning is a more economical plan to obtain effective education without overspending budgets. Online learning and face-to-face learning are the two main components of blended learning (Senanayake & Senanayake, 2021).

Blended learning has the following benefits: learners are not just submissive receivers of information; teachers are not just facilitators; individualised learning takes place; learners have independence in their learning; learners are motivated; learners' skills to become lifelong learners improve; digital competence develops; and teachers have an opportunity to differentiate and personalise teaching (European Commission, 2020). However, blended learning also entails challenges, such as that younger learners will struggle to learn independently, teachers need to have a high level of competence and be innovative and there needs to be a significant fundamental change in the education system (European Commission, 2020).

The flipped classroom is an approach to blended learning and entails an innovative and successful method that is used in classrooms. It is different from traditional teaching in classrooms. In a flipped classroom, learners have to come prepared for the topic to be discussed in the lesson. This implies that the content will be discussed to attain a deeper understanding of the topic. Learners watch pre-recorded videos before coming to class, and difficult concepts are elaborated on in the class. This concept shifts the teacher's role to guiding learners and no longer only lecturing (Hwang *et al.*, 2015). The flipped classroom method is learner-centred (Pallathadka

& Pallathadka, 2020). With the flipped classroom approach, distance learning happens before in-class learning (European Commission, 2020). The essentials of the flipped classroom approach are healthy surroundings, a switch in the learning culture, planned content and skilled teachers (Pallathadka & Pallathadka, 2020).

Flipped classrooms demand advanced experience of information before the class starts, support assistance in the education field, enhance the method to evaluate learners' cognitive ability and develop higher-order thinking with a focus on the inclusion of peer learning (Pallathadka & Pallathadka, 2020). The following advantages of the flipped classroom approach have been identified: the approach increases the quality of time spent in class; there is an end number of progressive results; teachers can successfully connect the learners' understanding inside and outside the classroom; learners can think more critically and ask questions, as they have background knowledge; team-building and problem-solving skills are increased; and the interactive cognitive ability of learners is advanced in the atmosphere of a flipped classroom (Pallathadka & Pallathadka, 2020). The disadvantages of the flipped classroom approach include the following: sceptical teachers; learners not watching the videos; learners who do not watch the material like others will not be able to participate and work at the same speed as the others; knowledge of technology is needed; and teachers need to find more materials for successful implementation (Pallathadka & Pallathadka, 2020).

2.2.4.6 Educational robotics

Educational robotics is a contemporary and successful instrument that naturally complements the virtual learning environment (Boyarinov & Samarina, 2020). According to López-Belmonte *et al.* (2021), educational robotics aims to teach learners to design and create a programmable robot that will be able to carry out numerous actions, such as moving, responding to stimuli or communicating through light, sound and images. Educational robotics contributes to learners' logical thinking, cognitive skills and special insight. Science, technology, technology, engineering, arts and mathematics are branches of educational robotics. Introducing educational robotics in schools will help learners to develop 21st-century skills (Alimisis, 2021), such as problem solving, critical thinking and teamwork.

The first educational robotic kit for schools was announced in 1988 and was called the "LEGO TG" (Leoste, & Heidmets, 2019). Ahmed and Manh La (2019) declare that the use of artificial intelligence, social robots and robotic kits in education has a positive impact on learners' problem-solving abilities, skills development and social and cognitive development related to science, technology, engineering and mathematics. Educational robotics is a rooted element of robotics.

With educational robotics, there are computational operations that empower learners to write programs and test them through a robot. Uncomplicated activities of educational robotics include movement with wheels and humanoid robots that walk and move their arms and legs. Knowledge of these computational concepts in primary and secondary education can further be explored by setting in motion algorithms, variables, conditional statements, loops, parallel implementation and event control. The role of robotics in education can be categorised into three categories, namely robots as tutors, robots as tools and robots as peers (Ahmed & Manh La, 2019).

Screpanti *et al.* (2021) identify the four main areas of educational robotics as assistive robotics, social robotics, socially assistive robotics and educational robotics. Assistive robotics assist in overcoming physical disabilities that may prevent teaching and learning. Social robotics is where the teacher or tutor transforms lessons to be interactive and connected. Socially assistive robots help learners to reduce their social and physical disabilities. Educational robotics assist learners in developing technological and content competencies. López-Belmonte *et al.* (2021) state that the common implementation process of educational robotics is through robotic kits that are given to learners. Robotics kits are fitted for a specific age and capabilities. There are also other resources to be used in educational robotics, such as Scratch, Wedo 2.0, Lego Boost, Makey Makey, Arduino and Microbit. Robotics systems that schools can use include physical robots, robotic kits, service robots, virtual agents and artificial intelligence applications for laptops, mobile devices and tablets (Ahmed & Manh La, 2019).

The advantages of educational robotics include the improvement of learning, the growth of particular cognitive skills and the instruction of complex scientific concepts (López-Belmonte *et al.*, 2021). Saéz *et al.* (2021) explain that educational robotics can be employed to work with real-life contexts to resolve different types of problems and situations. Using educational robotics makes it possible to integrate group work into the learning process (Boyarinov & Samarina, 2020). Despite the various advantages of educational robotics, the lack of well-established practices, assessment experiences and tools slows down the implementation process of educational robotics (Screpanti *et al.*, 2021). Problems with implementing educational robotics in schools include negative attitudes, a lack of teacher training, logistical problems and the non-availability of school resources (Saéz *et al.*, 2021). According to Leoste and Heidmets (2019), it is easier to implement robotics in technology subjects than in subjects such as mathematics although programming and using robots do include mathematics.

The financial implication of robotics poses a challenge to implement educational robotics in schools and even for families at home (Alimisis, 2021). However, there are options to lower the costs for schools, for example, by making learners build robots from scratch. As gathered from

the eCraft2Learn project, the arts and crafts method increases learners' understanding of how a robot works, increases creativity, triggers the curiosity of learners and ensures collaboration.

Although educational robotics has not formally been implemented in school education systems, the potential that it will be included in various education systems is positive (López-Belmonte *et al.*, 2021). It is, therefore, important for policymakers to get involved with teachers to provide a policy, vision, planning and funding to implement educational robotics in schools. It is necessary to involve different public and private funding organisations to provide funding for the implementation of educational robotics (Ahmed & Manh La, 2019).

2.2.4.7 Cloud computing

Cloud computing can be defined as the active provisioning of computing potential with hardware, software and services given by a third party for the network (Belbergui *et al.*, 2017). Nwadike (2021) defines cloud computing as the confinement of services including storage, database, development tools, networking capabilities, software, analytics and intelligence over the internet, flexible resources and economies of scale. Through cloud computing, users can store files and applications on remote servers and then access these files and applications through the internet. Cloud computing is a widening, innovative technology, with numerous benefits (Belbergui *et al.*, 2017). The cloud grants distant users access to various computing and resource storage capabilities that users pay for as used. Furthermore, cloud computing offers computing resources such as cluster computing, distributed systems and web-based services (Assaf *et al.*, 2021).

The first computing cloud was launched by Amazon in 2006, with an EC2 and S3 infrastructure (Abimbola, 2021). Since then, competition has emerged among cloud providers, with extensive technology innovations and creativity. Amazon Web Series, Google Cloud Platform, Microsoft Azure, IBM Blue Mix and Salesforce are regarded as the main public cloud providers (Abimbola, 2021).

There are mainly four sections of cloud computing, namely cloud security, cloud interoperability, cloud resources and service description, and cloud services discovery and selection (Agbaegbu *et al.*, 2021). Cloud systems can be managed by either someone inside the organisation or a third party (Belbergui *et al.*, 2017). Belbergui *et al.* (2017) identify five characteristics of cloud computing, namely free on-demand resources, extensive network access, combining resources, quick elasticity and remunerate as used. On the other hand, Assaf *et al.* (2021) indicate self-service, broad network access, resource pooling, rapid elasticity and measured service as the five characteristics of cloud computing. The benefits of cloud computing are on-demand service,

adjustability, flexibility and the cutting of costs. Risks of cloud computing include deficiency of infrastructure, robbery or loss of sensitive resources, instability among authorities and security risks. Security risks include data loss, modification of data, the inability to recover data and loss of control over data (Belbergui *et al.*, 2019).

Assaf *et al.* (2021) list the following benefits of cloud computing: increased modern security; cloud technology lowers and removes operating costs; cloud computing is adjustable and can be used with various applications; expansion adaptability; cloud computing is simple to set up and use; cloud computing provides fast deployment; cloud computing has the potential to respond to changing environments quickly and effectively; expert service providers maintain the network and data access, making it reliable; shared resources software and infrastructure in a central data set; disaster recovery in cloud computing is made simple and easy; multinational organisations have access to information, regardless of where they are geographically; and centralised infrastructure is used that reduces pollution because of less duplication of documents. Another advantage of cloud computing is that it gives organisations and businesses the chance to have access to high-quality computing without complex infrastructures (Abimbola, 2021). Moreover, there are no hardware differences in the cloud, as there is a homogeneous environment where the user uses root access to have full control, and there are no architecture differences in the cloud-computing resource.

However, cloud computing also holds particular risks, such as the following: security and privacy of the information on the cloud; networks and user machines; risk of shared technology; the changing from one provider to another can be an annoying process; internet speed affects the performance of the cloud; consistency compliance is a success factor that can prevent cloud computing from securely doing transfers; although cloud computing is cheap to install, it requires updating of features, which means high maintenance and operational costs; organisations can be vulnerable to threats and external hack attacks; and the control of information is a risk, as information is stored in third-party information centres and the provider has full control over the information (Assaf *et al.*, 2021). Challenges to the implementation of cloud computing include the cost of the software, hardware and server installation, which can impede the starting process (Assaf *et al.*, 2021).

There are private and public clouds (Agbaegbu *et al.*, 2021), as well as a hybrid cloud with both private and public clouds (Belbergui *et al.*, 2017). A private cloud is where the access is only within the institution and it is managed from within. The advantage of a private cloud is that it ensures greater privacy and security and keeps the control of structures and information within the institution, while the disadvantage thereof is the high cost and limitations to expandability. In

a public cloud, access is open to the public. The advantages of a public cloud are that no advance payment is needed, the customer is not limited by hardware or infrastructure management and the system can respond to the customer at any time. The disadvantages of a public cloud are that it is difficult to protect the cloud from being accessed by criminals and that the system is at risk due to many customers using the cloud at the same time (Agbaegbu *et al.*, 2021). A hybrid cloud is a combination of two different infrastructures that consists of the public, private community cloud and internal or external cloud hosting. A disadvantage of a hybrid cloud is that there are different security characteristics, and from these less critical systems, an attacker has an opportunity to access the system with critical security. Providers are not yet using special security measures that should address this problem. The security requirements of the hybrid cloud include accessibility, uprightness, confidentiality and audibility (Belbergui *et al.*, 2017). Internal cloud hosting refers to a cloud that is internal to the user organisation and shared with other privileged users inside one organisation. External cloud hosting is attainable through the internet and is supervised by an external provider (not the owner of the organisation). Risks of external cloud hosting include the reissuing of resources, the non-separation of data and environments, and the loss of governance and control (Belbergui *et al.*, 2017).

Belbergui *et al.* (2017) indicate that particular elements must be protected and secured when using a cloud, namely the access of items, information technology infrastructure, user resources and networks. Virtualisation as an enabling technology will ensure that servers are available to provide access to the computing experience for most of the cloud platforms. The cloud uses the data centres to merge underutilised servers. Through virtualisation and the merging of servers, the resource pool of the cloud environment is created. The cloud computing market will continue to grow. However, there is, as mentioned above, the issue of security that holds organisations back from using cloud computing. Several other advanced technologies, such as machine learning and artificial intelligence, can be introduced to improve data security management (Abimbola, 2021).

2.2.4.8 Virtual reality and augmented reality

Virtual reality is defined as a virtual item in a virtual environment known as a simulation or an artificial recreation, where a computer-generated real-life situation is created that gives the user the impression that he or she is experiencing the reality first-hand through what he or she can hear and see in the simulation (Rebbani *et al.*, 2021). Brown *et al.* (2019) define virtual reality as an artificial environment generated by software. The user makes use of data goggles, sensor suits, data gloves or helmets to feel that he or she is in a particular reality. Virtual reality is used more in upper secondary schools, as it is becoming more affordable and user-friendly (Graeske

& Sjöberg, 2021). Linowes (2018) states that virtual reality aims to attain a solid sense of being present in the virtual environment. Virtual reality is commonly used in games, but it also offers other different kinds of experiences for different applications (Linowes, 2018).

The benefits of making use of virtual reality in education are that it expands learner participation in learning, expands the number of genuine learning experiences, allows for human experiences and empowers learners to be creative. Teacher-centred education leads to disengaged learners; this is where virtual reality can assist with learner engagement, as virtual reality is a hands-on, interactive experience. Learners have the opportunity to construct their understanding of the content through a meaningful virtual reality experience. Virtual reality, according to Sung *et al.* (2020), is an exceedingly emerging sense associated with technology. There are two types of classifications in virtual reality, namely non-immersive and immersive virtual reality (Rebbani *et al.*, 2021). Non-immersive virtual reality refers to a computer simulation of the real world, whereas immersive virtual reality includes dimensions of immersion interactivity where the user is detached from his or her environment. Virtual reality uses special electronic equipment, such as display goggles and motion sensors. Two types of headsets are used as processing units – one that needs a detached processing unit, like a personal computer and console that works with a powerful central processing unit, and another that uses mobile technology for processing (Linowes, 2018).

The advantages of virtual reality include refined incentives, extra efficient communication and evaluation, greater understanding of complex systems through effective graphics, possible alteration after individual needs, high security, less usage of material, environmental friendliness and cost-effectiveness (Häfner *et al.*, 2018). Furthermore, learners' motivation for creation and exploration in their work increases when they use virtual reality. Challenges of virtual reality, according to Graeske and Sjöberg (2021), are as follows: virtual reality instruments are very expensive and difficult to use, as they need specific technical expertise; organisation and logistics are necessary as virtual reality instruments are usually shared among learners; software is difficult to obtain, as the software is specific to particular scenarios; language can be a challenge, as English is usually used in producing the instruments, which makes the instruments difficult to use by smaller children whose first language is not English; and providing continuous development for teachers can be a challenge. Other challenges of virtual reality in schools are budgets, time and planning.

The concept of augmented reality is linked to virtual reality. Rebbani *et al.* (2021) define augmented reality as a system that complements the real world with virtual objects. It involves the process of combining the real reality and the virtual addition to it. Augmented reality makes it

possible for the user to experience different tasks, as the reality is overlaid with computer-generated improvements to the existing reality to be able to interact with it (Rebbani *et al.*, 2021). The characteristics of augmented reality are that it performs interactively in real time, merges real and virtual objects in a real environment, and the real and virtual objects line up with one another. Augmented reality aims to improve the exhibition and comprehension of the real world by overlaying virtual information on one's vision of the real world. The difference between virtual reality and augmented reality is that augmented reality makes use of the real environment and imposes virtual objects on it, whereas virtual reality designs a completely artificial environment. Bazavan *et al.* (2021) explain that the difference between augmented reality and virtual reality is in the devices it is displayed with. In augmented reality, a smartphone can be used to display virtual images over a real environment, while virtual reality needs a display device, such as virtual reality glasses to display an immersive virtual environment without the real environment. The technical difference between augmented reality and virtual reality is that in augmented reality, the real environment is augmented, and in virtual reality, it is an entirely immersive virtual environment. Moreover, in augmented reality, a presence of the real world is kept by the user, while in virtual reality, the visual sense of the user is under the virtual reality system control. In augmented reality, the user is partially immersed, while the virtual reality user is fully immersed. Lastly, augmented reality does not require special head devices, while virtual reality requires a virtual reality headset device (Bazavan *et al.*, 2021).

Virtual reality and augmented reality provide various educational opportunities over traditional training applications, such as the execution of tasks without risks, mistakes that can be made without an impact on safety, scenarios that can be simulated that can be experienced in reality, no time limitations and the fact that these technologies do not use a lot of space and different applications can be experienced by one system (Rebbani *et al.*, 2021). Still, there are some limitations to virtual reality and augmented reality: exclusive hardware is required; augmented reality and virtual reality products or devices are very expensive, which leads to customers not buying them; there are some problems in terms of mobility that may be solved when these products are more portable, lightweight and small-scale; and cyber security is a big risk when working with these technologies (Rebbani *et al.*, 2021).

Linowes (2018) states that the first successful virtual reality experience was the Titans of Space, where users could explore the solar system first-hand. The Virtual Reality Company (2020) in South Africa tested virtual reality with 50 children. First, the company let the children do a science experiment in virtual reality. After that, the children had to do the real science experiment in person. All 50 children could do the science experiment without fail.



Photo 2-1: Virtual reality experience (Virtual Reality Company, 2020).

Virtual reality must be paired with curriculum and educational goals (Graeske & Sjöberg, 2021). Augmented reality and virtual reality are powerful technologies that can change the way people interact with information worldwide (Linowes, 2018). Holographic imaging was developed from virtual reality devices (Habboosh, 2022).

2.2.4.9 3D and holographic imaging

A source of laser light, interference of light, light diffraction and light intensity recording are involved in the technology that is used in holographic imaging (Brown *et al.*, 2019). Khan *et al.* (2020) state that 3D and holographic imaging can assist the learning process through the 3D view, an exhibit that covers a 360° view, visual depth, actual-size presentation, true-life replication and the method by which information is presented. Holography was invented in 1947 by Dennis Gabor (Elmarash *et al.*, 2021). Theoretical and practical information can be presented in a classroom through the use of holographic imaging. Holographic imaging has the following characteristics: the hologram projects light to the eye that is similar to light coming to the eye from the original scene; the 3D hologram does not project the natural colour; a whole image is preserved by cutting the hologram into pieces to reconstruct; the 3D vision creates a real feeling through the hologram and not a physical experience; and the utmost depth of the item can be identified through the hologram as it is coherent with lengths of lasers (Elmarash *et al.*, 2021). The tools that are needed to create a hologram image are red lasers, lenses, a beam splitter, mirrors and holographic films. While there are numerous types of holograms, the transmission hologram, reflection hologram and hybrid hologram are regarded as the most extensive types of

holograms (Elmarash *et al.*, 2021). A transmission hologram, presented as a deep, sharp image, is observed with laser light that is regularly the same kind to make the recording. A reflection hologram is a 3D image of the accepted image; this hologram type is the most customary hologram, as it is simple to set up and is visible without laser light. The hybrid hologram is a merger of the transmission and reflection hologram (Elmarash *et al.*, 2021).

The advantages of holographic imaging are that the technology enables learners to understand content more successfully, different subjects and training programmes have the opportunity to present 3D dimensions in doing practical experiments and presentations, learners feel more inclined to learn and holographic imaging can be implemented in distance learning to provide distance learners from different geographical areas with real-life classes (Elmarash *et al.*, 2021). Other advantages of holographic imaging are that it provides an excessive storage capacity, increases the practicality of objects that also have depth (as all dimensions are visible) and does not require a projection screen (Habboosh, 2022). The disadvantages of 3D and holographic imaging are that these technologies require a complicated device, they are not suitable for learners who experience neurological vision problems, the quality of the 3D holographic imaging is a concern and the high costs of these technologies may hinder the implementation process. While the cost of holographic imaging components has been reduced, the cost of producing holograms extensively remains immense. The need for fast internet and an implementer with specific skills is another challenge to implementing holographic imaging. Moreover, skilled and innovative designers who can produce practical education with holographic technology are required (Elmarash *et al.*, 2021). Another challenge is the training of teachers and learners to use holographic imaging technologies (Habboosh, 2022).

A practical example of how holographic imaging can be used in a Life Science classroom entails using a hologram of human organs and then teaching learners simple dissections and protocols. With this image, the learners will experience and learn about dissection without risks and without requiring physical organs (Elmarash *et al.*, 2021). Hoon and Shaharuddin (2019) did a practical study of 3D holographic imaging in a primary school to determine the effectiveness of the model in enhancing learners' learning in the classroom. The findings of the study were that the learners' interest and attention were grabbed by the holographic imaging effect, teachers were also excited by the holographic imaging technology, the fan-type hologram was preferred to the pyramid projector hologram and it would be beneficial for the hologram projector to have a built-in sound system (Hoon & Shaharuddin, 2019). However, it was also found that the collection of data was a challenge for the learners. It was found in the study that holographic imaging should be used for presenting information in conjunction with guiding learners through a cognitive process during learning.

It is necessary to keep in mind specific issues that may arise when holographic imaging is used. These issues include failure of equipment, challenges with regard to electricity, electrical bulbs burning out and the breaking of components (Khan *et al.*, 2020). On the other hand, according to Elmarash *et al.* (2021), the implementation of holographic imaging may lead to a breakthrough in artificial intelligence.

2.2.4.10 Artificial intelligence

Artificial intelligence can be defined as a computer-based system that can fulfil a specific task through particular competencies and intelligent behaviour that previously were only recognised in humans (Chaudhry & Kazim, 2021). It is a type of technology that plays a role in creating social robots, smart learning and intelligent tutoring systems. Artificial intelligence assists machines to behave in the same manner that an intelligent human would do. This indicates that machines can carry out cognitive functions like a human's mind, such as problem solving and learning. An intelligent tutoring system is an intelligent system that interchanges information and gives a test of a learner's knowledge. This system can tutor learners by teaching a topic, asking them questions and even responding to their answers (Ahmad *et al.*, 2021).

Artificial intelligence was developed in four waves (Alam, 2021). The first wave started in the 1950s as an artificial intelligence program code; during the 1970s, artificial intelligence in expert systems began; during the mid-1980s, the artificial intelligence-grounded automatics data-processing system began; and from 2000, machine-learning integrated artificial intelligence was established. Artificial intelligence in the education field is still in the early stages, but several trials are being conducted and basic applications are available. The fact that more attention is given to artificial intelligence technology and not to the practical application thereof is the reason for its slower development in the education sector than the artificial intelligence technology itself. Virtual reality, augmented reality and next-generation technologies are used by artificial intelligence. Artificial intelligence is used by learners in flipped classrooms and with blended learning methods.

Baker (2021) points out that artificial intelligence can be used to determine what learners know and to assess learners' shortcomings. This can be done with dashboards that have information on learners' learning and challenges, where teachers can use the information to make informed decisions regarding strategies for their learners' learning process.

The following challenges of applying artificial intelligence are listed by ProFuturo Fundación Telefónica (2019): the development of a thorough general policy for artificial intelligence progress; establishing comprehensive and unbiased use of artificial intelligence in education; the

development of artificial intelligence-driven education; the development of comprehensive and quality data systems; research on artificial intelligence in education must be meaningful; and the collection, use and circulation of data must be ethical and transparent.

Artificial intelligence holds particular risks such as teachers fearing that they will be replaced by robots and the fact that artificial intelligence does not have emotions to make connections (Tao *et al.*, 2019). Other risks are that wrong decisions can be made, the digital divide will broaden and private information may be leaked (Qian, 2021). These risks can be minimised by the government putting in place improved laws and regulations regarding artificial intelligence and product developers ensuring that the use of data and algorithms is clear and balanced. Moreover, inclusive and fair applications should be encouraged, applications must be constructed efficiently and safely and teachers have to change their role orientation to implement artificial intelligence.

2.2.5 Covid-19

The coronavirus disease 2019 (Covid-19) was first discovered in Wuhan, China, in 2019 (Mhlanga & Moloi, 2020). On 11 March 2020, the World Health Organisation announced Covid-19 as a global pandemic. Covid-19 is a serious acute respiratory syndrome coronavirus and part of the coronaviridae family of viruses that cause respiratory infections (Lone & Ahmad, 2020). According to the World Health Organisation (2021), common symptoms include respiratory problems, fever, cough, shortness of breath and breathing difficulty. In serious cases, it may lead to severe acute respiratory syndrome, kidney failure, pneumonia and death. The World Health Organisation (2021) advises that to prevent the spread of the virus, one should regularly wash one's hands, cover one's mouth and nose and avoid close contact with other people.

Various Covid-19 vaccines are available. They differ in the way they are made and the way they work, but ultimately, they protect people against the Covid-19 virus. The World Health Organisation (2021) authorised these vaccines and extensively reviewed them. In this, the European Medicines Agency and other national regulatory agencies were consulted. Vaccines help people to increase immunity against a virus. The World Health Organisation (2021) encourages people to get vaccinated against Covid-19, as it is not only protecting themselves but also the people around them. A huge challenge incurred with Covid-19 was that there were various new strains. However, the feedback received by the World Health Organisation on the efficacy of the vaccines against most variants is reassuring. Although vaccines are a mechanism to make an impact on the pandemic, they did not immediately dissolve the virus.

Covid-19 vaccines that are intended to increase immunity against Covid-19 have become available in countries. No vaccine gives 100% protection against the disease. It is important that countries reach herd immunity. Herd immunity is when many people in a community are vaccinated. This makes it hard for the pathogen to circulate among individuals. There are several steps before Covid-19 vaccines are delivered and given to the public. Firstly, it should be proven to be effective and safe in substantial clinical trials. Secondly, evidence of independent reviews of the safety and efficacy of the vaccine is needed. Thirdly, the evidence has to be reviewed to make recommendations on implementation. Fourthly, the World Health Organisation has a panel of experts named the Strategic Advisory Group of Experts on Immunisation that inspects the clinical trial results. Fifthly, the panel makes recommendations on the implementation process. Lastly, officials of countries approve the vaccines for use and then develop policies of implementation in their country with recommendations of the World Health Organisation (Department of Health, 2021).

The seriousness of the pandemic became obvious when statistics of the cumulative positive cases and deaths in different countries were published on media platforms (Ramrathan, 2020). The main objectives of countries were to save lives and prevent damage to the economy and job losses. Therefore, numerous countries shut down their schools to prevent the spread of the disease. However, as a sense of ethics, it was important for education to continue during the pandemic, even if it could not be the traditional way of teaching (Le Grange, 2020). Schools had to make use of online learning and home-schooling to ensure that learning could continue (OECD, 2020a). Education technologies were useful tools to engage with the curriculum although, according to the OECD (2016), education systems are commonly disinclined to innovation.

2.2.6 Covid-19 in South Africa

South Africa recorded its first Covid-19 case on 5 March 2020 (Mhlanga & Moloi, 2020). President Cyril Ramaphosa declared the Covid-19 pandemic a state of disaster on 15 March 2020. On 23 March 2020, the president issued a national lockdown, which meant that schools had to close for 21 days. On 9 April 2020, the lockdown was extended by 14 days, after which it was extended again. On 31 May, the country was put on lockdown Level 4 of the Covid-19 pandemic strategy (South African Government, 2020a). The lockdown level was reduced to Level 3 on 1 June 2020, which meant that 33% of learners were allowed back at school. On 18 August 2020, the country was put on lockdown Level 2, which meant that 66% of learners could return to school (South African Government, 2020b). On 9 December 2020, Health Minister Doctor Zweli Mkhize reported that South Africa was entering a second wave of the Covid-19 pandemic due to a rise in Covid-19 cases and deaths (South Africa Coronavirus Online Resource & News Portal, 2020). Because

of this second wave, the opening of school after the summer holiday was postponed to 15 February 2021. The pandemic affected schooling in South Africa drastically, as normal vocational training could not be done effectively.

On 27 June 2021, South Africa entered an adjusted Level 4 lockdown, as the Delta variant drove the third wave of increased infections. Shocking information from the National Institute for Communicable Diseases was released on 19 June, namely that 10,2% of the Covid-19 cases at that time were individuals younger than 19 years. The number of Covid-19-related deaths among individuals from age zero to 19 was 267 (United Nations International Children's Emergency Fund [Unicef], 2020). Schools were closed on 30 June 2021 and ultimately reopened on 26 July. As of 26 July 2021, South Africa went back to lockdown Alert Level 3. From 13 September 2021 to 30 September 2021, South was on adjusted Alert Level 2. On 1 October 2021, South Africa was put on Alert Level 1 restriction until April 2022. On 4 April 2022, the president announced that the national state of disaster was lifted from 5 April 2022 (South African Government, 2022a).

According to the South African Coronavirus Online Resource and News Portal (2020), on 16 April 2022, there were 3 740 398 cases of infection and 100 144 deaths in South Africa due to the Covid-19 pandemic. These statistics increased daily. The government's vaccine strategy was to make use of the Pfizer and Johnson and Johnson vaccines (Unicef, 2021). The Department of Health (2021) indicated that the goal in South Africa was to immunise 67% of the population by the end of 2021. On 23 June 2021, the education sector, including 400 000 teachers, cleaners and food handlers started to receive the Johnson and Johnson vaccine (Unicef, 2021). On 28 February 2022, a total of 34 354 814 vaccines have been administered in South Africa (South African Coronavirus Online Resource & News Portal, 2020).

2.2.7 Covid-19 in New Zealand

New Zealand was one of the first countries that implemented a strategy against the Covid-19 pandemic. As New Zealand is an island nation, it had late exposure to Covid-19. New Zealand reacted fast by adopting the following strategies to control the pandemic: lockdown, tracing, testing contacts, instructing citizens to stay within bubbles with immediate family and promoting public messages (Hendrickson, 2020). Assistance by the government was provided to businesses to hold on to staff. In February 2020, preparations for hospitals and border control started. On 28 February, the first case of Covid-19 was detected in New Zealand – an individual returning from Iran (Hendrickson, 2020). One month later, on 21 March 2020, the prime minister initiated a national lockdown Level 4. Lockdown Level 4 entailed the mandatory lockdown of businesses and individuals (Hendrickson, 2020), which implied that people were to stay in their homes,

funerals could not be attended and all nonessential business and educational institutions were required to close. On 28 April 2020, the country moved to Level 3. Some children (mostly children of essential workers) were allowed to return to school, but the majority of education remained online. The country had seven weeks of national lockdown. On 8 June 2020, the country moved to lockdown Level 1, which meant that there were only 103 days of lockdown (Kunzmann, 2020).

On 5 August 2021, the Ministry of Health (2021a) reported that there had been 2 880 cases of infection and 26 deaths in New Zealand due to the Covid-19 pandemic. As the Covid-19 pandemic is not over yet, these statistics continue to change. The Covid-19 tracer application has three million registered users. However, only 31% of users use the application frequently, 24% use it sometimes and 21% do not use the application but are registered, while 24% have not installed the application (Morton, 2021).

On 5 August 2021, the Ministry of Health (2021b) reported that 1 312 879 people had received the first dose of the Pfizer Covid-19 vaccine and 795 688 had received the second dose of the Pfizer vaccine. An individual from the age of 16 can get the Covid-19 vaccine (Williams, 2021). On 17 April 2022, the *New Zealand Herald* (2022) stated that 4 023 184 first vaccine doses, 3 976 757 second vaccine doses, 31 684 third vaccine doses and 2 613 123 booster vaccine doses had been given. To that date, New Zealand had recorded 822 643 Covid-19 cases.

2.2.8 Sustainable development

In 2015, all United Nations member states adopted the 2030 Agenda for Sustainable Development. This agenda provides a blueprint for peace and prosperity for now and the future. There are 17 sustainable development goals. Education is Goal 4 of these goals and entails arranging fair access to quality education for all and filling openings in the education systems of the member states (United Nations, 2021).

Both South Africa and New Zealand adopted the 2030 Agenda for Sustainable Development Goals of the United Nations in 2015. Education plays a leading role in sustainable development, as education can change the behaviour of individuals to attain sustainable development (Sung *et al.*, 2020). The foundation of sustainable development is providing for the needs of the present without risking future generations to provide for these needs. South Africa released a baseline report in 2017 and a country report in 2019 (Statistics South Africa, 2019). In December 2019 Statistics South Africa launched an online data portal to track sustainable development goals. In 2019, New Zealand was part of the Voluntary National Review of the United Nations on sustainable development goals. The report gives an outline of New Zealand's approach,

challenges and future work regarding sustainable development goals. In New Zealand, Statistics New Zealand covers data on sustainable development, as well as other data on the country.

2.3 Conclusion

Education systems are very complicated, and as various external determinants affect one another, it can also be that one determinant may assist another. Educational institutions have realised the advantages of including technological services, such as ICT, in education, which leads to new models of education such as e-learning, interactive learning and blended learning. ICT elements are linked and part of one another; for instance, mobile learning begins distance and online learning, and virtual reality is part of mobile learning. As seen in this chapter, there are many ICT systems that seem to be a solution for countries for their education standing before and during the Covid-19 pandemic. School learners and even adult learners can learn with advanced online interaction, such as simulation, games, virtual reality and augmented reality. The concepts in this literature review are used throughout the research and data analysis process to determine the status of ICT in the school education systems of South Africa and New Zealand during the Covid-19 pandemic.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

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3.1 Introduction

Research is a process where a researcher takes small rational steps to understand a situation or an issue (Creswell & Guetterman, 2020). At the end of the day, research also improves practices. It is a scientific approach to solving the research problem through a systematic and orderly collection, organisation and analysis of data (Kabir, 2016). The specific approach that the researcher has chosen will structure the plan of action the researcher will use in the steps of the research. A research approach is the plan or course of action that cover the steps from general assumptions to detailed methods of data collection, analysis and interpretation (Creswell, 2014). In each approach, there are specific components to answer the research questions of a research study. This chapter elaborates on how it was accomplished in this research.

There are three main research approaches, namely the qualitative, quantitative and mixed-method approaches (Creswell, 2014). The type of data that is needed to answer the research problem indicates what approach will be used. Quantitative research generally uses numerical data, and qualitative research uses textual data. The qualitative research approach gives the opportunity for available data to be used in the data collection process (Marimo, 2020). Qualitative research takes from the interpretivist and constructivist paradigms. In this study, the researcher made use of the qualitative research design and an interpretivist paradigm. This paradigm pursues to construct an understanding of individuals' viewpoints (Creswell & Poth, 2018).

This research was done within the field of international and comparative education. Audiopedia (2018) defines comparative research as a research methodology in social science that aims to make comparisons across different countries or cultures. This type of research uses the comparative method to answer the research questions. With this method, by comparing various aspects, new things are discovered and many disciplines are used in one research study (Audiopedia, 2018). What separates comparative research from other research is the approach it uses (Milošević & Maksimović, 2020); however, the research techniques in comparative research do not differ from those of other fields of study. According to Bukhari (2011), there are two approaches to comparative research, namely descriptive comparison and normative comparison. The goal of descriptive comparison is not to effect changes to items, whereas normative comparison finds and describes similarities and differences to effect changes for improvement.

In the current study, the researcher made a normative comparison. Document analysis was used to gather data, and content analysis was used to analyse the data. During this process, the comparative method was used. The researcher followed the six steps in the process of research proposed by Creswell and Guetterman (2020). First, the research problem was identified, as discussed in Chapter 1. Second, the literature was reviewed in Chapter 2. Third, the purpose of the research and how it was conducted are explained in this chapter with regard to the research design and methodologies that were used. Fourth, data were collected, as explained in this chapter. Fifth, the data were analysed and interpreted, as discussed in Chapter 4. Last, the findings of the research are reported in Chapter 6. The reader is reminded that the aim of this study is to compare the status of ICT in the school education systems of South Africa and New Zealand during the Covid-19 pandemic.

3.2 Research design

A research design is a plan, structure and procedure to answer the research questions (Kumar, 2011). Asenahabi (2019) defines research design as a plan undertaken by the researcher before data collection to accomplish the research objectives. The research design aims to give a suitable framework for the research (Sileyew, 2020). According to Sileyew (2020), the researcher will be backed by the research approach to acquire research findings. The research approach regulates how the relevant data for the research are acquired. The nature of the research design is to convert the research problem into a data analysis to address the research problem and research questions at the lowest cost possible. In the research design, the researcher's ideas are considered in terms of how the research objectives are attained. With this, the conceptual research problems and the relevant, attainable, actual research are connected. The research design consistently determines the kind of analysis that is done to achieve the research objectives (Asenahabi, 2019). The research design includes the research paradigm and the research approach to be used in the research. The research approach and paradigm of this study are discussed next.

3.2.1 Research approach

According to Creswell and Guetterman (2020), when research is done in the education sector, the approaches considered are quantitative, qualitative or mixed-method research designs. In quantitative research, the aim is to determine a connection between studied variables, and in qualitative research, the aim is to understand the social condition from the contributor's viewpoint (McMillian & Schumacher, 2010). A mixed-method design involves the use of a quantitative and a qualitative research design (Creswell & Guetterman, 2020). In the quantitative research design,

numerical data are collected and then analysed by relating variables, comparing trends and interpreting the data (Creswell & Guetterman, 2020).

As stated earlier, this research made use of the qualitative research design. According to Leedy and Ormrod (2015), qualitative research usually involves a thorough study of a topic to understand the core event. Qualitative research makes a point of collecting data in a natural setting (Haradhan, 2018). Fraenkel *et al.* (2015) state that the data of qualitative research rely on words, and not numbers like quantitative data. The data of qualitative research can also be interview transcripts, field notes, photographs, audio recordings, videotapes, diaries, personal comments, memos, official records and textbooks. Every detail of the event is regarded as paramount in qualitative research (McMillian & Schumacher, 2010). In qualitative research, a researcher is a key tool, there are multiple sources of data and the data analysis is inductive and deductive (Creswell & Creswell, 2018). Fairbrother (2014) remarks that qualitative research aims to describe the context and views of a topic. Furthermore, qualitative research is characterised as inductive, flexible and exploratory (Fairbrother, 2014). Qualitative research is context-bound, and therefore, the researcher has to work delicately with the context (Haradhan, 2018).

The qualitative approach creates a specific benefit to developing countries in understanding the real occurrence of learners and teachers (Milošević & Maksimović, 2020). Milošević and Maksimović (2020) conclude that the qualitative approach is an essential part of comparative research, as it provides a full understanding of the event. Objectivity is challenged in the qualitative design, as the researcher is close to the subjects and sometimes can be seen as an instrument in the data collection process (Fairbrother, 2014). Leedy and Ormrod (2015) stipulate the following standards to assess a qualitative study: purposefulness, the directness of assumptions and biases, precise methods, open-mindedness, completeness, consistency, persuasiveness, consensus and usefulness. The advantages of qualitative research include that it is flexible and sensitive to contextual factors, available data are used in the research framework, smaller sample sizes save money and events can be evaluated in depth (Haradhan, 2018). The disadvantages of qualitative research include that the process of collecting data is time-consuming, the researcher can have a negative influence on data collection and the research relies on the researcher's skills (Haradhan, 2018).

“Qualitative research” can be used as a blanket term to refer to different theoretical designs (Haradhan, 2018). The grounded theory is one of these theories. It is an approach where theory expansion is grounded in the data. This research study made use of a qualitative research design with a grounded theory approach. The theory is the inductive and iterative process of collecting data, coding, categorisation and concluding the theory or the explanations of events (Saldaña &

Omasta, 2018). This theory is time-intensive in that it requires cycles of coding and insightful analysis. Haradhan (2018) states that the data collection in this approach is established on data to find a theory, rather than a theory to find data.

3.2.2 Research paradigm

Maree (2020) defines a research paradigm as the beliefs and assumptions that contribute to a specific worldview. Rehman and Alharthi (2016) define a paradigm as the way one understands the reality of the world and examines it. A paradigm consists of four components, namely ontology, epistemology, methodology and methods (Rehman & Alharthi, 2016). Ontology refers to the characteristic of reality. Epistemology refers to the knowledge and the connection thereof to the individual who knows (Maree, 2020). Furthermore, epistemology entails the manner in which knowledge is acquired and communicated. The methodology is a connected, conceptually informed approach to gathering data, and the method explains the way in which the data are collected in different ways (Rehman & Alharthi, 2016).

There is a connection between the research paradigm and the research design (Creswell, 2014). The paradigm, according to Cohen *et al.* (2018), does not drive the research, as research is driven by the research problem. There are different types of paradigms. Positivism is usually used in a quantitative design, as the reality is objective. Interpretivism (also sometimes called “constructivism”) is a paradigm that is associated with a qualitative design (Creswell, 2014). This study used an interpretivist paradigm. According to Pham (2018), with an interpretivist paradigm, the researcher obtains a deeper understanding of a phenomenon, just like the qualitative design. The aim of an interpretivist paradigm is an investigation to understand a specific event, and not to derive the discovery of the population (Tybey *et al.*, 2015). Rehman and Alharthi (2016) concur that interpretivism is not about discovering, but rather about understanding the interpretations of phenomena by different individuals. Interpretivism accepts different realities and is subjective. An indicative approach is used in interpretivism.

Creswell (2014) states that interpretivism is based on the following assumptions:

- Human life can only be understood from the inside.
- Social life is a human result.
- The human mind is the intended origin of connotation.
- Knowledge in the social world affects human behaviour.
- The social world does not continue without human knowledge.

Advantages of interpretivism include that a deeper understanding of an event is gained, the research takes place in a natural setting and the data collected will bring better awareness (Pham, 2018). The disadvantages of interpretivism are that because of a deeper understanding, a gap is left in verifying the validity and usefulness of research procedures, and the research outcomes are affected by the researcher's interpretation, which causes bias and the absence of political impact on knowledge.

The research methodology of this study is discussed next. In this discussion, the researcher explains how the comparison of the status of education technology in South Africa and New Zealand during the Covid-19 pandemic was done.

3.3 Research methodology

The research methodology is the way the researcher has to conduct the research to develop a research problem and objective during the research period (Sileyew, 2020). Maree (2020) defines a research methodology as the link between a research paradigm and the specific data-collecting tool. The research methodology includes how the data will be collected, document analysis, time allocation, finding data, categorising the data and data analysis.

3.3.1 Data collection process

The data collection process is the systematic process of collecting and evaluating data on topics of interest that answer the research questions (Kabir, 2016). In qualitative research, there are different forms of collecting data, namely observations, interviews, documents and audio-visual materials (Creswell, 2012). Data can be obtained through primary and secondary data (Marimo, 2020). Primary data can be difficult to obtain because of the demographical distance between the countries and the researcher. Secondary data are data that are already available in documentation. Cohen *et al.* (2018) indicate that secondary data include literature, scholarly journals, books, technical books and reports. Secondary data can be found in international and national databases (Cohen *et al.*, 2018), such as those of the World Bank, Unesco, the OECD, PISA (Programme for International Student Assessment), TIMMS (Trends in International Mathematics and Science Study), government offices, offices for national statistics, the National Centre for Educational Statistics and the Education Funding Agency.

Marimo (2020) lists the following advantages of secondary data: secondary data provide easy access to information, entail low costs, save time, give an opportunity for longitudinal analysis, offer new insight and understanding and provide useful information. Another advantage of

secondary data is that the extensive scale and amount of data are regarded as more than what one researcher can collect (Cohen *et al.*, 2018). Such large-scale data may be more powerful and have notable validity, while the standard of the data may also be more excessive and exact. Using secondary data is convenient, as the research about the phenomenon has already been done, which means that it saves time and money and provides a broad spectrum of available data.

There are also challenges associated with using secondary data. As secondary data are about previous research done, that research had its own specific research problem, questions and context, which can differ from what the current research is about. Moreover, the researcher needs to be aware that some secondary data are not unbiased, as they come from institutions, governments and associations and can, thus, be social, ideological and political products (Cohen *et al.*, 2018).

In the current study, the researcher used secondary data as the primary source of data. Document analysis was used to gather the data. The secondary data were collected through the internet. Internet research enabled the researcher to gather information worldwide, as the participants of this study were two different countries and the researcher demographically could not be there to gather information.

Creswell and Guetterman (2020) provide the following guidelines for collecting qualitative data, where the steps do not necessarily need to be followed chronologically:

- Identify the participants and areas to be studied. Work on a sampling strategy to find the best data to understand the event.
- Review public and private documents as sources of documents. In this research, public documents were used.
- After the collection of information, get permission. In this study, permission was not necessary, as the information was publicly available.
- After the collection of information, explore the accuracy and usefulness of the information to answer the research question.
- Record the information from the documents.

When the researcher collected the data, she focused on the research questions that entail the differences and similarities of ICT in the schooling systems of South Africa and New Zealand. The other research question involves finding the best practices identified regarding the schooling systems of South Africa and New Zealand. Within each of these research questions, five themes were searched, namely:

- Legislation and funding before and during Covid-19

- Preparedness and infrastructure of schools before and during Covid-19
- Execution and effectiveness of ICT before and during Covid-19
- Barriers that influence ICT before and during Covid-19
- Future prospects of ICT in education.

As seen in each of the themes, aspects of Covid-19 were involved. The following types of documents were collected:

- Government documents from South Africa
- Government documents from New Zealand
- Journal articles from South Africa
- Journal articles from New Zealand
- Documented information from South Africa
- Documented information from New Zealand

In collecting the data, the research questions, themes and type of data were considered.

3.3.2 Type of data collection – document analysis

Creswell and Guetterman (2020) assert that when data are collected, the researcher has to understand the information; that is where document analysis comes into play. Collecting data by reviewing existing documents is called “document analysis” (Marimo, 2020). The analysis consists of picking the information apart, interpreting it and then summarising it all together to answer the research problem. During this process, the researcher makes conclusions about the data by presenting the information in tables, figures and pictures (Creswell & Guetterman, 2020).

O’Leary (2017) suggests that the following types of documents can be used to gather data:

- Official data and records. These include international data that are gathered by organisations such as the United Nations, the World Bank and the World Health Organisation. Each country has national data. Different local governments have reports, surveys and information available. Furthermore, there are university data and the legislation of a country.
- Organisational communication documents. These include press releases, catalogues, pamphlets, meeting agendas and minutes, safety records, and so forth.
- Personal communication documents. These include e-mail correspondence, letters journals, education records, Facebook, blogs, and so forth.
- Media entertainment. This is information from newspapers, advertisements, news, programmes, and so forth.

- Social artefacts. These data include videos, social media, and so forth.

The advantages of document analysis are that it is an inexpensive research method and is less time-consuming, as the collection part of the data is more of a selection process, numerous documents are available on the internet, the researcher's presence does not change the data collected in the documents and data can be collected from different periods (Marimo, 2020). The disadvantages of document analysis are that it is biased in terms of the data selected by the researcher, some documentation is not available and some documents are generated for the specific research (Marimo, 2020).

As indicated earlier, different categories or types of documents for this research were analysed according to a coding system. This is further explained in Section 3.4. These documents include government documents from South Africa and New Zealand, journal articles from South Africa and New Zealand and documented information from South Africa and New Zealand.

3.3.3 Time allocation

Creswell (2012) states that the researcher has to predict the amount of time allocated to locating and obtaining permission for public and private documents. This research took place during a specific time frame, as indicated below.

Chapter 1 Introduction and background (research proposal), January to March 2021

Chapter 2 Literature review, March to July 2021

Chapter 3 Research design and methodology, July to September 2021

Chapter 4 Data analysis, September 2021 to January 2022

Chapter 5 Findings, recommendations and conclusion, January to April 2022

Finalisation of the dissertation, including language editing and submission, May to July 2022

3.3.4 Finding data

In comparative research, secondary analysis of qualitative data is fairly extensive because of the expense of acquiring primary data from different countries (Audiopedia, 2018). O’Leary (2017) stipulates the following steps for collecting data through documents:

- Plan for the possible occurrence
- Collect the documents
- Assess the credibility of the documents, and question the written and unwritten information
- Reflect, refine and analyse the data

In this study, the researcher collected data from the internet. O’Leary (2017) suggests some techniques to remember when doing online searching, such as checking credentials, the intention of the writer, whether recognised authority is present, objectivity, verifiability and whether the information is current. Data for the period of 2016 to 2022 were collected, as in this period, it was evident how ICT was used in the schooling systems of the two countries under investigation. This would give a clear indication of the “before” and “during” element in the themes that were analysed. The documents used were found in journals, agendas, legislation, Google Scholar and published papers. The World Bank, Unesco, Statistics South Africa and the World Economic Forum provide reliable information to researchers. Also, government documentation was used. The following keywords were used to search for data: “ICT” or “information and communication technology”, “education”, “South African education system”, “New Zealand education system” and “Covid-19”.

3.3.5 Categorising data

According to Linneberg and Korsgaard (2019), the outcomes of research will not appear automatically, but need intentional tasks to recognise main elements and connect them to logical and conclusive answers that are loyal to the data and give insight into the research objectives. McMillian and Schumacher (2010) state that qualitative research has a lot of data that must be summarised and processed. They identify five sources that researchers can use to categorise data (McMillian & Schumacher, 2010):

- The research problem, the main research question and the secondary questions
- The research instrument
- Themes, concepts and categories
- Prior knowledge of the researcher
- The data

In this study, the researcher made use of the research questions, themes, sub-categories and the type of data, as mentioned above. The research questions are the main items to be discussed. As the comparative method was used in this study to determine the similarities and differences regarding ICT in the school education systems of South Africa and New Zealand during Covid-19, this is one of the categories that was considered when the data were analysed. Furthermore, the best practices that were identified are discussed. Themes were used, as explained in Section 3.3.1. Within each of the research questions, there were five themes that were search for, namely:

- Legislation and funding before and during Covid-19
- Preparedness and infrastructure of schools before and during Covid-19
- Execution and effectiveness of ICT before and during Covid-19
- Barriers that influence ICT before and during Covid-19
- Future prospects of ICT in education

There are also sub-categories that look at events with regard to ICT in South Africa and New Zealand before and during the Covid-19 pandemic. The type of data that were used was categorised. This was done by coding (see Section 3.3.5), as Linneberg and Korsgaard (2019) profess that coding is a key tool in turning qualitative data into honest findings. All of the different categories form part of the data analysis after the collection of data. Next, the data analysis process is discussed.

3.4 Data analysis – content analysis

Analysing the data in research entails making sense of the information and coding the research themes (Creswell & Guetterman, 2020). Haradhan (2018) states that qualitative data analysis can be complex, as there is a magnitude of data that can be gathered, and it can be difficult to manage an in-depth analysis and organise findings in a compact and logical way. The comparative method is a data analysis process and a coding strategy that separates the data into reasonable pieces that allow them to be compared for similarities and differences (Randall, 2019). Leedy and Ormrod (2015) point out that the comparative method in qualitative research moves back and forth between data collection and data analysis. Haradhan (2018) also indicates that in the qualitative research design, the data collection and data analysis progress at the same time.

Creswell (2012) states that analysing and interpreting data involve the drawing of conclusions about the data (results), making use of tables, figures and pictures to summarise the data (findings) and describing the conclusions to answer the research question (discussion). Data collection and data analysis are simultaneous processes in qualitative research (Creswell & Guetterman, 2020).

The type of data analysis used in this research study was content analysis. Leedy and Ormrod (2015) define content analysis as a detailed and systematic examination of the contents of a particular body of material to identify patterns, themes or biases. Content analysis is generally carried out on forms of human communication.

Leedy and Ormrod (2015) propose four general steps in content analysis:

- Step 1: The researcher recognises a specific type of material to be examined. If the type of material is small, the whole type will be examined. In a large type of material, a random sample will be selected to be examined.
- Step 2: The researcher defines the features or quality to be examined in the material.
- Step 3: In material that has complex or large units, the researcher breaks the items up into more manageable segments to be analysed individually.
- Step 4: The researcher inspects the material for instances as in Step 2. If the study involves the search for specific words in a text, only one recorder is needed. If the study involves categorising sections of material to transfer diverse messages about the nature of the event, two or three assessments are generally involved.

Denscombe (2014) suggests the following steps in content analysis:

- Step 1: Selecting a suitable sample of data
- Step 2: Texts are breached into small components
- Step 3: Categories are developed for analysing the data
- Step 4: Coding is done according to categories
- Step 5: The frequency of occurrence of coding units is conducted
- Step 6: Texts are analysed from the different coding components

The following advantages of content analysis are listed by Fraenkel et al. (2015): the researcher can detect the contents without being observed; the researcher can delve into documents and records, and time and space do not limit the researcher to specific material; and organising content analysis is relatively easy and inexpensive.

In this study, during the process of analysing the documents, the different categories of data, such as themes, research questions, sub-categories and the type of data, were used when the content analysis was done. Table 3-1 shows the layout of how the data were analysed, considering all the different categories of the types of data that were collected. The data were also categorised into the categories “before Covid-19” and “during Covid-19”.

Table 3-1: Example of how data were analysed taking into consideration the different categories of data.

Theme	
Before or during Covid-19		
Sub-theme	South Africa	New Zealand
1.		
2.		
3.		

Within the different categories of how the data were analysed, there is also the type of documents that was used for the research. Coding was used during the process of categorising the different types of documents that were used in the data analysis. Cohen *et al.* (2018) define a code as merely a marker or name that the researcher gives to specific text that contains information or an idea. Coding is an early form of analysis (Linneberg & Korsgaard, 2019). During the coding process, the researcher assigns a category label to a piece of data. These categories are clear before the data are collected. During the coding process, sections of the written data are divided into smaller components and then explored, differentiated, conceptualised and categorised. Linneberg and Korsgaard (2019) state that the central working of coding is the examination of logical pieces of factual information and labelling it to summarise the information.

The researcher sometimes starts with codes that have been decided on beforehand and then adjusted to the given data. The data that contain the same code can be explored, collected and assembled by the researcher. Codes can be given in the form of abbreviations (Cohen *et al.*, 2018). Cohen *et al.* (2018) advise that before a specific code is assigned, the researcher should read and re-read the information thoroughly to get a clear understanding of the meaning, issues and ideas of the whole text. It is also necessary for the researcher to be aware of the fundamental philosophies, as in the grounded theory, as they have implications for the coding exercise (Linneberg & Korsgaard, 2019). The advantages of coding are that it gives a creative interpretation and analysis of the data, ensures that data are easily attainable and retrievable, arranges and structures the data, ensures transparency, ensures validity and gives the viewpoints of the participants (Saldaña, 2013).

The coding of qualitative data includes inductive, deductive and abduction coding. With inductive coding, the researcher develops codes from the phrases or themes obtained from the participants instead of the theoretical vocabulary of the researcher. Inductive coding is sometimes referred to

as the inductive approach or the grounded theory. While inductive coding is true to the data, there is a possibility of a complicated process with a lack of focus from the researcher. Deductive coding involves a pre-defined list of codes that the researcher has built before the coding started. This type of coding works for theory-driven approaches. The codes are chosen from theoretical concepts or themes from the literature. Deductive coding normally has a limited number of codes from five to ten. Abduction coding involves a combination of inductive and deductive coding; this indicates that the coding will be done between the data and the theory (Linneberg & Korsgaard, 2019). The researcher previously determined codes but was open to changes as findings arise in the coding process. In this research, the abduction coding process was used.

Saldaña (2013) lists six methods of coding that form part of the grounded theory, namely open (initial) coding, in vivo coding, process coding, focused coding, axial coding and theoretical coding. Cohen *et al.* (2018) indicate the different kinds of coding as open coding, analytical coding, axial coding, selective coding and theoretical coding.

Open coding is the first step in data analysis (Haradhan, 2018). With this method, important words are identified in data and then labelled. The coding can be carried out line by line, phrase by phrase or sentence by sentence, based on the type of information. In analytical coding, the code is more descriptive (based on theory). Axial coding is done after open coding, when extensive categories appear from the data (Haradhan, 2018). In this step of coding, the researcher is able to describe the event of the study. Axial codes refer to casual situations, occurrences, contexts, negotiable conditions, interactions and consequences. Axial coding links the codes to the sub-categories and the main research aims. It works in one category. During selective coding, the researcher determines the central category and connects it with other crucial categories to conclude a theory (Haradhan, 2018). During theoretical coding, the researcher realises how the categories and codes are combined to determine a theory.

In this research study, coding was used for the types of data that were collected, as coding is the initial stage in qualitative data analysis (see Haradhan, 2018), and then used in the analysis process where the categories were compared using the comparative method. The coding process started with specific codes given to specific documents that were collected. Table 3-2 below indicates how the coding for each type of document was carried out.

Table 3-2: Documents coding system used in research.

Code for the documents	Type of documents	Reason for use of document	Number of the document for this code
GD(number)-SA	Government document from South Africa	Government documentation gives an indication of the legislation, implementation, funding, preparedness, infrastructure and execution of the relevant element of the research in the specific country	21
GD(number)-NZ	Government document from New Zealand		11
J(number)-SA	Journal article from South Africa	Journal articles give the research evidence of previous research that has been conducted on the topic in the specific country	13
J(number)-NZ	Journal article from New Zealand		5
DI(number)-SA	Documented information from South Africa	As the concept of ICT is used and implemented worldwide, the information that documented information provides is insightful to the research problem	22
DI(number)-NZ	Documented information from New Zealand		16

During the coding process, each document was captured and can be found in the annexure of this dissertation. This explains the name of each document used for its referencing.

3.5 Ethical considerations

During research processes, the use of non-discriminating language and respect for readers should be considered and observed (Creswell & Guetterman, 2020). The information gathered must be reported ethically, without any alteration or change to satisfy particular statements (Creswell & Guetterman, 2020). According to Saldaña and Omasta (2018), the Belmont report principles are adopted by various universities, but guidelines do differ. They mention specific elements that are important for researchers, such as consent, confidentiality, comprehensive information, communication and conflict-free research (Saldaña & Omasta, 2018). The North-West University (2020) has a code of conduct regarding research with four crucial principles for research that a researcher must adhere to, namely:

- Honesty throughout the whole research.
- Responsibility in performing the research.
- Professional respect and integrity in working with others.
- Good management of research on behalf of others.

As the researcher made use of document analysis as the data collecting method for this study, no confidential information was dealt with, as the documents were publicly available. During the data collection process, secondary data were used. While collecting the data, the researcher considered each piece of secondary data in order not to misinterpret the original finding of the original researcher. During the collecting process, attention was given to the purpose of this research together with the purpose of the research from which the data were collected. In analysing the documents, the researcher paid special attention to the correct analysis of the data to report findings that would be reliable and valid. Cohen *et al.* (2018) assert that the researcher has to ensure that the correct data analysis approaches are used. Furthermore, the researcher should avoid doing the following when data are analysed to ensure that the data analysis is ethical: judge the data when the data are analysed; create false data; misrepresent the data; utilise improper statistics or data; select data that exaggerate the situation; disregard outliers; and break the ethical essentials of confidentiality and anonymity (Cohen *et al.*, 2018). Ethical practices were considered during all the research steps in this research study.

3.6 Trustworthiness and credibility

Trustworthiness can be defined as the sharp devaluation of the data analysis, findings and conclusions (Maree, 2020). Maree (2020) proposes a few approaches to use to guarantee credibility when using document analysis as a data collection technique. First, the researcher should use established research methods and a research design to answer the research question, and establish the theoretical basis of the research question and methods. Second, the researcher should have constant discussions with superiors. Third, the researcher should make use of a thorough explanation of the event under inspection.

Transferability does not involve general conclusions, but the researcher and the reader make their own connections between components of the events. To expand transferability, the researcher should focus on how representative the documentation is of the event and the contexts of the findings (Maree, 2020). Dependability is ensured through the research design and execution, the detail or implementation of the data collection and the reflective evaluation of the research. (Maree, 2020). Conformability is the standard of objectivity in the way the findings are created by the documentation and the researcher's bias, incentive or attentiveness. Strategies that can be implemented to ensure credibility are triangulating data, seeking expert review, affecting a background check and investigating the references of the documentation (O'Leary, 2017).

3.7 Role of the researcher

In qualitative research, the researcher becomes absorbed in the social condition (McMillian & Schumacher, 2010). Maree (2020) states that the role of the researcher is to work in partnership with the respondents to gather data and analyse the data to understand the event and answer the research problem. During the research process, the researcher has to keep trustworthiness in mind. Researchers have to examine the new information and the theoretical perspective that they create in any research (Creswell, 2014). Creswell and Creswell (2018) suggest that researchers should integrate reflexive thinking during qualitative research. This includes reflective notes about their observations and experiences during the research.

3.8 Conclusion

In this chapter, the researcher explained the research design and methodology of the research. It was also explained how the data had been collected (through document analysis) and analysed (through coding and categories) to answer the research questions. Chapters 1, 2 and 3 provide a description of what was investigated and how the research was implemented. In Chapter 4, the data collected through documentation and relevant literature are analysed.

CHAPTER 4 DATA ANALYSIS

4.1 Introduction

The data analysis of the research is where the data that have been collected are analysed. This study is a qualitative study with an interpretive paradigm. The focus is to compare ICT in the school education of South Africa and New Zealand during the Covid-19 pandemic. It is also important to determine how ICT in South African and New Zealand schools compared before Covid-19. With this comparison, the secondary research questions will be answered. These secondary questions are as follows:

- What are the differences regarding the status of ICT in the schooling system of South Africa and New Zealand during the Covid-19 pandemic?
- What are the similarities regarding the status of ICT in the schooling system of South Africa and New Zealand during the Covid-19 pandemic?
- What are the best practices that can be identified regarding ICT in the schooling systems of South Africa and New Zealand?

This chapter indicates how the information gathered on ICT in the schooling systems of South Africa and New Zealand before and during Covid-19 was analysed to answer the research questions.

4.2 Background on ICT and Covid-19

In 2020, schools in New Zealand had to close down because of the Covid-19 pandemic (Yates & Starkey, 2020). This pandemic made governments across the world aware that crises in education could occur. Crises do happen in countries and can force schools to close down. Wars, civil conflict and natural disasters, such as earthquakes, can suspend schooling. New Zealand previously also experienced a crisis when the Canterbury earthquake struck. Remote learning can be used in schools during times of crisis. Schools have started to utilise digital technologies, not just in teaching and learning but also in managing the digital environments, using technology in teachers' professional work and managing data systems and analysing them (Yates & Starkey, 2020).

The data analysis of the current research study will determine the implementation of ICT before and during Covid-19 when many schools were forced to close down and, in the end, had to make use of ICT to continue effective teaching and learning. According to Unicef (2020), 42% of primary

schools worldwide and 74% of secondary schools worldwide made use of digitally based learning during the pandemic.

The Covid-19 lockdown emphasised the seriousness of confronting the digital divide among learners. The so-called digital divide refers to learners who do not have access to acceptable devices with internet connectivity and, therefore, cannot join their teachers and classes and have no access to learning material (Greater Christchurch Schools' Network Trust, 2020). There are three types of digital divides: first, some learners do not have access to a device or the internet; second, some learners do not know how to use these technological devices; and third, some learners do not have the understanding, confidence and ability to use digital technologies (Greater Christchurch Schools' Network Trust, 2020). There is also a difference in the types of schools there are in each country. In New Zealand, schools are separated into 10 deciles. These deciles are established on the socio-economic status of the learners (not the location of the school itself). Decile 1 schools receive more funding from the government, whereas Decile 10 schools receive funding from donations and families (Network for Learning, 2018). In South Africa, there is a similar system according to quintiles ranging from 1 to 5. Quintile 1 schools are located in under-served communities where resources are limited, and Quintile 5 schools are well resourced (Jantjies, 2020).

According to Statistics South Africa (2022), some schools in South Africa did not provide remote learning options for their learners. Daniel (2020) states that the Covid-19 pandemic presented enormous challenges to the education system. He gives guidance to teachers, heads of organisations and officials to overcome the pandemic. An example of a tip for teachers is that educational videos must be between five and 10 minutes long (Daniel, 2020). He also suggests that during the pandemic, it is important for teaching to be adjusted to utilise the benefits that asynchronous learning has to offer (Daniel, 2020). This signifies that time is flexible in the preparation and delivery of lessons and activities. Learners have the freedom to study when they have the opportunity to do so, as it demands learning at home.

4.3 Data analysis process

Creswell (2012) explains that analysing data leads to conclusions of the data by making use of tables and discussions of the data. During the data analysis process of this study, tables were used with each theme that arose in the literature before and during Covid-19. Colours were used in the table to distinguish between the two countries – South Africa is presented in green, and New Zealand is presented in blue. Coding was also used to categorise the type of documents

that were used. In the annexures, a complete table of all the documents that were used is provided. The documents were coded in six categories, namely:

- Government documents of South Africa, consisting of 21 documents.
- Government documents of New Zealand consisting of 11 documents.
- Journal articles from South Africa, consisting of 13 documents.
- Journal articles from New Zealand, consisting of five documents.
- Documented information from South Africa, consisting of 22 documented information.
- Documented information from New Zealand, consisting of 16 documented information.

Table 4-1 shows how the documents were coded.

Table 4-1: Example of coding of documents.

Code of document	Name of document	Author
Government documents South Africa		
GD(1)-SA	Annual Performance Plan 2021/2022	DBE
Code of document	Name of document	Author
Government documents New Zealand		
GD(1)-NZ	Household Statistics: Access to telecommunication systems (total responses) by tenure of household, for households in occupied private dwellings 2018 census	Statistics New Zealand
Code of document	Name of document	Author
Journal articles from South Africa		
J(1)-SA	The effectiveness of Information and Communication Technologies (ICTs) in teaching and learning in high schools in Eastern Cape Province	O.A. Ojo and E.O. Adu
Code of document	Name of document	Author
Journal articles from New Zealand		
J(1)-NZ	Were we ready? New Zealand high school students' experiences of online learning during school closures of Covid-19	A. Yates & L. Starkey
Code of document	Name of document	Author
Documented information from South Africa		
DI(1)-SA	Training Room Online partners with the DBE to deliver innovative digital learning platform to public school sector	Endeavour South Africa
Code of document	Name of document	Author
Documented information from New Zealand		
DI(1)-NZ	A framework to guide an education response to the Covid-19 pandemic of 2020	F.M. Reimers & A. Schliecher

To determine the status of ICT in South African and New Zealand schools, it is necessary to determine whether there is any legislation and how it functions in the country. If there is funding

and legislation, it needs to be determined how they are used to get the infrastructure. It should also be determined how prepared schools are to implement ICT in the school, including in teaching and learning. Thereafter, it needs to be determined how effective the execution of ICT in schools was. There is also the aspect of barriers that influenced the execution of ICT. As ICT is an important sustainable development goal for countries, it is necessary to determine the future prospects of ICT in the schools of South Africa and New Zealand. These are the five themes that were used to analyse the data. Within every theme, there are more sub-themes to compare the countries regarding ICT. The themes and sub-themes are as follows:

Theme 1: Legislation and funding: countries' strategies; legislation and policies; legislation – curriculum; school policies; and funding.

Theme 2: Preparedness and infrastructure: government partnership with other organisations; organisations or educational technology companies; education portals; government support; access to connectivity; data costs; access to ICT; teachers' ability and usage of digital technologies; and games, platforms and applications.

Theme 3: Execution and effectiveness: outcomes of ICT; usage of digital technologies; and use of mobile learning.

Theme 4: Barriers that influence ICT: access; costs; funds; security or safety; speed of technological innovation; ICT or technical support; teachers' ability; knowledge and training; control of learners' usage; integration to curriculum; network infrastructure; learner engagement and wellbeing; technical support; pedagogical change; support of parents to use ICT; time or workload; and mobile phones banned in schools.

Theme 5: Future prospects of ICT.

4.4 Data analysis per theme

The data analysis is presented in tables for before and during Covid-19.

4.4.1 Theme 1: Legislation and funding – before Covid-19

Table 4-2: Theme 1: Legislation and funding – before Covid-19.

Theme	1. Legislation and funding	
Sub-theme	Before Covid-19	
	South Africa	New Zealand
Countries' strategies	<p>In 2013, the South African Government introduced the <i>National Development Plan 2030</i>. Its objectives are based on the developmental goals of the World Health Organisation and the United Nations. It indicates that South Africa has to improve its innovative edge to contribute to global scientific and technological advancement. The aim is that by 2030, ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy in South Africa that are more inclusive and prosperous (GD(14)-SA).</p> <p>South Africa provides a constitutional basis for access to the internet, as it is part of the corollary right of the right to access to information in the <i>Constitution of South Africa</i> (J(7)-SA).</p> <p>The core of the <i>South African National e-Strategy</i> (Department of Telecommunications and Postal Services, 2017) is to transform South Africa into a fully digital society. This strategy was shaped by other policies, such as the <i>Integrated ICT Policy White Paper</i>, the <i>ICT RDI Roadmap</i> and the <i>Industrial Policy Action Plan</i>. Operation Phakisa was launched to ensure the connectivity of schools, the Department of Home Affairs, municipalities and health services (GD(16)-SA).</p>	<p>On 17 May 2005, Minister David Cunliffe launched the Digital Strategy of New Zealand. With this strategy, the government strives to increase access to broadband in all regions of New Zealand through the PROBE project. It also supports and promotes access to fibre networks and implementing the advanced network by 2006 (GD(10)-NZ).</p>

Theme	1. Legislation and funding	
Legislation and policies	<p>The <i>White Paper on e-Education</i> (Department of Education, 2004) declares the government's reaction to ICT in education. The paper indicates that the Department of Education and the private sector will work together to improve ICT and that teachers have to use computers in their classrooms (GD(15)-SA).</p> <p>The <i>Integrated Strategic Planning Framework for Teacher Education and Development</i> was published in April 2011 and was to be used from 2011 to 2025. This framework refers to the need for special educator knowledge and the establishment of professional learning communities to improve teacher professionalism (GD(9)-SA).</p>	<p>In 2019, the Minister of Education formally included digital technology in the National Education Curriculum. This was done with two concepts: firstly, computational thinking for digital technology; and secondly, designing for digital outcomes (DI(14)-NZ).</p>
Legislation and policies	<p>In South Africa, the ICT policy framework is guided by different legislation, namely:</p> <ul style="list-style-type: none"> • The <i>Electronic Transactions Act of 2005</i> • The <i>Electronic Communications Act of 2005</i> • The <i>Broadband Policy</i> <p>These policies were established by the Department of Communications and are regulated by the Independent Communications Authority of South Africa (DI(4)-SA).</p> <p>The DBE Action Plan 2019 commits the DBE and its partners to improving the computer literacy of teachers as part of Goal 16 for Sustainable Development 2030 (GD(10)-SA).</p>	<p>In January 2014, the Te Toi Tupu Consortium provided the <i>e-Learning Planning Framework</i> (English medium). This tool assists teachers and schools to be able to evaluate their e-learning extent. It reinforces constant self-appraisal and succeeding development of e-learning knowledge and skills (GD(4)-NZ).</p>

Theme	1. Legislation and funding	
Legislation: curriculum	<p>In 2012, the <i>Curriculum Assessment Policy Statement</i>, better known as “CAPS”, was started for Grades 1, 3 and 10, and by 2014, it was rolled out to the other grades. The curriculum includes more specification of content, details of teaching schedules and new content in some areas. Also, more focus was put on language in Grade 1 and Mathematics in Grades 10 to 12 (DI(18)-SA).</p>	<p>On 5 July 2016, a press release was made on Beehive.govt.nz, the official website of the New Zealand government, that the New Zealand Curriculum and Te Marautanga o Aotearoa 2018 would integrate digital technology into learning. Following that Rachel Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016. Principals and teachers commented on the inclusion of digital technologies. Of these comments, 40% were positive and indicated that it was necessary. However, 17% of teachers and 15% of principals were concerned about professional development, and 22% of teachers and 30% of principals were concerned about funding (DI(11)-NZ).</p> <p>Digital technology in the New Zealand Curriculum was also indicated in the AlphaBeta report to unlock New Zealand’s digital potential (DI(14)-NZ).</p>
School policies	<p>A union in South Africa did a study of teachers in education where 986 teachers were used to determine their perspectives, attitudes, skills, user experience and intentions towards ICT. It was found that there are ICT policies in Quintile 5 schools to support ICT (J(10)-SA).</p>	<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, schools included the following in their policies and strategies for providing a safe digital learning environment:</p> <ul style="list-style-type: none"> • 79% of school strategies included proactive priorities of safe online practices. • 70% of school strategies included active management of site-blocking filters. • 67% of school strategies included incident management. • 57% of school strategies included relying on internet service providers to block inappropriate sites. (DI(3)-NZ).

Theme	1. Legislation and funding	
School policies		<p>A study was done by partnering with the Ministry of Education, other government agencies and other business partners. Surveys were conducted at 339 primary schools and 125 secondary schools during 2016/2017. In the survey, eight out of 10 principals indicated that more than half of the learners at their schools had internet access at home. It was observed that principals from higher decile schools had more learners with internet access than those of lower decile schools. Seven out of 10 principals indicated that their schools had policies for taking charge of online safe practices, active administration of site-blocking filters and incident administration. Furthermore, 25% of principals indicated that they were aware of their responsibilities under the <i>Harmful Digital Communications Act</i> (DI(10)-NZ).</p> <p>According to the Digital Technologies in Schools survey done in 2016/2017, a national average of 74% of schools had an ICT strategic plan. Within the ICT plan, the following was indicated:</p> <ul style="list-style-type: none"> • 88% of schools have a safe digital learning environment • 85% of schools have teacher professional development • 84% of schools have network infrastructure • 81% of schools have pedagogy • 78% of schools have equipment and software upgrades • 55% of schools have change management • 55% of schools ask for learners' feedback • 49% of schools include personal digital devices. (DI(3)-NZ)

Theme	1. Legislation and funding	
Funding	<p>The National Treasury (2019) indicated that in the financial year 2019/2020, the following would be provided to increase education technology use:</p> <ul style="list-style-type: none"> • 300 teachers will be supported to receive ICT training. • 300 schools will be supplied with subject-related software. • 300 schools will be supplied with subject-specific computer hardware. • 200 technical schools will be supported with repairing and maintaining workshop equipment. • 1 000 schools will be supported with laboratory equipment. (GD(17)-SA) <p>In 2016, Gina and Kubsyi indicated that R400 million was spent on infrastructure in schools. R50 million was set aside for teacher training in ICT specifically. R200 million was dedicated to Gauteng’s provincial treasury to invest in devices and equipment for connectivity (DI(19)-SA).</p> <p>A study was done in South Africa in 2017, where 1 274 public schools completed a survey. It was found that 62% reported that funding for technology was received from the Department of Education and 41% of the schools used the money from the school budget for technology infrastructure. A total of 24% of schools received funding through external organisations (DI(20)-SA).</p>	<p>According to the Digital Technologies in Schools survey done in 2016/2017, the following percentages of schools used the school budget for digital technologies:</p> <ul style="list-style-type: none"> • 27% of the schools spent more than 20%. • 1% of the schools spent none. • 27% of the schools spent 1 to 5%. • 26% of the schools spent 6 to 10%. • 12% of the schools spent 11 to 15%. • 7% of the schools spent 16-20%. (DI(3)-NZ)

The above table deals with legislation and funding in South Africa and New Zealand before Covid-19. Both countries have national strategies to implement ICT in their countries. Special projects have been initiated in each country to materialise these strategies – in South Africa, Operation Phakisa, and in New Zealand, the PROBE project. However, the focus in New Zealand is not on having access to connectivity but on having access to fibre networks. Both South Africa and New Zealand have legislation and policies regarding the implementation of ICT in schools, and it is also included in the national education curricula of both countries. School policies are not evenly implemented in South Africa, as most schools that have ICT policies are Quintile 5 schools. This implies that approximately 80% (Quintiles 1 to 4) of schools do not have ICT policies. However, in New Zealand, according to surveys done, 74% of primary schools and 80% of secondary schools have ICT policies. Funding has been made available in both countries, although the scale thereof is not equal in the two countries. In New Zealand, funding from the financial support of disaster relief has assisted in the implementation of ICT in schools. In South Africa, it was found in a survey that 62% of the funding for ICT was from the Department of Education, and 24% of schools received funding from external organisations.

4.4.2 Theme 1: Legislation and funding – during Covid-19

Table 4-3: Theme 1: Legislation and funding – during Covid-19.

Theme	1. Legislation and funding	
Sub-theme	During Covid-19	
	South Africa	New Zealand
Legislation and policies/strategies	<p>The Professional Development Framework for Digital Learning gives a new approach to the development of teachers using digital content resources and tools to improve learner outcomes. (GD(11)-SA).</p> <p>The DBE provides teacher guidelines for implementing revised annual teaching plans. These have been available since 6 July 2022 and give advice regarding blended learning and how to control aspects of home learning (DI(16)-SA).</p>	<p>In April 2021, AlphaBeta, released information on New Zealand’s digital potential by 2030. Across 10 industries, 40 digital technology applications are introduced. In education and training, technological applications are to be implemented for personalised learning, online retaining programmes, e-career centres, and digital job platforms (DI(14)-NZ).</p> <p>In 2021, a new digital strategy was released for the following five years. The digital focus is on leadership, integration of services foundations, investment and new ways of doing things (GD(11)-NZ).</p>
Legislation: curriculum	<p>The final <i>Curriculum and Assessment Policy Statement</i> was ready on 19 March 2021. In 2022, a pilot for Coding and Robotics for Grades 4 to 6 and 8 was started. Full-scale implementation of Coding and Robotics for Grade 9 will be implemented in 2025 (GD(1)-SA).</p>	<p>In 2020, the New Digital Technologies and Hangarau Matihiko curricula were fully implemented in schools (GD(9)-NZ).</p>

Theme	1. Legislation and funding	
Funding	<p>The government funded a learner support programme that consisted of 123 radio stations and six television channels that, in the end, reach 35 million people. The government also introduced zero-rated platforms (J(5)-SA).</p> <p>The DBE has allocated R424,8 million in its budget for 2022/2023 to the Mathematics, Science and Technology Grant (this is a 2,9% increase from the previous budget). Also, with Operation Phakisa, ICTs will receive R14,2 million, which is a drastic increase of 27,6% from the previous budget (GD(20)-SA).</p>	<p>The Ministry of Education indicates in its report that the following funding was given for ICT during Covid-19 to ensure that learners had access to online teaching and learning when schools were closed:</p> <ul style="list-style-type: none"> • NZ\$51 340 million was allocated to gain equity to enable distance learning for all learners. • NZ\$36 440 million dollars was allocated to enable access to online learning. This included internet connections and devices. Needs were prioritised. • NZ\$20 126 million was allocated to internet connections. • NZ\$13 387 million was allocated for devices (including laptops and Chromebooks). • NZ\$4 825 million was allocated for cross-line and on-demand television services. <p>NZ\$1 996 million was allocated for new connections and teacher home connections. (GD(8)-NZ)</p> <p>The Aotearoa EdTech Excellence Report 2021 indicates that NZ\$319,6 million has been spent on education software and projects that in 2025, this amount will reach NZ\$319,6 million (GD(9)-NZ).</p>

The above table deals with legislation and funding for ICT during Covid-19. Teacher guidelines were provided by the South African government to teachers for the implementation of revised teaching plans and blended learning approaches. Also, the Professional Development Framework for Digital learning assists teachers with new approaches to professional development that will improve learner outcomes as well. In 2021, during Covid-19, the curriculum for Coding and Robotics was ready for pilot implementation. In New Zealand, technical applications were introduced in education for personalised learning, online retaining programmes, e-career centres and digital platforms. Furthermore, in 2021, a new digital strategy was announced for the following five years. New digital technologies were also fully implemented in the New Zealand and Hangarau Maathiko curricula.

Where funding is concerned, both countries set out to support the learning of learners in these countries. South Africa opted for a learner support programme that involved radio stations and different television channels. Also, zero-rated platforms in education were introduced. In the budget allocation, ICT will receive funding (within Operation Phakisa), while there is also a Mathematics, Science and Technology Grant. In New Zealand, the Ministry of Education focuses on a distance learning package, which includes internet connection and devices. Evidence has been received of how the budgets were spent. Like South Africa, New Zealand also makes use of television services. Education software received a substantial amount during 2021, and a projected amount was given until 2025.

4.4.3 Theme 2: Preparedness and infrastructure – before Covid-19

Table 4-4: Theme 2: Preparedness and infrastructure – before Covid-19.

Theme	2. Preparedness and infrastructure	
Sub-theme	Before Covid-19	
	South Africa	New Zealand
Government partnership with other organisations	<p>The DBE and Training Room Online, a private company, developed the DBE cloud in 2017 and implemented it in January 2018. This cloud gives learners, teachers, parents and administrators access to CAPS-aligned digital content (DI(1)-SA).</p> <p>The Department of Education of the Western Cape has a partnership with Stellenbosch University for using telematics. The Free State Department of Education uses an Internet Broadcast Programme in partnership with the University of the Free State. The Department has a partnership with PLATCO Digital and Mindset to broadcast and have recorded lessons for 2014. It is available on Channel 201 (which indicates that MultiChoice is also on board) and on the PLATCO platform (DI(19)-SA).</p>	<p>During the Covid-19 lockdown, Google gave 1 000 schools in New Zealand free access to a complete set of digital tools for cooperating and communicating in distance learning (DI(14)-NZ).</p> <p>In 2013, the Manaiakalani Education Trust launched a digital teaching academy (DI(7)-NZ).</p> <p>Since 2018, Google has worked with the trust to provide 1 600 days of training to graduate teachers throughout New Zealand with the Digital Fluency Intensive Programme. A total of 95% of these students were of Pasifika ethnic origin or Māori (DI(14)-NZ).</p>

Theme	2. Preparedness and infrastructure	
Organisations / educational technology companies	<p>In 2014, Vodacom started its Vodacom e-School platform where Vodacom users have free access to digital learning content on a mobile device, laptop, desktop or tablet, whereas other users are charged data tariffs. The application is CAPS-aligned and gives learners access to digital learning content of various subjects from Grade R to 12 (DI(2)-SA).</p> <p>The DBE and non-government organisations have the following programmes:</p> <ul style="list-style-type: none"> • SchoolNet project • ICT4RED project • Intel Teach Programme • Google in Education • Microsoft Partners in Learning • Operation Phakisa ICT in Education Lab (DI(13)-SA) 	<p>There are 93 educational technology companies in Aotearoa, of which 60% are start-up companies. Of these companies, 67% have less than 10 employees (GD(9)-NZ).</p> <p>SillsVR gives hypnotic virtual reality training for professional learners. It utilises 3D virtual reality and mobile content (GD(9)-NZ).</p> <p>Maths Adventure is a New Zealand company that includes a series of educational games that enable learners in mathematics. The company has a few iPad applications and digital games with globally more than 11 million downloads. Gamefroot is a web-based games development platform that assists younger learners to learn how to code and develop their problem-solving and design thinking skills. Also, teachers receive training tutorials. The Ministry of Education, the New Zealand Qualification Authority and Te Puni Kōkiri are also partnering with Gamefroot (GD(9)-NZ).</p>
Education portals	<p>In September 2015, the Western Cape government launched an e-portal. With this portal, it is able to supply digital content for teachers and learners (GD(5)-SA).</p>	<p>On 19 May 2014, the Ministry of Education introduced the New Zealand education portal. The aim of the portal is to assist people to find what they need regarding education (GD(21)-SA).</p>

Government support	<p>The Western Cape Department of Education started a Game Changer Roadmap, from 2016 to 2019, an initiative that consists of seven game changes that will bring improvement to people’s lives. Two of the game changers that involve ICT are delivering high-speed security and implementing quality e-learning at schools. The goal was to create 178 free wi-fi hotspots in public areas and broadband at 1 875 public sites, with schools as the priority. Furthermore, the goal was to provide 6 000 technological classrooms and 28 808 learner devices (GD(5)-SA).</p> <p>The DBE partnered with Africa Teen Geeks and Standard Bank and with computer applications technology and information technology experts to develop the Coding and Robotics curriculum for the General Education and Training band (GD(7)-SA).</p> <p>The DBE plans that with the digital technology rollout plan, by 2024, 26 703 schools must be connected to the internet (GD(6)-SA).</p> <p>On 20 July 2015, the Gauteng Education Department launched a “paperless classroom” project. With this project, by the end of August 2015, 375 high schools in the Gauteng Province, especially in the township and rural areas, had been provided with ICT assistance. Furthermore, 4 000 Grade 12 classrooms were renovated, which also included being provided with special lights, blinds and interactive whiteboards. In addition, 17 000 tablets were given to Grade 12 learners, and 18 000 interactive whiteboards with teaching software were given to schools (GD(13)-SA). This project had an expected budget of R17 billion over five years (DI(6)-SA).</p> <p>The Gauteng Department of Education also spent R200 000 on repairs during 2015, the majority of which was on screen damages (DI(7)-SA).</p> <p>The Department of Telecommunications hired Vodacom, MTN, Cell C and Neotel to connect 5 250 schools from April 2015 to 2020. Furthermore, the Department of Telecommunications teamed up with other stakeholders such as Microsoft, Vodacom, Hauwei, Mindset and Unicef. The University</p>	<p>A multi-site case study, with 14 participants, five primary schools and one special Catholic school, was done and submitted in 2016. The study focused on the use of ICT in mathematics. It was found that all six schools received financial support from disaster relief funding after a massive earthquake, which assured that these schools had digital devices, software and access to applications (J(2)-NZ).</p> <p>In 2016, the Ministry of Education started a New Zealand Schools’ Cloud Transformation Project that enabled all schools to move to the cloud (GD(9)-NZ).</p>
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Theme	2. Preparedness and infrastructure	
	<p>of South Africa developed 76 teacher centres. Furthermore, 200 teachers were trained by Unicef and Papervideo to prepare for examinations making using technology (DI(19)-SA).</p>	
Access to connectivity	<p>The 2017 School Monitoring Survey indicated that 68% of principals, 59% of teachers and 21% of learners had access to the internet (GD (1)-SA).</p>	<p>Network for Learning published a report in 2018 on the opportunities and challenges facing schools using technology for learning. In this report, 53% of schools indicated that more than 25% of their learners did not have internet access at home (DI(7)-NZ).</p>
Access to connectivity	<p>A study was done in 2018 in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. It was found that 58,67% of these teachers and 46,45% of these learners had access to internet connectivity (J(1)-SA).</p> <p>Altogether, 18 000 schools have been connected to the internet. However, only 8% of those have high-speed internet (GD(6)-SA).</p> <p>Statistics South Africa indicates that in 2018, 60,1% of South Africans had access to the internet through a mobile device, 10,4% had internet access at home and 16,2% had access at work. Only 45% of South Africans in rural areas had access to the internet through a mobile device, compared to metro areas with 67,5% and urban areas with 63,7% (GD(12)-SA).</p> <p>In a study done with 197 school teachers from rural schools in South Africa across seven provinces, 55 teachers indicated that they had access to the internet (DI(5)-SA).</p> <p>It was indicated that 90% of households in South Africa had access to a mobile phone and 60% of those had access to internet connectivity, but these statistics include adults (J(8)-SA).</p>	<p>According to the New Zealand census in 2018, 86,1% of households in New Zealand have access to the internet, while 91,9% of households in New Zealand have access to a cell phone or mobile phone (GD(1)-NZ).</p> <p>According to the OECD PISA 2018 results, the principals of 88% of learners agreed or strongly agreed that the internet bandwidth or speed of the school was strong (DI(1)-NZ).</p> <p>A study was done by a partnership of the Ministry of Education, other government agencies and other business partners. Surveys were conducted with 339 primary schools and 125 secondary schools during 2016/17, where eight out of 10 principals indicated that more than half of their learners had internet access at home. It was observed that principals of higher decile schools had more learners with internet access than those of lower decile schools (DI(10)-NZ).</p> <p>Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016 in which 82% of teachers indicated that their school had sufficient and dependable internet access (DI(11)-NZ).</p>

The following was found in a report on the state of ICT in South Africa in 2018:

- Fixed-line telephone internet access is decreasing, and only 8% of households have internet access with a line telephone.
- 4% of households have no access to any form of communication.
- 62% of households indicated that at least one member of the household had access to the internet, and 57% of those utilised a mobile device.
- 60% of households in rural areas use the internet.
- 75% of households in urban areas use the internet. (DI(10)-SA)

In a pilot study done with 20% of all schools across the nine provinces, it was found that access to connectivity for teachers and administrators was available. However, only 32% of learners have access to connectivity (DI(11)-SA).

In the report of the Independent Communications Authority of South Africa on the state of the ICT sector in South Africa, the following was found through information gathered by means of the general household survey of Statistics South Africa in 2019:

- 63% of households have access to the internet anywhere, while 58,7% of these are through mobile devices.
- 74,2% of households in Gauteng have access to the internet (this province has the highest access).
- 43% of households in Limpopo have access to the internet (this province has the lowest access). (DI(12)-SA)

Network for Learning compiled a report in 2018 with surveys conducted with 2 342 school principals. This included 450 schools, but only 20% of these schools completed the survey completely, and 84% of the schools that completed the survey were primary schools.

The following was found on learner connectivity:

- 52% of schools indicated that 25% of their learners did not have internet access at home.
- 85% of Decile 1 to 3 schools indicated that 75% of their learners had internet access at home.
- 36% of schools indicated that the shortage of home internet affected learning and teaching.
- 74% of secondary schools indicated that they planned for maintenance costs for wireless network infrastructure upgrades, whereas only 52% of primary schools indicated that costs were planned for (this may be because secondary schools rely on the wireless network infrastructure to implement the National Certificate of Educational Achievement curriculum).
- 71% of the schools that indicated that they planned for upgrades were large schools, whereas only 42% of small schools indicated plans for upgrades. These larger schools also are more probable to have in-house skills like a dedicated IT person or department.
- Only 22,7% of schools were confident and 7,45% of schools are very confident that their school budget would be able to cover the upgrades. Network for Learning supplies nearly all schools in New Zealand with dependable fibre internet connections. The connection goes through the school's server cabinet and the usability connection of the school and classrooms.
- Schools indicated that they had to pay for commercial web filtering services as Network for Learning did not offer group-level filtering. By the end of 2019, Network for Learning will be supplying group-level filtering. (GD (7)-NZ)

Theme	2. Preparedness and infrastructure	
Data costs	<p>In December 2019, the Competition Commission in South Africa confirmed that data prices in the country were too high, especially the cost of mobile prepaid data. The recommendation was that the mobile networks reduce the bundles that were below one gigabyte. Furthermore, the commission suggested that the mobile networks introduce a zero-rated approach to educational and public benefit websites (DI(9)-SA).</p> <p>The following was found in a report on the state of ICT in 2018:</p> <ul style="list-style-type: none"> • 36% of respondents indicated that the cost of smart devices was the main reason why they were not online. • 15% of respondents indicated that the internet was too expensive. • 47% of respondents indicated that the cost of the internet was the reason why they limited their internet usage. (DI(10)-SA) 	<p>Mobile broadband is more expensive than fixed wireless broadband. It has been indicated that mobile broadband of 12 gigabyte costs NZ\$69,99, whereas fixed wireless broadband costs NZ\$75 for a month with 120 gigabyte (DI(16)-NZ).</p>

Access to ICT	<p>In 2017, the School Monitoring Survey indicated that in South African public schools, 64% of Grade 12 learners attended schools that did have computer laboratories, 40% of which are Quintile 1 schools and 93% of which are Quintile 5. Also, among the provinces, there is a substantial difference, with 91% of Grade 12 learners in the Free State attending schools that have computer laboratories, while only 25% of learners in Limpopo attend schools with computer laboratories (GD(1)-SA).</p> <p>A study was done in 2018 in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. The following was found about access to ICT in these schools:</p> <ul style="list-style-type: none"> • 90,67% of the teachers and 86% of the learners indicated that they had access to a mobile phone. • 68% of the teachers and 58,44% of the learners had access to a computer. • 74% of the teachers and 23,78% of the learners had access to a laptop. • 28,67% of the teachers and 23,56% of the learners indicated that they had access to an interactive whiteboard. • 80,67% of the teachers and 64% of the learners had access to a scanner. (J(1)-SA) <p>In a study done with 197 school teachers from rural schools in South Africa across seven provinces, the following was found. Out of 197 teachers, 186 indicated that tablets for learners and teachers were available. Four teachers indicated that tablets were only available for teachers, six teachers indicated that tablets are only available for learners, and one teacher indicated that there were no tablets at school. Altogether 121 teachers indicated that they owned a laptop or computer, 133 teachers indicated that they owned a digital device, and 67 teachers indicated that they had access to a printer (DI(5)-SA).</p> <p>A study done by Saal et al. (2019) used Grade 5 learners who wrote the TIMSS in 2015 and their Mathematics teacher. It was found that 68,57% of the learners indicated that they did not have their own digital devices,</p>	<p>According to surveys done by the OECD (considering the PISA and the Teaching and Learning International Survey results of 2018), the following was found:</p> <ul style="list-style-type: none"> • 59% of the teachers indicated that the utilisation of ICT in teaching was part of their formal education or training. • 76% of the teachers indicated that they believed that they could assist learning by using digital technology. • 73% of the teachers indicated that ICT skills for teaching were part of their formal education or training. • 44% of the teachers indicated that they took part in common professional learning at their schools a minimum of once a month. • 14% of the teachers indicated that they need professional development in ICT skills for teaching. • 33% of the teachers indicated that they took part in online courses or seminars in the 12 months before the survey was done. • 58% of the teachers indicated that they were part of a network of teachers who specifically worked on professional development in the 12 months before the survey was done. • 18% of the principals indicated that the deficiency of digital technology for teaching obstructed the function of these schools to give quality instruction. • 76% of the principals agreed or strongly agreed that there was an effective online learning support platform available. • 3% of the principals indicated that limited internet access impeded the position of these schools to give quality instruction. • 92% of the learners indicated that they had access to a computer at home to do schoolwork. • 79% of the learners in the bottom quartile of the socioeconomic profile indicated that they had access to a computer at home to do schoolwork. (DI(5)-NZ)
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Theme	2. Preparedness and infrastructure	
	<p>while 76,07% of the learners had access to digital devices at home. The problem that the learners experienced was not having an internet connection for these devices (J(11)-SA).</p>	<p>Network for Learning compiled a report in 2018 with surveys conducted with 2 342 school principals. This included 450 schools, but only 20% of these schools completed the survey completely, and 84% of the schools that did the survey were primary schools. In this survey, 71% of the schools that indicated that they planned for upgrades were large schools, whereas only 42% of the small schools indicated that they had plans for upgrades.</p>

These larger schools also more probably have in-house skills, such as a dedicated information technology person or department. Only 22,7% of the schools were confident and 7,45% of the schools were very confident that their school budget would be able to cover the upgrades. The schools further pinpointed a few programmes that they wanted to carry out, namely:

- Organise more devices: 57% of the secondary schools and 37% of the primary schools are likely to execute a one-to-one learner ratio with devices.
- Hardware and wireless networks to be upgraded: 74% of the secondary schools and 52% of the primary schools planned funds for the maintenance of school network and wi-fi infrastructure.
- Using the cloud to store data: 64% of the secondary schools planned to move their data to the cloud, whereas only 33% of the primary schools plan to move their data. A secure environment is a general concern among schools.
- Further network security is required by 14% of the schools.
- Initiate wireless projects in the community: 11% of the schools were planning for these projects.
- Integrating a new digital curriculum. (GD(7)-NZ)

A study was done by a partnership between the Ministry of Education, other government agencies and other business partners. Surveys were done with 339 primary schools and 125 secondary schools during 2016 and 2017. The findings included the following:

- 75% of schools in New Zealand have ICT strategic plans to use digital technologies in teaching and learning. In numerous schools, the ICT strategic plans do not make provision for change management. Also, 50% of the schools that have ICT strategy plans do not have policies for personal digital device use for learning.
- Less than 33% of schools indicated that they received charitable support for learning with digital devices.

		<ul style="list-style-type: none"> • The balance of learners to a school-provided digital device in primary schools was two learners to one device, and in secondary schools, it was three learners to one device. The digital devices provided by schools are desktop computers, laptops, Chromebooks and tablets (including iPads). • 8 out of 10 principals indicated that more than half of their learners at their schools had internet access at home. It was observed that principals from higher decile schools had more learners with internet access than those of lower decile schools. • A small number of schools made use of cloud platforms like Google Classroom and Microsoft Office 365. Out of the two, Google is used more. • 4 out of 10 principals indicated that more than half of their learners had access to their own devices. • 1 out of 5 principals indicated that all their teachers had the necessary skills for digital learning. • 7 out of 10 principals indicated that their schools had policies for taking charge of online safe practices, active administration of site-blocking filters and incident administration. • 6 out of 10 principals indicated that they depended on their internet service provider to block and identify inappropriate sites. • 25% of principals indicated that they were aware of their responsibilities under the <i>Harmful Digital Communications Act</i>. • 1 out of 5 principals indicated that they made use of Māori language support resources that were supplied by the Ministry of Education. (DI(10)-NZ) <p>Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016. Teachers indicated the following with regard to infrastructure for digital technologies at their schools:</p>
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Theme	2. Preparedness and infrastructure	
		<ul style="list-style-type: none"> • 62% indicated that their school had effective technical support to dispense problems. • 60% indicated that their school had sufficient and dependable equipment. • 56% indicated that the necessary knowledge and skills to roll out learning with digital technologies were available. • 56% indicated that the school had strong leadership in digital technology usage. • 52% indicated that digital technology was available when needed. <p>Furthermore, principals indicated the following regarding infrastructure for digital technologies at their schools:</p> <ul style="list-style-type: none"> • 65% indicated that their school had the necessary skills to support good-quality learning with digital technologies. • 52% indicated that funding for maintenance and replacement of digital technologies was a big issue at their school. • 45% indicated that their school had the necessary resources to support good quality learning with digital technologies. <p>(DI(11)-NZ)</p>

Theme	2. Preparedness and infrastructure	
Teachers' ability and usage of digital technologies	<p>In a cross-sectional survey done in September and October 2017 in Gauteng, 375 schools and 493 teachers were used. The following were found on teachers' ability to use ICTs for teaching and learning:</p> <ul style="list-style-type: none"> • 70,5% of the teachers indicated that they could effortlessly teach classes using technology. • 69,7% of the teachers indicated that it was simple for them to find instructional technologies for teaching purposes. • 66,4% indicated that they had the necessary skills to utilise technology for teaching and learning. • 85,5% of the teachers indicated that they were willing to integrate ICTs in their classrooms. (DI(6)-SA) <p>A study was done by Adegbenro <i>et al.</i> (2017) with 21 in-service teachers in the Gauteng Province (an area that is mostly urban schools.) It was found that the attitude of the 21 participating teachers towards ICT was positive. Only 13,04% of the 21 teachers were uncertain about their preparedness to learn about ICT and implement it in their teaching and learning, and 100% of the teachers agreed that it was important to make use of ICT in their classrooms. Altogether 50% of the teachers needed skills in software installation, web design software, a database using MS Access and electronic resources, and 34,78% of the teachers did not understand the basic function of the software. In total, 26,09% of the teachers used computers in teaching and learning, 56,62% made use of a computer at school that was connected to the internet, and 65,22% of the teachers made use of websites to support their teaching and learning activities (J(12)-SA).</p>	<p>In Bolstad's (2016) report on the NZCER national survey of primary and intermediate schools, 75% of the teachers indicated that the most useful online resource for supporting their teaching was the Te Kete Ipurangi. Furthermore, the following information was given by teachers regarding their work and professional learning with digital devices:</p> <ul style="list-style-type: none"> • 37% indicated that they did not have an online professional learning network. • 49% indicated that they had a regular connection with one to 20 individuals in their online professional learning network. • 11% indicated that they often communicated with more than 20 individuals in their online professional learning network. • 20% found the virtual learning network useful. <p>Furthermore, 11% of the teachers found Network for Learning useful, and 37% found Facebook and Google useful as online resources for supporting their teaching. Of the parents who completed the survey, 36% indicated that it was highly important for their children to learn with digital technologies (DI(11)-NZ).</p>

Theme	2. Preparedness and infrastructure	
Games, platforms and applications	<p>According to Tracxn, there are 138 education technology start-up companies in South Africa, such as the following:</p> <ul style="list-style-type: none"> • The Student Hub is an application that has an ERA Online platform where users can buy, sell or rent textbooks or e-books. • Demy is an online learning management platform where courses are given and audio, videos, texts and PDFs are supplied. • Syafunda is an online platform that creates a digital portfolio for learners. Learners can do assignments, homework and tests, receive announcements, have access to video lessons and be assessed. Schools can register with learners. • Lightbulb Education is an application that provides blended tutoring services in Mathematics, Physical Science. Life Science, Accounting and languages. • Eduze is a content platform where videos, audio lessons, PDFs, e-books and quizzes are available on CLOX. • Siyavula is an application that provides educational resources such as textbooks, workbooks, videos, simulations, extension activities, guides, concept maps and posters for Mathematics and Science. It also provides a dashboard for teachers to monitor learner performance. • Numberwise is an online Mathematics education platform. The application is available on computers and mobile phones. The focus is on basic numeracy, mental mathematics, number facts, addition, subtraction, multiplication and division. (DI(22)-SA) <p>M-Thuto is an application led in the North-West and Gauteng Provinces where teachers gave the content for this technology. It is suited for learners from age 15 to 18 years to have access to class notes, class exercises and quizzes in English and other South African languages for Mathematics on their mobile phones. With this application, learners can switch between languages (J(13)-SA).</p>	<p>A report for the NZCER involved innovative game-based learning and teaching practices. The study was done over two years and involved 12 schools with 21 interviewed teachers and 100 learners aged three to 13 years of age. The learners indicated that games gave them some independence, innovation, motivation, challenges and the chance to fail and learn for them to make progress in their learning. Comments about digital games were also provided. It seems that there are teachers who eagerly use digital games and design.</p> <p>Computing has become more accessible, enabling learners to create games with virtual worlds and developing 2D and 3D games, kinetic games, augmented reality and virtual reality (DI(9)-NZ). The following applications, games and platforms are available:</p> <ul style="list-style-type: none"> • Education Perfect platform encourages curiosity, confidence and self-learning. The platform is lavish in data, with more than 40 000 subject-specific lessons that are curriculum-aligned. It hosts nine different languages and subjects such as Mathematics, Science, Health and Social Science and Digital Technology. The platform currently is used in 4 500 schools across 55 countries. • Amy.app is an augmented reality-based private mathematics tutor application. It is designed to adjust to learners' knowledge and strength, giving distinctive activities and assessments. • Geo AR Games is centred on geospatial augmented reality with mobile gaming. It is attainable with smartphones or tablets. This company also partners with the New Zealand Council to promote the use of Aotearoa parks. • Komodo Wellbeing has a web and mobile application that monitor the wellbeing and mental health of learners. The application uses surveys and questions that focus on topics such as relationships, bullying and transition periods. (GD(9)-NZ)

The above table shows data on the preparedness and infrastructure of ICT in schools before the Covid-19 pandemic in South Africa and New Zealand. Both governments had partnerships with various organisations. In South Africa, there were partnerships with private companies (e.g. PLATCO, Mulitchoice, Vodacom, MTN and Cell C), universities and non-government organisations. In New Zealand, there were partnerships with Google, the Manaiakalane Education Trust and various educational technology companies that assisted education with ICT services. Both countries had education portals to contribute to digital content for learners. Also, both governments supported ICT in their schools, although they had different approaches. New Zealand had projects such as the Cloud Transformation project and financial relief packages for disasters that contributed to ICT in schools. The South African government concentrated on the new Coding and Robotics curriculum; there were also plans for the roll-out of internet connection, the Gauteng Education Department introduced a paperless classroom by using digital technologies in the township and rural areas, the Western Cape Education Department suggested seven digital game changers for schools and partnerships were searched by the Department of Telecommunications. Where access to connectivity is concerned, this is where the two countries differ a lot. In South Africa, access to the internet is mostly through mobile devices, and the statistics are average for internet access in households and rural areas. In New Zealand, a high percentage of schools and teachers have access to the internet; also, a high percentage of households have access to the internet through mobile devices. Not only is there internet access, but this access is also strong internet bandwidth with high speed. Internet access and the speed of such access influence the implementation of digital learning. The cost of the internet also differs in the two countries, as data tariffs in New Zealand are high, while fixed wireless broadband is more affordable. In South Africa, it was found by the Competition Commission that the data tariffs were too high. With regard to access to ICT, it has been found that teachers have access but learners have a low percentage of access to ICT in South Africa. In New Zealand, the majority of schools provide ICT at school and schools also have ICT plans. More information on access to ICT in New Zealand was found in comparison to South Africa. Considering teacher ability, in South Africa, a high percentage of teachers agree that ICT is important and learning and that they need more skills to implement it. In New Zealand, a high percentage of teachers use ICT in their teaching and they make use of ICT for professional development. Both countries have digital games, platforms and applications that assist in learning and teaching.

4.4.4 Theme 2: Preparedness and infrastructure – during Covid-19

Table 4-5: Theme 2: Preparedness and infrastructure – during Covid-19.

Theme	2. Preparedness and infrastructure	
Sub-theme	During Covid-19	
	South Africa	New Zealand
Government partnership with other organisations	<p>During the Covid-19 pandemic, the DBE was in partnership with the Department of Communications and Digital Technologies. With this partnership, 152 sites in 76 education districts had virtual classroom infrastructure. This digital revolution of remote learning enabled districts to benefit through curriculum specialists and streamed lessons on digital platforms (GD(1)-SA).</p>	<p>In 2021, Google and the Ministry of Education started an agreement from 1 July 2021 to 30 June 2024. With this agreement, Google gives extra functionality and security to existing Google applications. There will also be means to control Chromebooks from a cloud-based administration device. This software license initiative is funded by the Ministry of Education and gives all New Zealand state and state-integrated schools free access to approved providers. Independent schools will receive a 20% discount on license costs (GD(6)-NZ).</p>
Government partnership with other organisations	<p>A partnership between the Department of Education, the Dell Foundation and other stakeholders created a data-driven districts initiative. This initiative educated the districts on how to advance e-education and beneficial approaches (GD(1)-SA).</p> <p>The DBE has acquired the University of South Africa to assist with 24 ICT laboratories to train 72 000 teachers. In 16 000 primary schools, a minimum of three teachers must be trained to teach coding (GD(6)-SA).</p>	<p>Network for Learning provided a free internet filtering service, named Switch on Safety, to all learners in New Zealand (GD(8)-NZ).</p>

Theme	2. Preparedness and infrastructure	
Organisations / educational technology companies	<p>In a roundtable discussion between mobile network operations and the DBE, the mobile network companies stated that they would supply ICTs to special schools. As a result of this, 191 special schools received ICTs, including devices, assistive technologies and learning and teaching software, with Cell C providing one device, Telkom 19 devices, MTN 31 devices and Vodacom 140 devices (GD(19)-SA).</p>	<p>The following organisations that assist communities to improve education were identified in the Aotearoa EdTech Excellence Report:</p> <ul style="list-style-type: none"> • Digital Future Aotearoa is a charity that supplies digitally focused education programmes to children in New Zealand. It has programmes that involve 3 500 teachers and volunteers that teach computer programming. • The Greater Christchurch Schools' Network strives to allow schools and learners to learn about digital technologies. • Te Awakairangi Access Trust (Taka) is a charitable trust that provides access to digital services and the internet to children. • IT Professionals New Zealand provides TechHub talks to educate learners on the experience of working for a technical company. (GD(9)-NZ)

Government support	<p>Statistics South Africa indicated in a 2022 report that the DBE assisted learning through radio and television broadcast media (GD(2)-SA).</p> <p>Woza Matrics was launched by the DBE in 2020 as a catch-up campaign for all matric learners. This programme was mostly used by second-chance matriculates (400 000 learners made use of Woza Matrics). Woza Matrics and the Tswelopele Campaign were established with the National Education Collaboration Trust (GD(1)-SA).</p> <p>With these campaigns, learners can access learning resources through DBE-TV on Open-View, Channel 122, SABC 1, MultiChoice DSTV Catch-Up and YouTube channels. A complication with this resource is that it focuses on early childhood development and Grades 10 to 12 across the three television programmes and is available 1,5 hours per day, which is not equivalent to the teaching time learners would traditionally receive in schools (GD(4)-SA).</p> <p>The DBE also promotes the African Storybook Series through the 2Enable application (DI(14)-SA).</p> <p>A WhatsApp group called Teachers Connect was launched in 2020 by the DBE. This tool was used for daily reporting. The entire school community of learners, teachers, parents and support staff can use this as a Covid-19 self-assessment and mentorship programme. A health check is integrated into the platform, which is a mapping tool and risk assessment (GD(1)-SA).</p> <p>In the DBE annual performance plan, it is indicated that between 2021 and 2022, the DBE will monitor 27 schools for utilisation of ICT resources, and 307 special schools will receive 207 electronic devices. Also, 81 schools will be monitored for piloting and the implementation of a compulsory Robotics curriculum. In 2022, the pilot for Grades 4 to 6 and 8 for Coding and Robotics was started. Full-scale implementation of Coding and Robotics for Grade 9 will be done in 2025 (GD(1)-SA).</p>	<p>The New Zealand Ministry of Education supported remote learning by broadcasting to two television channels, named Home Learning, in English, and Māori Reo Ora in te Reo Māori. Three online websites with online resources were provided that also supported schools to make sure that all learners had access to the internet or printed learning resources (J(1)-NZ).</p> <p>The distance learning package of the Ministry of Education included access to online learning (including connectivity and devices), the delivery of hard packs and television broadcasts. Internet service providers were contracted by the Ministry to connect 53 267 households. In addition, the Ministry bought 5 000 modems to ensure that specific learner households would have a connection to the internet. From 7 July 2021, 2 167 of the modems have been returned and relocated. Kura and schools indicated to the Ministry that 98 029 Chromebooks or laptops were needed on 9 July 2020. Also, the Talanoa Ako on-air radio programme was hosted from 20 April 2020 to 28 June 2020 (GD(8)-NZ).</p> <p>The Ministry of Education published a case study report where four different organisations were interviewed to comprehend the response to the Covid-19 lockdown in New Zealand. In the report, it was indicated that schools provided over 16 000 devices to learners in their schools (GD(8)-NZ).</p> <p>The Ministry of Education identified problems for digital exclusion and implemented the following initiatives:</p> <ul style="list-style-type: none"> • Homes that do not have digital connections: There were 60 000 to 80 000 households with children who did not have access to the internet. To respond to this issue, copper or fibre connections were installed. Also, mobile base stations in several locations were set up to service disconnected communities. • Eliminate the device and connection costs barrier: Internet service providers were asked to get rid of the data cap for new connections. By November 2020, 16 000 school-owned
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<p>In 2020, the DBE launched guidelines for teachers for work-from-home or alternate work arrangements. This guideline is an all-in-one aid for teachers during Covid-19 with a guideline for remote teaching and learning, online learning and teaching tools, and teaching with radio and television (GD(8)-SA).</p> <p>The DBE upgraded its educational website during this period by adding material such as study guides and revision booklets (for Grades 10 to 12), workbooks (for the Intermediate Phase) and material for special needs groups. Moreover, pointers were given to parents to assist their children during remote learning. Also, psychosocial resources were made available with guidelines. The DBE also added multimedia materials for mobile learning (DI(8)-SA).</p>	<p>devices and 25 000 new laptops, Chromebooks and iPads were delivered to learners.</p> <ul style="list-style-type: none"> • Confronting the shortage of device reserve: There was a low inventory at information technology suppliers and telecommunication, and it was exhausted fast. A team searched globally for this equipment. Singapore was able to supply in the demand, and the Ministry of Foreign Affairs and Trade assisted to get extra shipments to New Zealand. • Supplying non-digital learning to expand inclusion: The content was broadcast on two television education channels in te Reo Māori (official language of New Zealand) and English. Over five weeks, it received 3,6 million views. • Operating with Māori <i>iwi</i> (the largest social units) and community mediators to acquire information and initiate trust: It was difficult for the Ministry of Education to work with the communities, as there was not always a level of trust. Therefore, community organisations or <i>iwi</i> groups were used to communicate with households. It was found that community members preferred wi-fi repeaters on streetlamps instead of personal fibre installations in their homes. There were also communications with the community organisations on the advantages and disadvantages of these models. • Developing digital policies and skills: Although there was already an education system digital strategy and a roadmap for digital infrastructure before Covid-19, since Covid-19, the Ministry had to review its policy. Data security and device security were a concern; therefore, basic content filters were installed to ensure that learners would not have access to inappropriate content on the devices. Further operating systems were put on the devices to ensure that when these devices were missing, stolen or sold, they could be recovered. Insurance for schools was also covered on behalf of schools if the devices were damaged or lost. • Synchronise and speed up digital inclusion:
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Theme	2. Preparedness and infrastructure	
		<p>An all-government response with the Digital Inclusion Team within the Digital Public Services Branch was provided. The Ministry also worked with roughly 50 various communication service providers to point out unconnected homes, and fibre and mobile connections were installed to give internet connection to these homes. (GD(2)-NZ).</p>
Access to connectivity	<p>In a report by Statistics South Africa, the following was found on access to ICT in South Africa during the Covid-19 pandemic:</p> <ul style="list-style-type: none"> • 7% of households had individuals between the ages of five and 24 who had access at home, where 66,8% of these were from the use of smartphones. • 15,6% of individuals between the ages of five and 24 had access to the internet via a workplace. • 13,1% of individuals between the ages of five and 24 had access to the internet via wi-fi. • There is a 19% gap in access to the internet between large urban and rural areas. • There is a 12% gap in access to the internet between metropolitan and rural households. (GD(2)-SA) 	<p>The Greater Christchurch Schools' Network Trust did a study with 3 105 participants from 150 schools in Canterbury and discovered that 1,9% of the learners did not have access to internet connectivity before the lockdown, with 2,2% of the parents indicating that they did not have any internet connectivity before the lockdown. There were schools, parents, caregivers, family members, workplaces of parents, internet providers, and government or community services; of these, 30,8% had internet connectivity. Still, 69,2% of learners did not have access to internet connectivity (DI(2)-NZ).</p> <p>Network for Learning compiled a full Touchpoint Report with surveys done at 550 schools with 563 respondents. This report states that 10% of these schools indicated that half of their learners did not have internet access at home. The report further indicates that the Ministry of Education did research and found that approximately 82 000 homes required an internet connection. The Ministry of Education provided 33 000 homes with free internet until the end of 2021 (DI(6)-NZ).</p>

Theme	2. Preparedness and infrastructure	
Access to connectivity	<p>In a study done in 127 Eastern Cape schools, 64% of the teachers indicated that they did not have internet access at home, 48% of the teachers had internet access at school; 70% of those were connected with wi-fi, 20% with network cables and 10% with data routers. However, the teachers indicated that those connections were mostly available in the administration areas (J(6)-SA).</p> <p>Mobile service providers, such as MTN, Vodacom and Cell C, provided free access to zero-rated applications and educational websites (DI(14) SA).</p>	<p>According to the 2018 Touchpoint Report, it was found that 47% of Decile 1 to 3 schools indicated that less than half of their learners had internet or digital devices at home. In the 2021 report, it had decreased to 23%. The following are the percentages of schools where less than half the learners had access to the internet:</p> <ul style="list-style-type: none"> • Tai Tokerau: 30% internet access. • Bay of Plenty: 14% internet access. • Waikato: 12% internet access. • Nelson, Marlborough or West Coast: 12% internet access. • Taranaki or Whanganui: 13% internet access. • Hawkes Bay: 9% internet access. • Wellington: 2% internet access. • Canterbury: 3% internet access. • Auckland: 10% internet access. • Southland: 4% internet access. (DI(6)-NZ)
Data costs	<p>After the first confirmed Covid-19 case in South Africa, the networks made the following changes:</p> <ul style="list-style-type: none"> • Vodacom reduced the price of one gigabyte data by 34% and introduced zero-rating educational websites. Also, the Vodacom e-school portal was available with digital resources for free. • MTN reduced the price of monthly one gigabyte bundles by between 25% and 50% and also zero-rating for educational websites. • The day before the lockdown, Telkom stated that educational and government websites could be accessed for free on its network. • Cell C also introduced zero-rating on selected public and government websites, as well as a lifeline package for prepaid customers. (DI(9)-SA) 	<p>According to a study done by Tefficient, data charges in New Zealand are the third most expensive among 44 developed countries. The reason for the expensive data charges is that the majority of New Zealanders make use of wi-fi connectivity instead of mobile networks (DI(15)-NZ).</p>

Theme	2. Preparedness and infrastructure	
Access and utilisation of digital opportunities	<p>Access to television in households with individuals aged five to 24 was 91,2% in urban and 85,8% in rural areas.</p>	<p>The Education Review Office published a report on a survey that was conducted among 10 000 learners and 700 teachers from 110 schools and 95 early childhood centres. It was found that 30% of the primary school learners indicated that they watched Home Learning TV or Papa Kāinga TV, whereas only 7% of the secondary school learners watched it. It seems that the older the learners, the less they watch Home Learning TV or Papa Kāinga. In the lower decile (1-3), 22% of the learners watched Home Learning TV or Papa Kāinga TV, and 19% of these learners had to share a device, whereas in Decile 4 to 10, 17% of the learners watched Home Learning TV or Papa Kāinga TV, and 14% had to share a device (DI(12)-NZ).</p>

Theme	2. Preparedness and infrastructure	
Access to ICT	<p>In a report by Statistics South Africa, the following was found on access to ICT in South Africa during Covid-19:</p> <ul style="list-style-type: none"> • 91,3% of households with children between the age of five and 24 had access to a cell phone. • 24,7% of households with children between the age of five and 24 had access to a computer. • 70,5% of Grade 7 learners did not have their own mobile devices. • 82,1% of Grade 12 learners owned a mobile device. • 11,6% of rural households had access to computers and laptops. • 34,1% of metropolitan households had access to computers and laptops. • 11,7% of learners between the age of five and 24 were provided with remote learning options. • 63,3% of schools mainly attended by white learners did not provide remote learning, whereas 91% of schools attended by black South Africans did not provide online learning. (GD(2)-SA) <p>In a study done in 127 Eastern Cape schools, 71% of the teachers indicated they had access to computers at work (J(6)-SA).</p> <p>During Covid-19, free access to the Siyavula Math and Science application was provided in partnership with MTN (DI(14)-SA).</p> <p>A survey was done with 1 260 participants between the ages of 15 and 24. In this survey, 88,9% of the respondents indicated that they had a cell phone but only 34,7% had access to a laptop in their household. However, only 23,9% had access to the internet (DI(15)-ZA).</p> <p>Remote learning was provided through different options that included television, radio, digital and paper-based packages. However, these options were not available equally (GD(3)-SA).</p>	<p>The Greater Christchurch Schools' Network Trust did a study with 3 105 participants at 150 schools in Canterbury. It was discovered that 1,9% of the learners did not have access to internet connectivity. Furthermore, 7,9% of the parents indicated that they did not have any devices for any of their children, whereas 22,3% of the parents indicated that there was a device available, although maybe not for all their children. Devices were provided by schools, parents, caregivers, family members, workplaces of parents, internet providers and government or community services. This ensured that 71,4% of learners received a device. Still, 28,6% of learners did not have a device. The teachers and schools indicated that they were well-resourced to do online learning (DI(2)-NZ).</p> <p>The full Touchpoint Report by Network for Learning was compiled with surveys conducted at 550 schools with 563 respondents. In the report, 24% of the schools indicated that half of their learners did not have access to digital devices. According to the 2018 report, 47% of Decile 1 to 3 schools indicated that less than half of their learners had internet or digital devices at home. In the 2021 report, the number had decreased to 23%.</p> <p>The following are the percentages of schools where less than half the learners had access to a digital device:</p> <ul style="list-style-type: none"> • Tai Tokerau: 42% device access • Bay of Plenty: 38% device access • Waikato: 35% device access • Nelson, Marlborough or West Coast: 27% device access • Taranaki /Whanganui: 23% device access • Hawkes Bay: 21% device access • Wellington: 19% device access • Canterbury: 18% device access • Auckland: 17% device access • Southland: 9% device access (DI(6)-NZ)

Theme	2. Preparedness and infrastructure	
Access to ICT		<p>Network for Learning compiled a report in 2020, with surveys conducted at 550 schools with 563 respondents. The report indicates that 88% of the schools (of different sizes, deciles or types of school) are certain in their capacity to protect learners online. The following strategies were indicated by schools to protect learners online:</p> <ul style="list-style-type: none"> • 86% of the schools indicated that they used internet usage agreements. • 84% of the schools indicated that they used filtering. • 52% of the schools indicated that the school leaders managed it proactively and policies and guidelines were reviewed regularly to control cyber safety. • 49% of the schools used a board of trustees that included management risks of online safety. • 46% of the schools did professional learning and development for staff about teaching online safety and digital residency. • 38% of the schools held workshops for learners on online safety and digital residency. • 32% of the schools brought in guest speakers to address the school. • 26% of the schools used Netsafe’s online Schools Review Tool for safety. • 23% of the schools made use of a reporting tool to evaluate online activity. • 454 of the schools responded with five themes for approaches that the schools used to enhance their cyber safety: web filtering (40%), education (15%), monitoring and supervision, internet use agreements, and experienced staff. (DI(6)-NZ
Teachers’ ability		<p>The Ministry of Education provided a Covid-19 professional learning and development support package that supported schools in transitioning to distance learning (GD(8)-NZ).</p>

Theme	2. Preparedness and infrastructure	
Games, platforms and applications		<p>The House of Representatives of New Zealand created a parliament 360° virtual reality tour that was released on 14 May 2020. It is called the Parliament XR and is a free application for tablets and smartphones. Virtual reality headsets can also be used. Parliament XR forms part of Social Studies so that learners can understand how government systems operate and how they differ from other systems. This will give learners insight into how formal and informal decisions are made. The application also includes a scavenger hunt, a research feature and a reflection on the research (DI(8)-NZ).</p> <p>Outschool is a platform that offers more than 140 000 live online courses to more than 900 000 learners. Throughout the Covid-19 pandemic, the platform rapidly expanded. The Outschool platform was valued at US\$320 million, and from April 2021 it is valued at US\$1.3 billion (GD(9)-NZ).</p>

The above table presents data on the preparedness and infrastructure of ICT in schools before the Covid-19 pandemic. The governments of both countries partnered with other organisations during the Covid-19 pandemic. New Zealand partnered with Google and Network for Learning (just like before Covid-19). Other stakeholders also contributed towards improving education. In South Africa, the DBE partnered with the Department of Communications and Digital Technologies, as well as universities and foundations. Other companies, such as MTN, Vodacom and Cell C, were also in partnership with the DBE. Both governments assisted education during Covid-19 through radio and television with special programmes. In New Zealand, the Ministry of Education assisted online learning by giving devices and getting internet service providers to connect households to the internet. As discussed above, both governments attempted to support learning through ICT in different ways. The access to connectivity in South Africa was more focused on smartphones, while in New Zealand, there was a focus to get more homes connected through wireless internet. During the Covid-19 pandemic, data costs were still expensive in New Zealand, whereas in South Africa, zero-rating was provided for education sites. Where access to ICT is concerned, the difference between the two countries is that in South Africa, ICT devices are more focused on mobile devices, while in New Zealand, it is more on different devices. Access to each ICT in each country was discussed through previous research done and published work. During the Covid-19 period, the Ministry of Education in New Zealand launched a special application and the Outshool platform.

4.4.5 Theme 3: Execution and effectiveness of ICT – before Covid-19

Table 4-6: Theme 3: Execution and effectiveness of ICT – before Covid-19.

Theme	3. Execution and effectiveness of ICT	
Sub-theme	Before Covid-19	
	South Africa	New Zealand
Outcomes of ICT	<p>A cross-sectional survey was done in September and October 2017 with 375 schools and 493 teachers in Gauteng. The following findings were made during the study on ICT:</p> <ul style="list-style-type: none"> • 54,2% of the teachers indicated that they used interactive whiteboards, social media platforms and Google Docs. • 58,6% of the teachers indicated that technology made it possible for learners to work on their own with minimal support from the teacher. • 59,6% of the teachers stated that they used ICT educational websites as cognitive tools to advance learner-directed learning. • 66% of the teachers agreed or strongly agreed that they used simulation software and interactive whiteboards as cognitive tools that lead to stimulating critical thinking. • 54,7% of the teachers indicated that they used ICTs to evaluate and practise skills of concepts learnt by learners. • 63,8% of the teachers indicated that they used ICTs for remedial work. • 47,8% of the teachers agreed or strongly agreed that the role of ICT was to assist with drill and practise exercises for learners. • Furthermore, the teachers indicated that they believed that ICT was relevant to their class activities and helped them to achieve their learner objectives. Gauteng teachers are more likely to make use of ICT than traditional teaching and learning. (DI(6)-SA) 	<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 80% of the participating principals stated that digital technologies had a positive impact on learner attainment (DI(3)-NZ).</p> <p>According to surveys conducted by the OECD (considering the PISA and Teaching and Learning International Survey results of 2018), preceding the Covid-19 pandemic, 80% of teachers indicated that they let learners use ICT for projects or class work frequently (DI(5)-NZ).</p> <p>A study was done in partnering with the Ministry of Education, government agencies and business partners. Surveys were conducted at 339 primary schools and 125 secondary schools in 2016 and 2017. The findings included the following:</p> <ul style="list-style-type: none"> • 8 out of 10 of these principals indicated that digital technologies had an improving impact on their learner achievement. • 75% of the principals indicated that because of internet access at home, families had become more engaged with their children's learning. • 8 out of 10 principals believed that more than half of their learners that exited secondary schools had the necessary ICT skills to get paid work. (DI(10)-NZ)

Theme	3. Execution and effectiveness of ICT	
Outcomes of ICT	<p>A study was done among Grade 5 learners who wrote the TIMMS in 2015 and their Mathematics teacher. Of these learners, 90% indicated that they did not have computers in their Mathematics classrooms. The learners who had received teaching with computers had an average score of 431,88, while those who had received teaching without computers had an average of 371,08 (J(11)-SA).</p> <p>Only 6% of individuals between the age of five and 24 were engaged in remote learning in 2020. While 18,3% of white individuals engaged in remote learning, only 5,3% of black individuals did so (GD(2)-SA).</p> <p>In 2018, a study was done in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. The following was found about the utilisation of ICTS in these schools:</p> <ul style="list-style-type: none"> • 61,33% of the teachers and 29,33 of the learners indicated that they used a computer for teaching or learning. • 52% of the teachers and 22,67% of the learners used mobile phones for teaching or learning. • 29,33% of the teachers and 23,56% of the learners used the internet for teaching or learning. • 37,33% of the teachers and 12,44% of the learners made use of a laptop for teaching or learning. • 22,67% of the teachers and 19,33% of the learners made use of an interactive whiteboard for teaching or learning. • A further observation was that the use of radio, television, video recorder and fax machines was below the 10% use for teachers and learners. (J(1)-SA) <p>In 2018, it was found in a report on the state of ICT in South Africa that mobile devices were the most favoured device used to access the internet in South Africa, and 32% of the respondents indicated that they also used public wi-fi at least once a month (DI(10)-SA).</p>	<p>The full 2018 Touchpoint Report of Network for Learning includes the results of surveys conducted with 2 342 school principals. The respondents included 450 schools, but only 20% of these schools completed the survey completely, and 84% of the schools that did the survey were primary schools. The schools indicated that they used technology in the classroom in the following ways:</p> <ul style="list-style-type: none"> • Making movies • Making games • Coding • Robotics • 3D printing • Virtual reality • Augmented reality • Utilising YouTube for teacher professional development • Using technology for painting and dancing • Using technology for education outside the classroom (GD(7)-NZ)

Theme	3. Execution and effectiveness of ICT	
Outcomes of ICT		<p>Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016. The focus of the survey was on the impact and role of digital technologies in these schools. The following were found:</p> <ul style="list-style-type: none"> • 92% of the participating teachers indicated that learners used digital technologies to prepare subject-specific skills. • 80% of the teachers indicated that digital technologies were used to do research through the internet. (DI(11)-NZ)
Usage of digital technologies	<p>The Department of Rural Development and Land Reform funded a project called ICT for Education, in which 197 teachers and 6 895 learners at 24 schools across seven provinces were trained over a year and a half on how to implement mobile technology in their teaching and learning. Before the training, it was found that 76% of the teachers made use of their mobile phones or computers to check their e-mail. It was found that 52% of the teachers typed their question papers and 74% of the teachers recorded their marks on the schools computer systems (DI(21)-SA).</p> <p>A study done by Fisher et al. (2017) with 58 private and 1 274 public schools indicated that 20,2% of those teachers made use of mobile phones, 20,2% made use of smartboards, 28.2% made use of laptops with Windows and 21,2% made use of android tablets. Chrome, Apple and iPad were used the least. The following software programs were indicated to be used: Microsoft Office, Adobe Suite, SA-SAMS, GeoGebra, Green Shoots, Hey Maths, Thutong, Encarta Kids, Edukite, Vodacom Classroom, Google applications for education, Cami Maths, Tux Maths, Reading Rocket, Talking Stories, and so forth. Technology was mostly used in subjects like Mathematics, Natural Sciences, Physical Sciences, Social Sciences and in reading and writing. Furthermore, 29% of the teachers indicated that using technology produced results, whereas 67,6% indicated it was still too early to know (DI(20)-SA).</p>	<p>Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016. The focus of the survey was on the impact and role of digital technologies in these schools. The following were found:</p> <ul style="list-style-type: none"> • 70% of the teachers indicated that they used digital technologies to produce slideshow presentations or documents. • The teachers indicated that digital technologies were used for the following activities: <ul style="list-style-type: none"> ○ Practising skills. ○ Researching information. ○ Producing documents and slideshows (56% of the teachers indicated that they used this often). ○ Coding or programming (19% of the teachers indicated that they used this often). ○ Games or simulations (55% of the teachers indicated that they used this often). ○ Collecting information and analysing data (41% of the teachers indicated that they used this often). ○ Working together on school projects within the school (41% of the teachers indicated that this happened often). ○ Recording and maintaining learning achievements and goals (36% of the teachers indicated that this happened often).

Theme	3. Execution and effectiveness of ICT	
Usage of digital technologies	<p>In a study done with 197 school teachers from rural schools in South Africa across seven provinces, it was found that teachers used ICTs to communicate with colleagues and society members to build a social network (DI(5)-SA).</p>	<ul style="list-style-type: none"> ○ Working with other individuals outside the school (14% of the teachers indicated that this happened often). ○ Liaise with individuals outside the school (35% of the teachers indicated that this happened often). ○ Corresponding learning achievements and progress in public online communities (29% of the teachers indicated that this happened often). ○ Corresponding learning achievements and progress in private online communities (34% of the teachers indicated that this happened often). (DI(11)-NZ) <p>In 2015, the Network for Learning survey found that 50% of primary schools and 70% of secondary schools had a “bring your own device” policy (GD(9)-NZ).</p> <p>A study was done from 2016 to 2017 by a partnership between the Ministry of Education, other government agencies and business partners. Surveys were done at 339 primary schools and 125 secondary schools. Some of the findings were as follows:</p> <ul style="list-style-type: none"> • A small number of these schools made use of Microsoft Office 365 and cloud platforms such as Google Classroom. Of the two, Google is used more. • 1 out of 5 principals indicated that they made use of Māori language support resources that were supplied by the Ministry of Education. (DI(10)-NZ)

Theme	3. Execution and effectiveness of ICT	
		<p>In 2016, a study was done on the use of mobile learning in New Zealand classrooms with 20 participants within 10 schools. The following were found:</p> <ul style="list-style-type: none"> • Learners used mobile technology to gain access to information to construct knowledge in new ways in and outside the classroom. • Learners were very collaborative, engaged and motivated during the mobile learning sessions. • A pedagogical change and powerful infrastructure are crucial. • Teachers made a recommendation to other teachers to join personal learning networks. • Teachers had two main concerns, namely potential distractions when learners are using the internet and technical problems that occur. (J(4)-NZ)

The above table gives a presentation of data on the execution and effectiveness of ICT in schools before the Covid-19 pandemic. Outcomes of ICT were found in the data for both countries. Outcomes in South Africa were that learning with devices gave learners higher learner attainment and teachers made use of digital devices for e-mail correspondence, administration and preparation. Also, different applications and software that were used in South Africa were explained in the table. In New Zealand, data on mobile learning were found. It was also found in the data that in New Zealand, using digital technologies had a positive impact on learner attainment and teachers used ICT regularly. In addition, different ways of how ICT was used in the classrooms were discussed in the above table. It was also found that in New Zealand, a high percentage of schools had a “bring your own device” to school policy.

4.4.6 Theme 3: Execution and effectiveness of ICT – during Covid-19

Table 4-7: Theme 3: Execution and effectiveness of ICT – during Covid-19.

Theme	3. Execution and effectiveness of ICT	
Sub-theme	During Covid-19	
	South Africa	New Zealand
Outcomes of ICT	<p>In a study, the SA-SAMS online application that involves all information about schools was found to be beneficial. It was found to reduce the duplication of data submissions. In addition, the online tool makes it easier for schools and districts to access information and visualise statistics and also assists in better management and planning (GD(1)-SA).</p> <p>A study was done through interviews with 56 parents, learners and teachers from Southern African Development Community countries. A primary school learner indicated that she was avoiding online lessons for the subjects she did not enjoy and that the other learners made jokes during lessons that bothered her. Furthermore, the learner felt cyberbullied and was grateful when the teacher contacted her to ask why she did not attend the virtual classes (J(3)-SA).</p> <p>A 15-year-old secondary school learner indicated that she lost interest in her work and felt that the Zoom lessons she attended did not work for her. The learners in a specific Zoom lesson, Chemistry, started to leave the lesson and the teacher just continued with two learners. A teacher indicated that on a WhatsApp platform used for online learning, learners were engaging in informal WhatsApp conversations. The teacher did not feel comfortable with this, as it is important to keep the curriculum standard in language subjects (J(3)-SA).</p>	<p>In New Zealand, it was found in a study that the use of technology to assist learners during Covid-19 made it possible for them to have feedback on learning, positive social interaction and a variety of learning activities (J(1)-NZ).</p> <p>Of these learners, 90% agreed that when teachers did regular checks on them, the teachers were aware of their circumstances and the learners received the relevant support to learn effectively from home; 25% of the learners chose multi-media activities, such as YouTube, watching movies, educational movies and teacher-made recordings, as those gave visual information and not just text-based information; 25% of the learners chose interactive or collaborative activities that were done by Zoom or Microsoft Teams; 80% of the learners indicated that gamification contributed to their learning, including online quizzes, Education Perfect, online scavenger hunts and bingo, which are activities that enable learners to be competitive and socially interactive; 51% of the learners indicated that they learnt less by studying at home, whereas 21% of them indicated that they learnt more than in school; 73% of the learners indicated that they spent less time on their learning during remote learning than in schools. The learners also indicated that teacher-centred content that was delivered was less successful (J(1)-NZ).</p>

Theme	3. Execution and effectiveness of ICT	
	<p>A parent indicated that schools had impossible expectations regarding support for learning at home (J(3)-SA).</p> <p>In an article that did a qualitative literature search, it was found that private schools and schools in towns transitioned to online learning with digital platforms fairly well and were successful. The following digital communication platforms and messaging applications were found to be mostly utilised: Microsoft Teams, Google Hangouts, Zoom, WhatsApp and Blackboard. The virtual platforms that schools used worked effectively and needed a minimum amount of data (J(4)-SA).</p>	<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 23% of the participants experienced finding value for money for ICT to be a barrier to using digital technologies (DI(10)-NZ).</p> <p>In the Digital Technologies in Schools survey, the use of digital technology for distance learning was regarded by the majority of principals as the key responsibility for delivering education during the lockdown. Schools that already used digital technologies were effective because they adapted quickly, as some of the platforms were familiar to them already. In other schools, the lockdown allowed teachers to improve their skills swiftly to deliver the learning experience online (DI(13)-NZ).</p>
<p>Outcomes of transitioning to online learning Outcomes of transitioning to online learning</p>	<p>A study was done through interviews with 56 parents, learners and teachers from Southern African Development Community countries. The teachers indicated that they did not have time to prepare to change to virtual and distance learning. One teacher in a primary school indicated that it was difficult to establish lessons because of restricted interaction. The teacher struggled to find satisfactory teaching methods to deal with different learning abilities and found it difficult to assess learning (J(3)-SA).</p> <p>In the Eastern Cape, matriculants were given 55 000 Samsung tablets by the Education Department, but the learners failed to return the tablets. Sizwe Africa IT Solutions were contracted at R538 million to supply tablets to learners over three years, but because of irregularities found by Bhisho High Court, the deal came to a standstill (DI(3)-SA).</p>	<p>When isolation was initiated on 25 March 2020, the school holidays were brought forward. This gave teachers close to three weeks to arrange everything to give remote education to their learners from 15 April 2020 (J(1)-NZ).</p> <p>In the Aotearoa EdTech Excellence Report, the following benefits of educational technology were identified:</p> <ul style="list-style-type: none"> • Increased learning experiences and results. • Refined teacher experiences and results. • Extremely personalised education aimed at individual learners. • Increased access to education. • Enlarged economic advantages for all in New Zealand and the educational technology sector. • Potential to assist learners who are not able to attend traditional education models. • Increased equity in education. • Learners have a significant choice. • Considerable flexibility to deal with circumstances where face-to-face learning is not possible or teachers are not available. (GD(9)-NZ)

Theme	3. Execution and effectiveness of ICT	
Outcome (digital divide)	<p>A study was done by telephonically interviewing three teachers, three school governing body parents and one school principal. It was found that when schools were transitioning to online learning, township schools were not able to make that transition. The respondents indicated that these learners and their parents could not afford online tools such as smartphones and laptops, as parents were poor and unemployed. This increased the digital divide between urban schools and township schools (J(2)-SA).</p>	<p>The Greater Christchurch Schools' Network Trust did a study with 3 105 participants within 150 schools in Canterbury. The results indicated that half the learners preferred online learning to traditional learning, especially the primary and intermediate school learners. Learners who had devices before the lockdown advanced more on average than those who did not have access to a device before (DI(2)-NZ).</p>
Usage of digital technologies	<p>In a survey done by Statistics South Africa in 2020, 72,9% of the respondents indicated that between 17 June and 4 July 2020, their children took part in remote learning (GD(3)-SA).</p> <p>In a study done in 127 schools in the Eastern Cape, it was found that only 33% of the schools made use of ICTs in the classroom. Out of the 127 schools, only four made use of ICT, and two of the 27 teachers make use of online materials for teaching (J(6)-SA).</p> <p>The report of the Independent Communications Authority of South Africa on the state of the ICT sector in South Africa found that there were 60 million smartphone subscriptions in 2020, which show a seven million increase in 2019 (DI(12)-SA).</p> <p>During the first few days of the national lockdown in South Africa, it was indicated that smartphone subscriptions overflowed between 34% to 60% across all networks (DI(14)-SA).</p>	<p>Network for Learning is one of the biggest managed networks of its kind worldwide that supplies schools with fast, safe, reliable and secure internet services for learning. Network for Learning assists 1 916 primary and 464 secondary state and state-integrated schools, which adds up to a total of 792 000 learners. Furthermore, Network for Learning is associated with the government, education and technology sectors. Network for Learning published a data and insights report in which the following highlights were found for the period of 15 April to 3 July 2020:</p> <ul style="list-style-type: none"> • In the norm, Network for Learning blocks 2,9 million threats daily over their network when learners are at school. Learner data use in rural and urban schools is similar. • Primary school learners use in general half the data that learners in secondary schools use. • The West Coast, Manawatu-Whanganui and Nelson areas use the most data, whereas Marlborough, Northland and Tasman use the least amount of data. • All New Zealand schools favour the Hāpara's Teacher Dashboard. • Mathematic sites present fewer attributes than language-based learning websites. • Learners in smaller secondary schools use more data than those in larger secondary schools. • The most favoured media streaming platform for primary and secondary schools is YouTube.

- Education-related websites include sharing platforms, online learning activities and educational reference sites such as the following:
Seesaw, ClassDojo, Linc-Ed and Hāpara's Teacher Dashboard (sharing platforms); Prodigy Education, Kahoot, 3P Learning and Education Perfect (online learning activities); and Grammarly, Texthelp and Epic (educational reference sites). eTap is used for managing learner administration and Google Suite for Education is there to manage learner documentation.
- In primary schools, the top three websites in education are Linc-Ed, Hāpara's Teacher Dashboard, Seesaw and eTap, while the top three websites in education in secondary schools are Grammarly, Linc-Ed, Hāpara's Teacher Dashboard and Google Suite for Education.
- Kahoot is a website that allows users to compile multi-choice questions that also include Mathematics.
- Network for Learning blocks sites that are inappropriate or distracting for school learners. In secondary schools, the number of blocked sites had increased by 40% from the previous term, and in primary schools, it had increased by 15%. The following percentages of commonly blocked sites of all websites are provided:
 - 21,3% for file sharing and storage (these websites include iCloud, Dropbox or other file storage sites)
 - 20,4% for games (in primary schools, the gaming blocks increased by 99%)
 - 13,6% for freeware and software downloads
 - 11,8% for social networking
 - 5,5% for instant messaging
 - 2,9% for streaming media and download
 - 3,4% for anonymisers
 - 1,4% for pornography
 - 0,4% for gambling
 - 19% for other sites

(DI(4)-NZ)

Theme	3. Execution and effectiveness of ICT	
		<p>A journal article published in 2021 reports on the development and testing of virtual reality classrooms for food-based lessons for middle-school learners in a New Zealand school. The outcome indicated that learners were extremely motivated and regarded virtual reality as entertaining. Looking at the results, 10 out of 12 participants did better in the virtual reality classroom, with an average of 68%. But there are improvements to be made, such as testing in individual, separate rooms and video recording the sessions (J(3)-NZ).</p> <p>In January 2021, the Education Review Office published a report on living in a Covid-19 world. Different surveys were conducted (during and after the lockdown) and interviews were done with 740 principals and 36 focus groups (which contained teachers, trustees, learners and whānau). Whānau and learners in focus groups indicated that they recognised the value of timetabling being flexible during the lockdown and content that was connecting them to their home contexts (DI(13)-NZ).</p>

Thornton did a study where she interviewed 18 secondary school principals. The following were found with regard to the role ICT played in these schools during Covid-19:

- It was challenging to communicate information to relevant stakeholders, even information received by the Ministry of Education. Some principals indicated that they used their routine communication tools, such as newsletters and Facebook posts, while other principals widened their media sources depending on the message. They also made use of video logs, Google Hangouts and Facebook Live.
- Pastoral care was made possible through phone calls and messages. It was reported by all the principals that in all of the schools, regardless of the decile, the staff and teachers were still regularly involved with their pastoral care role throughout the lockdown.
- Learning was made more flexible. Synchronous contact time was done only in the mornings and not throughout the whole day.
- The principals realised that independent learning was very successful for some learners and it allowed learners to take charge of their learning. Out of 18 principals, 10 indicated that planning forward, they wanted to give senior learners more flexibility in their learning. (J(5)-NZ)

In January 2021, the Education Review Office published a report on living in a Covid-19 world. Different surveys were conducted (during and after the lockdown) and interviews were done with 740 principals and 36 focus groups (which contained teachers, trustees, learners and whānau). The use of digital technology for distance learning was regarded by the majority of these principals as the key responsibility for delivering education during the lockdown. Schools that already used digital technologies were especially effective, as they adapted quickly because some of the platforms were already familiar to them. In other schools, the lockdown allowed other teachers to improve their skills swiftly to deliver the learning experience online (DI(13)-NZ).

Theme	3. Execution and effectiveness of ICT	
Use of applications	<p>In the DBE professional development training programmes, teachers are taught how to use free applications, such as Duolingo (for early childhood development), GeoGebra, Math Mechanixs, GraphSketch, LiveMath Viewer, Calc 3D Pro and Geometer’s Sketchpad (for Mathematics) and Planet Geo, National Geographic Education and Google Earth VR (for Geography) (GD(6)-SA).</p>	<p>The Ministry of Social Development also did research looking at findings with regard to growing up during Covid-19. The survey was completed by 2 421 children between the ages of 10 and 11. The following were found on the applications used by these children and their percentage of use during the lockdown:</p> <ul style="list-style-type: none"> • 76% YouTube • 38% Google Hangouts • 33% TikTok • 23% Messenger • 13% WhatsApp • 11% Snap Chat • 9% Instagram • 8% House Party • 5% none • 3% Facebook • 1% Twitter • 1% Reddit (GD(3)-NZ) <p>In January 2021, the Education Review Office published a report on living in a Covid-19 world. Different surveys were conducted (during and after the lockdown), and interviews were done with 740 principals and 36 focus groups (which contained teachers, trustees, learners and whānau). Some learners favoured face-to-face learning, while others indicated that they thrived on using digital tools (DI(13)-NZ).</p>

The above table presents data on the execution and effectiveness of ICT in schools during the Covid-19 pandemic. In both countries, different outcomes of ICT were found in the data and discussed. More data were found on the usage of digital devices in New Zealand. In both countries, the use of applications during Covid-19 was evident. Moreover, as discussed in Section 4.4.5, it was found that the use of mobile devices was more prominent in South Africa, but there are data that indicate the use of other devices. In New Zealand, it was found in the data that half the learners who used digital learning prepared it for traditional learning. The partnership that the New Zealand Ministry of Education has with Network for Learning seems to eliminate some barriers to ICT, such as the security of ICT for learners. Furthermore, Network for Learning also provides schools and the Ministry with valuable information.

4.4.7 Theme 4: Barriers that influence ICT – before Covid-19

Table 4-8: Theme 4: Barriers that influence ICT – before Covid-19.

Theme	4. Barriers that influence ICT	
Sub-theme	Before Covid-19	
	South Africa	New Zealand

Theme	4. Barriers that influence ICT	
Access	<p>A study was done in 2018 in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. It was found that 58% of the teachers agreed that there was insufficient access to network connectivity. Also, 45,33% of the teachers strongly disagreed that there was insufficient software and materials for ICT (J(1)-SA).</p> <p>In a study, 38,61% of the participating principals indicated that the shortage of computers affected the implementation of technology in learning and teaching (J(11)-SA).</p>	<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, the following barriers were indicated by the participants in utilising digital technology in schools: 51% indicated the costs of the digital technology equipment; 37% indicated the costs of upgrades; 41% indicated the affordability of personal digital devices; 25% indicated the cost of online services; 23% indicated finding value for money; 13% indicated support for use of digital technology; and 19% indicated learner access to home internet. Moreover, 20% of the teachers had a challenge with access to suitable technology for teaching, whereas 49% of the teachers did not have a problem with it. Also, 36% of the teachers had a challenge with the inequity of learner access to technology at home, whereas 41% of the teachers did not have a problem with it (DI(10)-NZ).</p> <p>The 2018 full Touchpoint Report was compiled by Network for Learning on surveys conducted with 2 342 school principals of 450 schools. However, only 20% of these schools completed the survey completely, and 84% of the schools that did the survey were primary schools. Some respondents indicated that they still encountered problems regarding access to technology, access to devices and unequal access to the internet at home (GD(7)-NZ).</p> <p>Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016, in which 68% of the participating teachers indicated that access to digital technologies at home created some difficulties (DI(11)-NZ).</p>

Theme	4. Barriers that influence ICT	
Costs	<p>A study was done in 2018 in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. It was found that 25,33% of the teachers strongly agreed and 52,67% of the teachers agreed that the costs of attaining ICT facilities and devices were very high (J(1)-SA).</p> <p>South Africa is regarded as having the most expensive data charges (DI(4)-SA).</p>	<p>A study was done by a partnership of the Ministry of Education, other government agencies and business partners. Surveys were done with 339 primary schools and 125 secondary schools during 2016 and 2017. Eight out of 10 principals indicated the following barriers for their schools regarding the use of digital technologies for learning:</p> <ul style="list-style-type: none"> • High costs of digital technology equipment. • High costs of equipment and software upgrades. • Affordability of personal digital devices for parents. • Costs of online services. (DI(10)-NZ)
Funds	<p>A study was done in 2018 in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. It was found that 18% of the teachers strongly agreed and 59,33% of them agreed that there was a need for funding for ICT programmes and activities (J(1)-SA).</p>	<p>The full Touchpoint Report by Network for Learning was compiled in 2018 from surveys conducted with 2 342 school principals. This included 450 schools, but only 20% of these schools completed the survey completely, while 84% of the schools that did the survey were primary schools. Some respondents indicated that they encountered problems regarding insufficient funds for ICT (GD(7)-NZ).</p>
Security/safety	<p>With the “paperless classroom” project of the Gauteng Department of Education, it was indicated that 100 of the 1 800 interactive whiteboards installed in 2015 were stolen by January 2016. Furthermore, 54 000 out of 64 000 tablets were retrieved by the Education Department at the end of 2015, but Panyaza Lesufi (the Member of the Executive Council) indicated at the end of January that only 4 000 tablets had not been retrieved. Although the tablets had tracking devices installed, their sim cards were removed resulting in the tracking devices becoming pointless (DI(7)-SA).</p> <p>A union in South Africa did a study of teachers in education in which 986 teachers participated to determine their perspectives, attitudes, skills, user experience and intentions towards ICT. It was found that security in schools affected the implementation of ICT, as resources were stolen. Implementing security measures makes access difficult, and then ICT ends up not being implemented (J(10)-SA).</p>	<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 6% of the schools indicated online risks and harm to be a barrier to using digital technologies (DI(10)-NZ).</p> <p>Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016. Of the respondents, 57% indicated that digital technologies created other types of bearing safety issues, and 53% indicated that to use digital technologies, they had to go beyond school time to prepare (DI(11)-NZ).</p>

Theme	4. Barriers that influence ICT	
Speed of technological innovation	<p>A study was done in 2018 in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. It was found that 14% of the teachers strongly agreed and 61,33% of the teachers agreed that improper maintenance had an effect on the lifespan of ICT devices and facilities (J(1)-SA).</p>	<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 20% of the respondents found the speed of technological change to be a barrier to using digital technologies (DI(10)-NZ).</p>
ICT/technical support		<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 15% of the respondents indicated technical support as a barrier to using digital technologies (DI(10)-NZ).</p> <p>A study was done by a partnership between the Ministry of Education, other government agencies and business partners. Surveys were done with 339 primary schools and 125 secondary schools during 2016 and 2017. Seven out of 10 principals indicated the speed at which technology changed as a barrier to integrating ICT (DI(10)-NZ).</p>

Theme	4. Barriers that influence ICT	
Teachers' ability, knowledge and training	<p>A study was done in 2018 in the Eastern Cape by sampling surveys from 10 schools, 150 teachers and 450 learners. It was found that 15,33% of the teachers strongly agreed and 52% of the teachers agreed that there was a shortage of skills and knowledge to use ICT in schools. Furthermore, 17,33% of the teachers strongly agreed and 54% of them agreed that there was a need for proper teacher knowledge and user training to implement ICTs (J(1)-SA).</p> <p>A cross-sectional survey was done in September and October 2017 in Gauteng, where 375 schools and 493 teachers were used in the surveys. It was found that the lack of ICT self-efficiency could be an obstacle for teachers to implement ICTs in their classrooms (DI(6)-SA).</p> <p>A union in South Africa did a study of teachers in education where 986 teachers were used to determine their perspectives, attitudes, skills, user experience and intentions towards ICT. Of the participating teachers, 80% indicated that they needed professional development in ICT. The teachers also indicated that professional development was too expensive and there was a lack of support from employers (J(10)-SA).</p>	<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 16% of the participating staff indicated professional development and 10% indicated insufficient knowledge as barriers in using digital technologies (DI(10)-NZ).</p> <p>A study was done by a partnership of the Ministry of Education, other government agencies and business partners. Surveys were done with 339 primary schools and 125 secondary schools during 2016 and 2017, in which seven out of 10 principals indicated professional development for staff as a barrier to ICT (DI(10)-NZ).</p>
Control of learner usage		<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 4% of the respondents indicated managing learner usage as a barrier to using digital technologies (DI(10)-NZ).</p>
Integration with curriculum		<p>According to the Digital Technologies in Schools survey done in 2016 and 2017, 4% of the respondents indicated integration into the curriculum as a barrier to using digital technologies (DI(10)-NZ).</p>

Theme	4. Barriers that influence ICT	
Network infrastructure		According to the Digital Technologies in Schools survey done in 2016 and 2017, 8% of the participants indicated network infrastructure as a barrier to using digital technologies (DI(10)-NZ).
Learner engagement and wellbeing		<p>In the Digital Technologies in Schools survey done in 2016 and 2017, percentages, teachers indicated the following challenges in using digital technologies for learning (DI(3)-NZ).</p> <ul style="list-style-type: none"> • 21% of the teachers surveyed experienced challenges with learner engagement in learning, whereas 74% of the teachers did not have a problem with it. • 5% of the teachers experienced challenges with learner wellbeing, whereas 73% of the teachers did not have a problem with it. (DI(10)-NZ)
Technical Support		According to the Digital Technologies in Schools survey done in 2016 and 2017, 21% of the participating teachers experienced problems with technical support, whereas 49% of the teachers did not have a problem with it (DI(10)-NZ).
Pedagogical change		According to the Digital Technologies in Schools survey done in 2016 and 2017, 35% of the participating teachers experienced problems with pedagogical change, whereas 31% of the teachers did not have a problem with it and 33% of the teachers were neutral with regard to this challenge (DI(10)-NZ).

Theme	4. Barriers that influence ICT	
Support of parents to use ICT		A study was done by a partnership of the Ministry of Education, other government agencies and business partners. Surveys were done with 339 primary schools and 125 secondary schools during 2016 and 2017, in which seven out of 10 principals indicated the support of parents to use digital technologies as a barrier to ICT (DI(10)-NZ).
Time/workload	Makgato did a study with six public schools in Gauteng, South Africa, in which it was mentioned that there were time limitations for using computers (J(9)-SA).	According to the Digital Technologies in Schools survey done in 2016 and 2017, 56% of the participating teachers had a challenge with time for upskilling, whereas 17% of the teachers did not have a problem with it, and 27% of the teachers were neutral with regard to this challenge (DI(10)-NZ).
		<p>A study was done by a partnership between the Ministry of Education, other government agencies and business partners. Surveys were done with 339 primary schools and 125 secondary schools during 2016 and 2017. Barriers indicated in the report were the time necessary for teachers to upscale their skills and the inequality of learners' access to digital devices at home (DI(10)-NZ).</p> <p>Bolstad compiled a report on the NZCER national survey of primary and intermediate schools in 2016, in which 10% of the teachers indicated that using digital technologies was too time-consuming for the benefits gained (DI(11)-NZ).</p>
Mobile phones banned in schools	The Department of Rural Development and Land Reform funded a project called ICT for Education. At 24 schools across seven provinces, 197 teachers and 6 895 learners were trained over a year and a half on how to implement mobile technology in their teaching and learning. Altogether 90,6% of the respondents indicated that the use of mobile phones was banned in their schools (DI(21)-SA).	

The above table presents data on the barriers that influenced ICT in schools in South Africa and New Zealand before the Covid-19 pandemic. It is important to recognise the barriers that hindered the effective implementation and success of ICT in learning. In both countries, several barriers were found in the data. Some of the barriers before Covid-19 were the same in both countries, such as access, costs, funds, security, teacher's ability and time or workload. New Zealand also experienced ICT technical support, the control of learner usage, integration into the curriculum, network infrastructure, learner engagement and wellbeing, pedagogical change and the support of parents to use ICT as barriers that influenced ICT in education before Covid-19. In South Africa, the ban on mobile phones in schools was a barrier that influenced ICT before Covid-19.

4.4.8 Theme 4: Barriers that influence ICT – during Covid-19

Table 4-9: Theme 4: Barriers that influence ICT – during Covid-19.

Theme	4. Barriers that influence ICT	
Sub-theme	During Covid-19	
	South Africa	New Zealand
Access	<p>The Statistics South Africa report of 2020 indicated that there was a large gap between access to the internet at home among children younger than 24 years (GD(3)-SA).</p> <p>The lack of ICT infrastructure during the Covid-19 pandemic was the main challenge in implementing online learning (J(2)-SA).</p> <p>There is also a complication when a household has access to a device and connectivity but there are multiple children who need to share the device (J(8)-SA).</p> <p>For ICT, videos and video calls, fast and large amounts of internet data are required. This made it complicated for learners to use f ICT for learning and teaching during the pandemic (DI(15)-SA).</p>	

Security/safety		<p>The full Touchpoint Report by Network for Learning was compiled with surveys done at 550 schools with 563 respondents. In the report, five challenges to online safety were found, namely:</p> <ul style="list-style-type: none"> • Keeping learners from danger and disturbance. • Online safety outside the school. • Observing learners is time-consuming. • Technically sharp learners find ways to circumnavigate filters. • Educating learners to be good digital citizens is a strenuous task. (DI(6)-NZ)
Teachers' ability, knowledge and training	<p>A study was done by telephonically interviewing three teachers, three school governing body parents and one school principal. The respondents indicated that some teachers were familiar with information technology, but most teachers needed training. A teacher indicated that the younger teachers were better at using ICT and that teachers were not fully trained yet (J(2)-SA).</p> <p>A study done by utilising secondary sources indicated that numerous teachers in South Africa had not received essential training regarding the implementation of online learning (J(5)-SA).</p>	
Control of learner usage	<p>A study done by utilising secondary sources indicated that learners who made use of online learning had the likelihood of having multitasking behaviour, as there are distractions of e-mails to answer, texting, Facebook, WhatsApp, YouTube videos, browsing on Google and listening to music. This behaviour can lead to learners emotionally excluding themselves from their learning goals (J(5)-SA).</p>	
Learner engagement and wellbeing		<p>The Ministry of Education published a report in the <i>Education Gazette</i> that looked at 40 New Zealand and international research reports and articles. It was found that working remotely created anxiety and frustration, and increased screen time and online exposure to inappropriate online material had a negative impact on individuals (GD(5)-NZ).</p>

Support of parents to use ICT	In an article reporting on a qualitative literature search, it was indicated that there was a shortage of parental support for the assistance of children to use digital platforms effectively (J(4)-SA).	
Time/workload	A study was done through interviews with 56 parents, learners and teachers from Southern African Development Community countries. All the teachers indicated that their workload increased with virtual learning (J(3)-SA).	
Motivation		In a study done by Yates and Starkey, daily structure and insufficiency of motivation were indicated as key obstacles. Furthermore, 40% of the participating learners indicated that they lacked the motivation to do their schoolwork during the remote or distance learning that was used during Covid-19 (J(1)-NZ).

The above table presents data on the barriers that influenced ICT in schools before the Covid-19 pandemic. The data found that there was a difference in the barriers encountered by the countries. The data found that South Africa experienced access, teacher's ability, control of learner usage, support engagement and wellbeing, support of parents to use ICT, and time or workload as barriers that influenced ICT during Covid-19, while New Zealand experienced barriers in terms of security, learner engagement and wellbeing and motivation that influenced ICT during the pandemic.

4.4.9 Theme 5: Future prospects of ICT

Table 4-10: Theme 5: Future prospects of ICT.

Theme	5. Future prospects of ICT	
	<p data-bbox="232 440 412 464">South Africa</p> <p data-bbox="232 480 1200 711">A recommendation was made in a study that the DBE should support township schools by providing them with digital devices and supporting the installation of software to bridge the digital gap between township schools and urban schools. Furthermore, the study suggested that to improve online learning, teachers and learners should combine technology in their pedagogy. This can also be achieved by professional development (J(2)-SA).</p> <p data-bbox="232 751 1167 847">A cross-sectional survey was done in September and October 2017 in Gauteng, where 375 schools and 493 teachers were used in the survey. The following was indicated for prospects of ICT in education:</p> <ul data-bbox="282 855 1189 1286" style="list-style-type: none"> <li data-bbox="282 855 1189 1015">• District and provincial education departments and school managements have to provide, support and encourage the use of ICT in classrooms early on in a teacher’s career. This will give these teachers the confidence to make use of ICT in their teaching careers. <li data-bbox="282 1023 1189 1182">• The DBE increased its number of teachers with bachelor of education degrees. Bachelor of education degrees have programmes that provide content that incorporates the teaching of the pedagogical use of ICTs, which will ultimately increase teachers’ capabilities to utilise ITCs. <li data-bbox="282 1190 1189 1286">• Personal development can increase teachers’ ICTs competence and knowledge for effective ICT integration in learning and teaching. (DI(6)-SA) 	<p data-bbox="1225 440 1404 464">New Zealand</p> <p data-bbox="1225 480 2179 743">In a study by Yates and Starkey, learners indicated that they would like to continue using technology in their learning, as it had significant flexibility It was also found that adaptable policies and implementations were needed for teachers and learners to be digital-ready. Zoom or Google Teams can be used as communication tools where face-to-face education is not possible, such as when learners are absent. It is necessary for education systems to have policies for planning and training for more online and blended learning in the future (J(1)-NZ).</p> <p data-bbox="1225 783 2179 1182">The Greater Christchurch Schools’ Network Trust did a study with 3 105 participants within 150 schools in Canterbury. Learners were supported during the Covid-19 lockdown with devices and an internet connection but 40% of the learners who had borrowed devices and 87,9% of the parents who had borrowed devices had to return them. This made the digital divide bigger, as it had been temporarily reduced during the Covid-19 lockdown period. Learners, teachers, staff and parents made various submissions to enhance online remote learning. These submissions included improved devices, faster internet, stronger communication and direction, additional teacher correspondence, smaller workload, healthier learning environments, skills improvement for teachers and staff, significant assistance and direction and financial assistance (DI(2)-NZ).</p>

<p>In a pilot done with 20% of all schools across the nine provinces, it was found that to enhance ICT in education it was necessary to translate the supportive policy environments and energetic technology innovations into meaningful access and use of ICTs (DI(11)-SA).</p> <p>Champions of technology should be acknowledged and rewarded, as this way, the utilisation of technology is not just seen as a burden for teachers. Furthermore, it is recommended that e-learning ecosystems with various schools, parents, teachers, telecommunications companies and provincial and national governments must be established (DI(17)-SA).</p>	<p>On 19 January 2021, the Education Review Office published a report on living in a Covid-19 world. Different surveys were conducted (during and after the lockdown) and interviews were done with 740 principals and 36 focus groups (which contained teachers, trustees, learners and whānau). It was indicated that the leadership of 67% of the schools wanted to keep components of distance learning and expand the utilisation of digital technologies in their curriculum. Some leaders indicated that the ongoing use of online learning would prepare schools for possible future lockdowns. To sustain this, the leaders indicated that their objective was to access appropriate professional learning and development for teachers. The report further indicated that schools had to be intentional about how and when they used digital technologies to assist teaching and learning (DI(13)-NZ).</p> <p>Network for Learning compiled a report in 2018 on surveys conducted with 2 342 school principals. This included 450 schools, but only 20% of these schools completed the survey completely, and 84% of the schools that completed the survey were primary schools. In the survey, schools were asked what technologies they thought would have the most effect on learning for the following three years. The following findings were published:</p> <ul style="list-style-type: none"> • Devices were indicated 112 times, especially Chromebooks. • iPads were indicated 36 times. • Robotics was indicated 64 times, mostly accompanied by coding. which was indicated 60 times. • Internet access was indicated 30 times, as it underpins various technologies such as artificial intelligence and virtual reality. (DI(7)-NZ)
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In the above table, data on future prospects of ICT were discussed and analysed. It is evident that learners in New Zealand want to continue using technology in their learning. There is room for improvement in policies and the implementation of ICT for teachers and learners in New Zealand. Teachers also made various submissions to improve digital learning and indicated that devices, Ipads, robotics and access to the internet would be most efficient for effective learning. In South Africa, it was found that supportive policy, access and the use of technological innovation are seen as important to improve learning. The Department of Education wants to reward champions for using technology. It is clear that the digital divide needs to be reduced.

4.4 Conclusion

In this chapter, the data that were found on ICT in the schooling systems of South Africa and New Zealand were analysed according to five different themes before and during Covid-19. This was done with the main research aim, which was to determine the status of ICT in the school education systems of South Africa and New Zealand during Covid-19. The secondary research aims were as follows:

- to determine the differences regarding the status of ICT in the schooling systems of South Africa and New Zealand during the Covid-19 pandemic;
- to determine the similarities regarding the status of ICT in the schooling systems of South Africa and New Zealand during the Covid-19 pandemic; and
- to identify the best practices that can be identified regarding ICT in the schooling systems of South Africa and New Zealand.

In South Africa, the Covid-19 pandemic exposed the ICT infrastructure weakness and the digital content gap for learners and schools. It is important that the gap is closed. In New Zealand, the pandemic increased the progress of ICT in schools. In the next chapter, the researcher will present the findings, conclusion, limitations and recommendations of the study.

CHAPTER 5 FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

In Chapter 1 of this research, the research problem was discussed. In the 21st century, learning has changed so that learning with ICTs now forms a part of learning. Countries have integrated ICT as part of their strategies for sustainable development for 2030 (see Section 1.2). Furthermore, in Chapter 1, the main research question and research aim were identified (see Sections 1.3 and 1.4), the conceptual framework was discussed (see Section 1.5) and the research design and methodology were briefly discussed (see Section 1.6). In Chapter 2, an in-depth concept clarification (see Section 2.2) was given, including concepts such as education and education system, the education system of South Africa, the education system of New Zealand, ICT (which had 10 sub-concepts), Covid-19, Covid-19 in South Africa and Covid-19 in New Zealand. In Chapter 3, the research design (see Section 3.2) and methodology (see Section 3.3) were discussed in detail. This research used a qualitative research design with an interpretive paradigm. Data collection was done through secondary data. This suggests that the researcher made use of research that was done and published documentation. In Chapter 4, the data were sorted and analysed according to five themes (see Sections 4.4.1 to 4.4.9). These themes were analysed with regard to data before and during Covid-19 to recognise the status of ICT during Covid-19. In Chapter 5, the findings in terms of the differences and similarities regarding ICT in the schooling systems of South Africa and New Zealand are presented (see Sections 5.2 and 5.3). Also, best practices of ICT in these schooling systems are identified (see Section 5.4). Recommendations and future research are discussed (see Section 5.5), followed by a discussion of the limitations and contributions of the study (see Sections 5.6 and 5.7).

Potts and Stebletsova (2021) state that when the usefulness of online learning is understood, it will be possible to have online learning effectively and accessibly within face-to-face teacher-based classrooms too. During Covid-19, it was necessary to implement online learning, and through it, new commitments across a range of diverse learners were found.

5.2 Findings of the differences regarding the status of ICT in the schooling systems of South Africa and New Zealand before and during Covid-19

Before the discussion of the differences regarding ICT in the two countries, it is important to highlight particular differences. In South Africa, the DBE regulates the school system and in New Zealand, it is regulated by the Ministry of Education. The social division of schools in South Africa is done in quintiles, and in New Zealand, it is done in deciles (see Section 4.2). The two countries

differ a lot with regard to economy and culture. There were various differences found in terms of ICT in their schooling systems before and during Covid-19. According to Aluko (2017), there are schools in South Africa that are not in a position to implement ICT in classrooms, although they can make use of mobile technology. Aluko (2017) further states that various educational applications and curriculum-supporting websites are available that assist learners with learning material. Mobile technologies are more common in rural communities than desktop computers, DVDs, newspapers and dictionaries.

Focusing on the differences in ICT in the schooling systems of New Zealand and South Africa, the following was found: School policies are different in the two countries. In South Africa, evidence of ICT policies was found in Quintile 5 schools, while the majority of other quintile schools do not have ICT policies. In New Zealand, it was found that 74% of primary schools and 80% of secondary schools in New Zealand have school ICT policies. Aluko (2017) states that in Africa, there is a widespread lack of mobile learning policies although there are ICT policies. Digital strategies in New Zealand seem to be updated every five years, and in 2021, a new digital strategy was released. In New Zealand, during Covid-19, education software received a substantial amount, which contributed to giving learners the relevant educational software needed for teaching and learning. Some funding in New Zealand for ICT was given to schools through the disaster relief fund. It was also indicated by schools in a survey that more than 20% of the school budget was spent on ICT. In South Africa, the majority of ICT funding is received from the Department of Education, but other funds were received from school budgets and external organisations. With funding, there is a difference in how the government of each country indicates the funding of projects. In South Africa, it is difficult to find information about spending on ICT other than budgets, whereas in New Zealand, information about public spending, not only in budgets, is readily available.

In South Africa, the government partnered with organisations such as MTN, Vodacom, Cell C and Telkom to have zero-rated educational sites during Covid-19. New Zealand, however, has a big partnership with Google, and during Covid-19, Google gave 1 000 schools in New Zealand access to digital tools. Both governments supported their schools through different programmes during the pandemic.

When it comes to connectivity, the two countries differ a lot. In a report compiled by Gillwald *et al.* (2018), it was found that mobile devices were the most used to access internet connectivity. In New Zealand, the majority of users make use of wi-fi connectivity, rather than mobile networks (Bowen, 2021). The data tariffs in South Africa are too high, according to the Competition

Commission (Williams, 2021). Data tariffs in New Zealand are higher than fixed monthly wireless broadband (Commerce Commission New Zealand, 2019).

With regard to access to ICT, it was found that teachers had access but learners had a low percentage of access to ICT in South Africa. In New Zealand, the majority of schools provide ICT at school, and schools have ICT plans. More information was found on access to ICT in New Zealand than in South Africa.

The outcomes of ICT usage were explained in detail in Sections 4.4.5 and 4.4.6 with specific statistics for each country. The data were collected from previous research. It has been picked up that in South Africa, Gauteng teachers make more use of ICT in their teaching than the traditional ways (Mlambo *et al.*, 2020). Evidence has been found that a high percentage of schools in New Zealand have a “bring your own device” to school policy, whereas in South Africa, 90,6% of the respondents in a survey indicated that their schools had banned mobile phones.

When it comes to barriers to ICT, it seems from the research that New Zealand had more barriers than South Africa in the specific data found. It can also be because the utilisation of ICT in New Zealand is higher. New Zealand had barriers with regard to control of learner usage, integration into the curriculum, network infrastructure, learner engagement and wellbeing, pedagogical change and parental support. However, in South Africa, the only other barrier was that mobile phones were banned in schools.

5.3 Findings of the similarities regarding the status of ICT in the schooling systems of South Africa and New Zealand before and during Covid-19

The two countries are fairly different, but there are several similarities regarding ICT in the schooling systems of the countries. It was found that both countries had a national strategy to implement ICT in the country and in education. Both countries had special projects that materialised these strategies. In both countries, ICT was involved in the curriculum in some way. South Africa added Robotics and Coding as a subject to the curriculum in 2022, and in New Zealand, ICT has been included in the new curriculum since 2019. During Covid-19, both countries made use of radios and televisions in their strategies to bring education to their learners in their homes, and this strategy was funded by the respective governments. In both countries, schools received funding for ICT. However, the question arises whether the funds are enough to make a relative effect to contribute to the effective utilisation of ICT in schools.

In both countries, there are partnerships with organisations regarding ICT. New Zealand has 93 educational technology companies. Both countries have education portals. The Cloud Transformation Project was started in 2016 by the Ministry of Education in New Zealand. Similarly, in South Africa, the DBE cloud was implemented in 2018 to provide learners, teachers, parents and administrators with digital content.

The outcomes of the use of ICT are very similar in both countries. In Sections 4.4.5 and 4.4.6, the outcomes were explained in detail with specific statistics. In both countries, it was found that ICT gave learners higher learner attainment. In both countries, it was found that ICT made it possible for teachers to join learning networks with other teachers. Focusing on barriers that influence ICT, it became evident that both countries experienced access to ICT, costs, funds, security, teachers' ability and time or workload as barriers.

5.4 Findings of best practices that can be identified regarding ICT in the schooling systems of South Africa and New Zealand

National strategies for ICT are positive, and the implementation process has to be monitored. Making use of radio stations and television is a good practice to involve learners in learning, especially in poor households where usually there are, at least, radios and basic television.

In South Africa, the online application SA-SAMS is used to report on all administrative education information. This application also connects schools with their districts, where information about the learners, teachers, finances and learner attainment is easily available (DBE, 2021b). From 2016 to 2019, the Western Cape Department of Education had a project to create 178 free wi-fi hotspots in public areas (Western Cape Government, 2017). In New Zealand, Network for Learning is used, which provides almost all schools with dependable, fast, reliable fibre internet connections. Part of its services is supplying the Switch on Safe application, which is a free internet filtering service (Ministry of Education, 2020). Network for Learning also publishes information in reports regarding usage and does surveys and publishes the information gathered from them. This assists policymakers and schools in monitoring and tracking the performance of ICT in their schools (Network for Learning, 2018). Furthermore, Network for Learning is also connected to the government, education and technology sectors (Network for Learning, 2021a).

The Ministry of New Zealand launched the Outschool Programme, which provides live online courses (EdTech New Zealand, 2021). During Covid-19, teachers were forced to improve and work on their technical skills to provide digital learning for learners.

5.5 Recommendation and future research

When comparing the two countries, it is clear that it is important for South Africa to work on policies and funding to make infrastructure available. Furthermore, South Africa should consider barriers where teachers' ability plays a big role in implementing ICT in learning. It is also beneficial for South Africa to look at the outcomes of and barriers to ICT, because when policies are in place, they can address these barriers to ensure their ICT status. New Zealand also has to focus on addressing some of the barriers.

ICT is a fast-growing field, in which there are a lot of changes within a year. As Covid-19 is not completely a thing of the past, studies are still being done on the use of ICT during the pandemic in these two countries. It was found in this study that the digital divide is a problem in both countries. For future research, it would be interesting to identify the essence of the digital divide and find solutions thereto by comparing it with more than one country. A comparative study should preferably be done with three countries – one with a big digital divide gap, another with a smaller digital divide gap and yet another where the digital divide gap is very small.

5.6 Limitations of the study

During the research process, secondary data were collected. The implication thereof is that only research that had already been published or information that had been publicly published was used in this research and analysed to reach conclusions. The data collection was done in the period of the end of 2021 and the first half of 2022. The implication thereof is that from that time, other data have been made available that would have been useful to this study.

5.7 Contribution of the study

This research contributes to the field of international and comparative education, as it compares information regarding ICT in two countries – South Africa and New Zealand. This study will help teachers, education experts and policymakers to notice the status and potential that ICT brings to learning and teaching. By comparing these two countries, it is evident to the reader what works and what still needs to be developed to ensure the effective implementation of ICTs in schools.

5.8 Conclusion

In this research study, the importance of utilising ICTs in schools was identified. In the data analysis, different themes were discussed and compared before and during Covid-19 in both

South Africa and New Zealand. Several similarities and differences were found. For a country to improve its status in terms of using ICT in schools, it is necessary to look at what other countries have done. This is precisely what this research study has done. In the process, best practices were identified. As technology is a fast-changing element, it is not easy for schools to keep up with the latest technological advances. New Zealand has several barriers that can be addressed to prolong its ICT usage and success in education. In both countries, the digital divide has been identified as a problem, and it will be a good starting place to address this problem. South Africa needs to work on funding and legislation to give schools, teachers and learners the necessary support. For both South Africa and New Zealand to achieve their national goals for sustainable development, ICT in schools is a good starting point to improve the lives of all the citizens of these two countries.

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Date of access: 7 Aug. 2022.

ANNEXURES

Annexure 1: Coding of documents

Code of document	Name of document	Author
Government Documents South Africa		
GD(1) - SA	Annual Performance Plan 2021/2022	Department of Basic Education
GD (2) - SA	Education Series Volume VIII: COVID-19 and barriers to participation in education in South Africa	Statistics South Africa
GD (3) – SA	Social impact of COVID-19 (Wave 3): Mobility, Migration, and Education in South Africa	Statistics South Africa
GD (4) – SA	Annual Performance Plan 2022/2023.	Department of Basic Education.
GD (5) – SA	Game Changer Roadmap 2017: eLearning Roadmap	Western Cape Government.
GD (6) – SA	Implementation Programme Guide: For the National Digital and Future skills strategy of South Africa.	Department of Communications and Digital Technologies.
GD (7) – SA	DBE and partnership workshop Coding and Robotics curriculum for the GET band.	Department of Basic Education.
GD (8) – SA	Guidelines for educators: For work-from-home or alternate work arrangements.	Department of Basic Education.
GD (9) – SA	The Integrated Strategic Planning Framework for teacher Education and Development.	Department of Basic and Higher Education.
GD (10) – SA	Action Plan to 2019: Towards the realization of Schooling 2030.	Department of Basic Education.
GD (11) – SA	Professional Development Framework for Digital Learning.	Department of Basic Education.
GD (12) – SA	General Household Survey	Statistics South Africa
GD (13) – SA	Gauteng Education on Roll-Out of ICT in Schools.	South African Government

GD (14) – SA	National Development Plan 2030: Our future make it work. Executive summary.	South African Government
GD (15) – SA	White paper on e-Education: Transforming Learning and Teaching through Information Communications Technology.	South Africa Government
GD (16) – SA	National Integrated ICT Policy White Paper.	Department of telecommunications and Postal Services.
GD (17) – SA	Budgets: Estimates of National expenditure	Department of National Treasury.
GD (18) – SA	ICT Roll-Out: Development of Basic Education briefing; Coronavirus Measures.	Basic Education
GD (19) – SA	Minister Angie Motshekga: Basic Education Dept. Budget Vote 2021/22	South African Government (2022b)
GD (20) – SA	Minister Angie Motshekga: Basic Education Dept. Budget Vote 2022/23	South African Government
GD (21) - SA	Introducing New Zealand’s education portal.	Ministry of Education (New Zealand)
Code of document	Name of document	Author
Government documents New Zealand		
GD (1) - NZ	Household Statistics: Access to telecommunication systems (total responses) by tenure of household, for households in occupied private dwellings 2018 census.	Statistics New Zealand.
GD (2) - NZ	Tackling the digital divide during COVID-19.	Ministry of Education (2021b)
GD (3) - NZ	Growing Up in New Zealand: Life during Lockdown: Findings from the GUINZ COVID-19 Wellbeing Survey. Auckland.	Ministry of Social Development
GD (4) - NZ	The e-learning Planning Framework (English-Medium).	Ministry of Education
GD (5) - NZ	Evidence Review: Digital technologies in education during the COVID-19 pandemic.	Ministry of Education
GD (6) - NZ	Google Software for schools.	Ministry of Education (2021c)

GD (7) - NZ	Manaiakalani Digital Teaching Academy launch.	Beehive the official website of the New Zealand Government.
GD (8) - NZ	Education Report: COVID-19 Response – Distance learning package.	Ministry of Education.
GD (9) - NZ	Aotearoa EdTech Excellence: Transforming Educational Experiences, Digital Innovation and Economic Outcomes.	EdTech New Zealand.
GD (10) - NZ	Budget 2005: The Digital Strategy – Creating a digital future.	Beehive the official website of the New Zealand Government
GD (11) - NZ	Digital Government	Government New Zealand
Code of document	Name of document	Author
Journal Articles from South Africa		
J (1) - SA	The effectiveness of Information and Communication Technologies (ICT's) in teaching and learning in high schools in Eastern Cape Province.	OA Ojo and EO Adu
J (2) - SA	Towards a Digital Resource Mobilisation Approach for Digital Inclusion During COVID-19 and Beyond: A Case of a Township School in South Africa.	Themba Ralph Mkhize and Mogamat Noor Davids
J (3) - SA	Education in Times of COVID-10: Looking for Silver Linings in Southern Africa's Education Responses	Matizwa Mukute, Jane Burt, Buhle Francis, and Ben De Souza
J (4) - SA	Managing the COVID-19 pandemic in South African Schools: turning challenge into opportunity.	Jacobus Gideon Maree
J (5) - SA	Challenges and Opportunities via online learning: How has basic Schooling responded to COVID-19, A South African Perspective	Sphephelo P Zubane, Sekwenele Khoza, & Victor H Mlambo
J (6) - SA	Creation of Sustainable Learning Environments in South African Rural Schools: A Call for Effective Implementation of ICT's	Jogymoi Kalariparampil Alex

J (7) - SA	Online learning during COVID-19 and beyond: a human right based approach to internet access in Africa.	Bukola Faturoti
J (8) - SA	Counting the cost: Covid-19 school closures and its impact on children	Nic Spaul & Servaas van der Berg
J (9) - SA	Challenges Contributing to Poor Integration of Educational Technology at Some Schools in South Africa.	Moshe Makgato
J (10) - SA	The discourse on ICT teacher professional development needs: The case of South African teachers' union.	Reuben Dlamini
J (11) - SA	The Relationship between using Information and Communication Technology in Education and the Mathematics Achievement of Students.	Petronella Saal, Linda Van Ryneveld, & Marien Graham
J (12) - SA	In-Service Secondary School Teachers' Technology Integration Needs in an ICT-Enhanced Classroom.	Janet B. Adegbenro, Mishack Gumbo & Eunice Eytayo Olakanmi
J (13) - SA	Lessons learnt teachers' perspectives on mobile learning South Africa with cultural and linguistic constraints.	Mmaki Jantjies, & Mike Joy
Code of document	Name of document	Author
Journal Articles from New Zealand		
J (1) - NZ	Were we ready? New Zealand high school students' experiences of online learning during school closures of COVID-19.	Anne Yates & Louise Starkey
J (2) - NZ	What is happening in the use of ICT mathematics to support young adolescent learners? A New Zealand experience.	Karen Nicholas & Jo Fletcher
J (3) - NZ	Using Virtual Reality to Enhance Food Technology Education	Daniel Gorman, Simon Hoermann, Robert W Lindeman, & Bahareh Shahri.
J (4) - NZ	Changes to teachers' practice when using mobile technology with one-to-one classes.	Lucie Lindsay, Kerry Lee & John Hope.

J (5) - NZ	Leading through COVID-19: New Zealand secondary principles describe their reality.	Kate Thornton
Code of document	Name of document	Author
Documented information from South Africa		
DI (1) - SA	Training Room Online Partners with the Department of Basic Education to deliver innovative digital learning platform to public school sector.	Endeavour South Africa.
DI (2) - SA	Vodacom e-School: Lear anywhere – on your smart phone, tablet or desktop computer.	Vodacom e-School.
DI (3) - SA	Eastern Cape matric pupils fail to return 55,000 Samsung tablets to education dept.	News 24: Malibongwe Dayimani
DI (4) - SA	Exploring digital transforming challenges in rural areas of South Africa through a systematic review of empirical studies	Kehinde Aruleba & Nobert Jere
DI (5) - SA	ICT Support Environment in Developing Countries: The Multiple Case of School Teachers in Rural South Africa. IST Africa 2019 Conference proceedings.	Samwel Mwapwele, Mario Marais, Sifiso Dlamini, & Judy Van Biljon,
DI (6) - SA	Effects of Gauteng province's educators' ICT self-efficacy on their pedagogical use of ICTS in classrooms.	Shepherd Mlambo, Patient Rambe, & Luzaan Schlebush
DI (7) - SA	Paperless Classroom Hasn't Taken off yet.	Mail and Guardian: Lloyd Gedye
DI (8) - SA	The Impact of COVID-19 on a Fragile Education System: The Case of South Africa	Crain Soudien, Vijay Reddy, & Jaqueline Harvey.
DI (9) - SA	South Africa's digital divide detrimental to the youth	Kristal Duncan-Williams
DI (10) - SA	The State of ICT in South Africa.	Alison Gillwald, Onkokame Mothobi, & Broc Rademan
DI (11) - SA	Enhancing ICT readiness of schools in South Africa.	Darelle van Greunen, Kevin Kativu, Alida Veldsman & Johan Botha

DI (12) - SA	The State of the ICT Sector Report in South Africa.	Independent Communications Authority of South Africa
DI (13) - SA	Barriers to Electronic Access and Delivery of Educational Information in Resource Constrained Public Schools: A Case of Greater Tubatse Municipality	Tholo Pholotho & Jabu Mtsweni
DI (14) - SA	COVID-19 and the Digital Transformation of Education: What Are We Learning on 4IR in South Africa?	David Mhlanga & Tankiso Moloji
DI (15) - SA	Navigating Education in the Context of COVID-19. Lockdowns and School Closures: Challenges and Resilience Among Adolescent Girls and Young Women in South Africa.	Zoe Duby, Kim Jonas, Brittany Bunce, Kate Bergh, Kealebonga Maruping, Chantal Fowler, Tarylee Reddy, Darshini Govindasamy, & Catherine Mathews
DI (16) - SA	Schools in the Time of COVID-19: Impacts of the Pandemic on Curriculum.	Ursula Hoadley
DI (17) - SA	What South Africa's teachers brought to the virtual classroom during COVID-19.	Mmaki Jantjies
DI (18) - SA	CAPS explained	School Guide
DI (19) - SA	Provision of ICT in schools: Department of Basic Education & Department of Telecommunications and Postal Service briefing	Ms N Gina & Ms M Kubsyi
DI (20) - SA	Blended Beyond Borders: A scan of blended learning obstacles and opportunities in Brazil, Malaysia, & South Africa.	Julia Freeland Fisher, Katrina Bushko, & Jenny White
DI (21) -SA	Findings from a mobile tablet project implementation in rural South Africa. 15 th International Conference Mobile Learning.	Martha Herselman, Adèle Bothma, Mario Marias, & Nare Mahwai
DI (22) – SA	EdTech Start-ups in South Africa	Tacxn
Code of document	Name of document	Author
Documented information from New Zealand		

DI (1) - NZ	A framework to guide an education response to the COVID-19 Pandemic of 2020.	Fernando M. Reimers & Andreas Schliecher
DI (2) - NZ	Closing the digital divide during the COVID-19 lockdown: Student, whānau and staff perspectives.	Greater Christchurch Schools' Network Trust
DI (3) - NZ	Digital Technologies in Schools. A Report for the 20/20 Trust.	Research New Zealand.
DI (4) - NZ	Data & Insights Report.	Network for learning. (2021a)
DI (5) - NZ	School education during COVID-19 were teachers and students ready? New Zealand.	OECD (Organisation of Economic Co-operation and Development).
DI (6) - NZ	Touchpoint (full report) June 2021: The voice of schools on topics of online safety, digital inclusion and other IT challenges.	Network for learning (2021b)
DI (7) - NZ	Opportunities & challenges facing schools using technology for learning: Touchpoint (full report) 2018.	Network for learning
DI (8) - NZ	Parliament 360° Virtual Reality Tours: Teacher information and student resource.	House of Representatives New Zealand
DI (9) - NZ	Games, gamification, and game design for learning: Innovative practice and possibilities in New Zealand schools.	Rachel Bolstad & Sue McDowall
DI (10) - NZ	Digital Technologies in Schools 2016-17. Prepared of 20/20 Trust.	Research New Zealand. Prepared by Mark Johnson, James Maguire, and Annita Wood
DI (11) - NZ	Digital Technologies for Learning: Findings from the NZCER National Survey of Primary and Intermediate Schools 2016. s	Rachel Bolstad
DI (12) - NZ	COVID-19: Learning in lockdown.	Education Review Office
DI (13) - NZ	Learning in the COVID-19 World: The Impact of COVID-19 on Schools	Education Review Office.
DI (14) - NZ	Unlocking New Zealand's Digital Potential: The economic opportunities of digital transformation and Google's contribution.	AlphaBeta for Google

DI (15) - NZ	New Zealand's mobile data is third most expensive in the world.	Patch Bowen
DI (16) - NZ	Mobile Market Study –Primary Findings.	Commerce Commission New Zealand

Annexure 2: Certificate of ethics clearance



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Senate Committee for Research Ethics
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ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Faculty of Education Research Ethics Committee (EduREC)** on 29 July 2021, this committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCRE) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Comparing the status of education technology in South Africa and New Zealand during COVID-19																															
Study Leader/Supervisor (Principal Investigator)/Researcher: Dr ZL de Beer																															
Student / Team: CMS Bothma (MEd student - 21686734), Dr S Naidoo																															
Ethics number:	<table border="1"><tr><td>N</td><td>W</td><td>U</td><td>-</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>-</td><td>2</td><td>1</td><td>-</td><td>A</td><td>2</td></tr><tr><td colspan="3">Institution</td><td colspan="5">Study Number</td><td colspan="2">Year</td><td colspan="5">Status</td></tr></table>	N	W	U	-	0	1	0	0	1	-	2	1	-	A	2	Institution			Study Number					Year		Status				
N	W	U	-	0	1	0	0	1	-	2	1	-	A	2																	
Institution			Study Number					Year		Status																					
<i>Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation</i>																															
Application Type: Single Study	Risk: <table border="1"><tr><td>No Risk</td></tr></table>	No Risk																													
No Risk																															
Commencement date: 29/07/2021																															
Expiry date: 29/07/2022																															
Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.																															

Special in process conditions of the research for approval (if applicable):

General conditions: While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply: <ul style="list-style-type: none">• The study leader/supervisor/principal investigator/researcher must report in the prescribed format to the EduREC:<ul style="list-style-type: none">- annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and- without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.• The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the EduREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.• Annually a number of studies may be randomly selected for an external audit.• The date of approval indicates the first date that the study may be started.• In the interest of ethical responsibility, the NWU-SCRC and EduREC reserves the right to:<ul style="list-style-type: none">- request access to any information or data at any time during the course or after completion of the study;

- to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;
- withdraw or postpone approval if:
 - any unethical principles or practices of the study are revealed or suspected;
 - it becomes apparent that any relevant information was withheld from the EduREC or that information has been false or misrepresented;
 - submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or
 - new institutional rules, national legislation or international conventions deem it necessary.

The EduREC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the EduREC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely



Prof JAK Olivier
Chairperson NWU Faculty of Education Research Ethics Committee

Original details: (2021/103) C:\Users\2021/103\Desktop\ETHICS APPROVAL LETTER OF STUDY.docx
8 November 2018

Current details: (2021/103) S:\00218037\Monitoring and Reporting Cluster\Ethics\Contributed\Templates\Research Ethics Approval Letter\0.1.0.0.1.03.ERC Ethical Approval
Letter.docx
8 December 2018
File reference: 0.1.0.0.2

