PEDAGOGICAL INTEGRATION OF THE IPAD TO ENHANCE TEACHING AND LEARNING OF GRADE 10 LIFE SCIENCES

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DECLARATION

I declare that this research report is my own unaided work. It is submitted for the degree of Masters of Education at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination to any other university.

_____ _____

Signature Date

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ABSTRACT

This study explored the pedagogical integration of the iPad to enhance the teaching and learning of Grade 10 Life Sciences in two schools in the Gauteng Province, Scool A and School B. School A is a public school with the majority of learners coming from the townships. School B on the other hand is a privave school with the majority of learners coming form privileged families in the country. The study sought to explore how teachers and learners from the two different socioeconomic learning contexts are using iPads to enhance teachig and learning of Life Sciences. The study also explored the challenges that are faced by teachers and learners when they use the devices in the classroom. Qualitative data were collected through teachers' and learners' interviews, lesson observations and document analysis. The findings of the study indicated that iPads have great potential to transform the teaching and learning of Life Sciences in the studied schools. The use of iPads resulted in more time on task on the part of learners, increased independent learning, and improved skills to search for information. The study revealed that meaningful use of iPads requires adequate training of teachers through subject-specific technological professional training. Furthermore, the study showed that effective integration of iPads requires reliable wireless connection, technical support, consistent grid power supply and mechanisms for overcoming learners' distraction as a result of social networks and games available on the iPads.

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TECHNICAL DEFINITION OF TERMS

App Store: Apple's digital store for apps.

App: A mini-program, which can be downloaded onto an iPad from the iTunes or App Store.

eBook: The generic term used for an electronic text.

ELearning: Flexible learning using ICT resources, tools and applications, focusing on: accessing information, interaction among teachers, learners, and the online environment, collaborative learning, and production of materials, resources and learning experiences (DoE, 2004, p. 15).

iTunes Store: Apple's digital store for purchasing music, movies, TV shows, and apps, and downloading podcasts and other media.

WIFI: A common term for wireless networking

ABBREVIATIONS AND ACRONYMS

3D	Three Dimensional
BECTA	British Educational Communications and Technology Agency
BYOT	Bring Your Own Technology
CAPS	Curriculum Assessment Policy Statements
DoE	Department of Education
GDE	Gauteng Department of Education
ICT	Information and Communication Technology
N/A	Not Applicable
NSW	New South Wales
TPACK	Technological Pedagogical and Content Knowledge
TYB	Train Your Brain
UNESCO	United Nations Educational, Scientific, and Cultural Organisation
USA	United States of America

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CHAPTER 1: BACKGROUND AND OVERVIEW OF THE STUDY

1.1 Introduction

The use of iPads in education is becoming prevalent. Many schools in America (McClanahan, William, Kennedy & Tate, 2010), Australia and Canada (Peluso, 2012) are using this technology to enhance teaching and learning. A significant number of South African schools are also integrating this technology for improved instructional practices. In 2014 the Gauteng Department of Education (GDE) distributed 88 000 iPads to all public schools in an effort to enhance the quality of teaching and learning in the province (DoE, 2014). Likewise, in 2012, Peermont handed out 500 iPads in addition to 700 devices distributed in 2011 to disadvantaged high schools and their feeder primary schools in Ekurhuleni and Sedibeng catchment areas in an effort to improve teaching and learning in these particular schools (LeadSA, 2013).

IPads are touted as pedagogical change agents holding great potential to shift teaching from teacher-centred to learner-centred pedagogies. They pioneer new approaches to teaching and learning that occur at anytime and anyplace at the learner's pace (Joshi, 2012). They allow for a redefinition of the learning time and space, letting learners experience more flexible learning environments (Cochrane, Narayan, & Oldfield, 2013). Learning is no longer driven by classroom teachers or tied to school hours. Learners can work across formal and informal learning contexts within school, outdoor or even on-the-go (Traxler, 2010).

IPads show promise in educational settings as they allow teachers and learners to access broader and more flexible sources of learning materials; which are richer than what could be offered by teachers in traditional classroom settings (NSW, 2012). They provide teachers and learners with an array of donwloadable intuitive and interactive apps to facilitate the understanding of the subject content. The integration of iPads promote learners' higher-order thinking, most importantly, when they are embedded in social constructivist teaching approach (Cochrane, Narayan, & Oldfield, 2013).

1.2 Statement of the problem

Many South African schools are either integrating or planning to integrate iPads, yet none seems certain of the outcomes or the process to undertake to ensure that the devices serve their intended purposes. To date there is little published research to confirm that iPads are valuable to classroom instruction (Shuler, 2012), especially in the South African context. There is also a dearth of empirical research on how to implement iPads in the classroom (Pegrum, Howitt & Striepe, 2013). Classroom teachers are in the dark as they attempt to integrate the devices in effective ways. Thus, there is need to conduct research on the pedagogical integration of the iPads in the South African context in order to generate knowledge that guides the integration process.

1.3 Significance of the study

The study took place in two Schools in Gauteng, School A and School B. The two research sites were selected based on the socio economic backgrounds of learners attending them. School A is a public school with the majority of learners coming from surrounding townships. The average teacher- learner ratio is 1:35. School B on the other hand is a private school with the majority of learners coming from privileged families in and outside the country. The average teacher - learner ratio is 1:12. It was crucial to investigate how iPads are used and how they are contributing to teaching and learning in these two different learning contexts.

As many Life Sciences teachers would agree, Life Sciences teachers do not have enough and adequate resources to teach the subject. The subject requires well-equipped laboratory for learners to understand biological concepts. Lack of proper equipment makes Life Sciences a difficult subject to teach and thus difficult to learn. This study investigated how the use of iPads would transform the teaching and learning of Life Sciences, Grade 10 Life Sciences in particular. Most learners find Grade 10 Life Sciences to be a very difficult (Rian, 2011). This is partially because learners are not familiar with the language and terminology used in Life Sciences as the subject starts at Grade 10 level. It was thus crucial to investigate how the use of iPads helps learners to understand this subject.

1.4 Research questions

In order to explore the pedagogical integration of iPads to enhance the teaching and learning of Life Sciences, the study was guided by the following research questions:

1. How do teachers and learners use iPads to support the teaching and learning of Life Sciences?
2. What pedagogical shifts, if any, take place when iPads are used for the teaching and learning of Life Sciences ?
3. What are teachers' and learners' perceptions of the benefits and limitations of using iPads in a Life Sciences classroom?

CHAPTER 2: LITERATURE REVIEW

The purpose of this study was to explore the pedagogical integration of iPads through the experience of teachers and learners in Life Sciences. The study sought to examine pedagogical approaches that teachers are using to integrate iPads in their classrooms, to determine the pedagogical shifts that are taking place because of integrating iPads in the classroom, the educational benefits, and challenges faced. To carry out the study, I reviewed existing literature on the use of iPads in educational settings. The literature review that follows focuses on the following main features:

- Defining the pedagogical integration the iPad
- Progress of technology integration in South African schools
- Evolution of iPads in South African schools
- Unique affordances of the iPad
- Mode of integrating the iPad
- Knowledge required to integrate the iPad meaningfully
- Educational challenges of iPad integration
- Conceptual framework

2.1 Defining the pedagogical integration of the iPad

In an attempt to define the pedagogical integration of the iPad, it is crucial to define the core terms of pedagogy, technology integration, the iPad, and the pedagogical integration of the iPad.

2.1.1 Pedagogy

The term pedagogy is widely used in educational discourse to refer to techniques and strategies of teaching a knowledge domain or a subject (Hall & Murphy, 1996). Dron (2012) argues that pedagogy is to be understood as “a method, a technique for instruction, or as a repeatable and communicable method of teaching” (p.12). In this

way concept of pedagogy encompasses methods or strategies teachers employ on a daily basis to teach the subject.

2.1.2 Technology integration

Technology integration on the other hand refers to “how to use technology to support the way teaching is currently done in schools” (Reigeluth & Joseph, 2002, p. 9). In other words, technology integration means the use of technology to support prevailing pedagogies. While this definition does not imply a change of pedagogy, Etmer (2005) uses the term “technology integration” to mean “technology transformation”. The latter implies the use of technology in classroom environments to bring significant pedagogical shifts that were previously not possible. That is use of technology to allow a shift from direct instruction to learner-centred approaches, a shift from context-dependent to flexible learning, and a shift from individual learning to peer-assisted and collaborative learning, with the teacher acting as a coach rather than a sage on the stage (Reigeluth & Joseph, 2002).

2.1.3 The iPad

The iPad is an Apple product similar to iPod Touch and iPhone. The device is small and portable. The iPad has an intuitive touch screen, which rotates automatically as the user turns the device. The iPad users communicate with the device by touching the screen with their fingers. The device has long battery life, which lasts from eight to ten hours of active work. It connects to the internet wirelessly or through a 3G network. It also comes with built- in applications such as email, calendar, contact, iTunes, notes, map, iBook and many more. Users can also download additional free applications or purchase them from the App Store (Pratt, 2010: Valstad, 2010). In effect, the iPad is a multifunctional device that holds the potential to support a range of instructional activities.

2.1.4 Pedagogical integration of the iPad

Pedagogical integration of the iPad is using the iPad as an integral aspect of the teaching and learning processes. This study uses Etmer (2005)’s view of technology integration. The study presupposes that the core aim of integrating the iPad into the

classroom is to bring about significant qualitative pedagogical changes, which were not previously possible.

2.2 Progress of technology integration in South African schools

The White Paper on e-Education strongly encourages schools to integratage technology in the quest to transform teaching and learning. The White Paper stipulates that successful integration of ICT results in meaningful learning experiences, promotes higher-order thinking, brings new learning opportunities, accommodates different learning styles. Use of technology removes barriers to learning by providing expanded opportunities and individualised learning experiences (DoE, 2004). In light of these advantages, it was the goal of the South African government that every South African learner be ICT capable by 2013 ” (that is: to confidently and creatively use ICT in the development of the skills and knowledge they need as lifelong pupils to achieve their personal goals and to be full participants in the global community)”(DoE, 2004, p. 17).

Much has been done in South Africa to enhance the quality of teaching and learning using technology. Projects such as Khanya, Gauteng Online and Connectivity have been undertaken at different provincial levels to provide teachers and learners with ICT tools. At national level, organisations such as SchoolNet SA, Intel® Teach to the Future, the South African Institute for Distance Education and many more, provide ICT professional development programmes (Isaacs, ICT in education in South Africa, 2007). Sentec and Telcom Foundations also provide teachers and learners with technological infrastructure (DoE, 2005).

The research by Strydom, Thomson and Williams (2005) on the extent to which South African teachers who completed the Intel® Teach to the Future training have integrated technology into their teaching practices revealed that 33% of teachers had never used technology-integrated lessons; even though they had access to computers. The same study revealed that 48.5% of the teachers had used technology in their lessons more than once per month while 13,3% had used it only about once a month. These findings concur with Bonfadelli (2002) that mere access

to ICT does not translate into use of ICT, nor does use of ICT directly translate into significant learning gains. Meaningful use of ICT occurs when teachers feel able to use the technology in everyday teaching practices in order to enhance learning.

The research done to identify critical factors of ICT adoption in the Western Cape province (Miller, Naidoo, Van Belle & Chigona, 2006) reported that the use of ICT was limited to developing ICT skills rather than integrating ICT for improved and engaged teaching and learning activities. Schools that had computers placed them in the computer rooms which were under utilised as the priority was given to specific subjects. Schools used first-come-first-served booking systems to access the computer rooms, the priority being given to the subject English and Mathematics.

It is clear that implementing computers in these South African schools did not bring about significant pedagogical changes. The two major challenges that constrained effective integration were lack of computers that could be used by all subject teachers and learners and the general lack of relevant teacher knowledge on how to integrate technology in meaningful ways. The teacher's ability to integrate technology is central to the failure or success of any technology integration. Wade (2008) asserts that providing teachers with technology without developing the teacher 's ability to use it in meaningful ways is like giving books to illiterate people in the hope that the books will heal illiteracy. Wade strongly argues that teachers must be empowered to use technologies in meaningful ways in order to reap the full benefits that technology affords.

2.3 The evolution of iPads in South African Schools

In an attempt to make learning more effective the educational sector is investigating the affordances of mobile handheld technologies for teaching and learning.
It is believed that iPads have the potential for ubiquitous learning (NSW, 2012; Joshi, 2012). They provide teachers with opportunities for immediate assessment of their learners and offers the opportunity to provide learners with timely feedback to reinforce learning (Amelito, 2010). IPads enhance learner interest and motivation to learn. They have the potential to enhance active learning as they provide students

with opportunities for collaboration and communication in seamlessly connected learning environments (Li, & Pow, 2011). IPads have the potential to shift teaching from teacher-centred to learner-centred pedagogy, thereby providing learners with access to broader and flexible sources of information which are richer than what the teacher can offer in a traditional classroom environment (NSW, 2012).
There is a very strong reason schools are implementing iPads at the expense of conventional personal computers. Traxler (2010) argues that desktop technologies do not allow the learner to interact with the peers beyond the computer rooms and the lesson period. IPads on the other hand allow the learner to interact with the peers at any time and from anywhere. The learning experience does not end with the lesson period or school hours. Learners who need help can still collaborate with their peers and teachers beyond the school walls.

The survey by UNESCO in partnership with Nokia and Worldreader to investigate the habits, preferences and attitudes of mobile readers in seven developing countries (Ethiopia, Ghana, India, Kenya, Nigeria, Pakistan and Zimbabwe) indicated that people read more and enjoyed reading when they read on mobile devices. People who disliked reading developed a positive attitude towards reading when they started reading from their mobile handheld devices. The report recommends that governments invest in mobile devices such as iPads to bring the text to remote areas where printed books are scarce and unaffordable (West & Chew, 2014).

The study also conducted in the USA to compare reading satisfaction, accuracy and speed between digital e-readers and standard paper for patients with low vision indicated that mobile digital devices may have use in visual rehabilitation for low vision patients (Gill, Mao, Powell, & Sheidow, 2013). Patients read accuratey and faster when reading from the iPad than when given printed text. The iPad provided them with a big display screen and better magnification to read the text (Gill et al, 2013). Mobile handheld devices may therefore better accommodate learners with visual impairment than paper-based text.

2.4 The Unique affordances of the iPad.

A study by Churchill, Fox, & King (2012) to identify how higher education teachers used the iPad to enhance their teaching practices identified six iPad affordances; teaching tools, notes tools, communication tools, blogging tools and content accessing tools. Similarly the study by Alyahya & Gall (2012) on how graduate students were using iPads at the University of Northern Colorado identified six iPad affordances; access to written materials, internet resources and services, note taking, organising, presentation, and tools for working assignments. The iPad provides learners with an array of tools to construct their own understanding of the learning content. The findings cited above suggest that there are significant pedagogical benefits of using iPads in teaching and learning.

The iPad affords anytime and anywhere learning. Its portability and modest size make it easy for students to move around in order to share information with their peers. Alternatively, a group of students can work on a table while sharing information on their iPads (Melhuish & Fallon, 2010). The connectivity of iPads computers gives students the added advantage of interacting with learning materials whenever and wherever they are, allowing them to engage in learning activities as part of their real life. The iPad's iTunes application allows students and teachers to access more than 350 000 free tutorials from different subject experts around the world (Valstad, 2010). In this way, the teacher is no longer at the centre of the learning process as students can access online communities, collaborate, or research at any time and from anywhere (Goodwin, 2012).

The iPad has a 9-inch multi-touch interface screen that serves as the primary mode of interacting with the divice. The screen rotates as the user turns the device allowing the user to read or type from any direction. It connects to wireless connections and has bluetooth capabilities to support peer-to-peer networking (Murray & Olcese, 2011).The iPad allows users to work for long hours due to extended battery life which can last for ten hours of active work. The iPad's bright screen adjusts automatically to match ambient light so that users are at ease when reading. The screen has an LED backlit display that allows the screen to be readable even in a dimly lit room (Valstad, 2010: Hutchison *et al*, 2012 & Wieder, 2011).

Reading eBooks from the iPad provides an added advantage over printed texts as this allows manipulation of the text to meet the user's needs and interests (Eagleton & Dobler quoted in Hutchison et al, 2012, p. 17). This manipulation in the form of highlighting, adding sticky notes and reading from any orientation makes the experience more individualised, interactive, and engaging for the student (Larson quoted by Hutchison et al, 2012).

The iPad provides the facility to get the definition and pronunciation of any word on the screen by simply touching it. The audio note taking application offers the opportunity to take notes with a voice recording. During playback, the student can highlight a word and then hear what the teacher said the time the note was written (Valstad, 2010).

2.5 Mode of integrating the iPad

There is no single fixed mode of integrating the iPad. There are times when learners are engaged in self-learning and times when they collaborate with their peers, teachers, and experts in the field (Looi, Seow, Zhang, So, Chen & Wong, 2010). Some schools favour a one-to-one model in which students use their own devices (Bobel, 2010). This model is linked to Bring Your Own Device (BYOD) or Bring Your Own Technology (BYOT) model. The learner is encouraged to have a device which is available at all the times in order to promote ubiquitous learning (Benton, 2012). Other schools use a multiple-user model. The devices do not belong to specific learners but are distributed to learners during the lesson or for classroom group work (Benton, 2012).

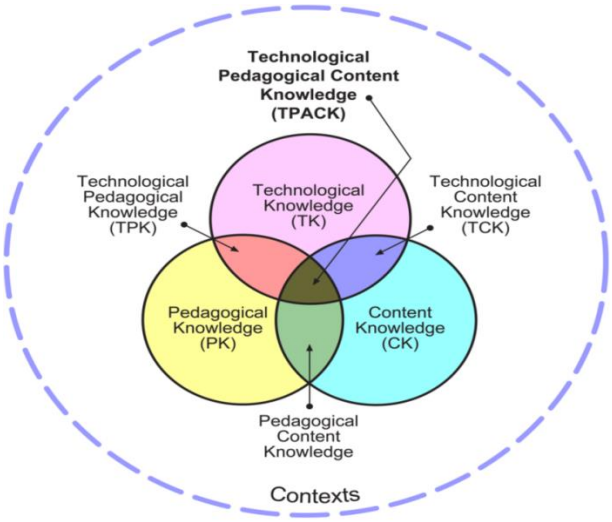
2.6 Knowledge required to integrate the iPad meaningfully

It is indisputable that iPads have the potential to transform teaching and learning. However, in the South African context where most teachers are not familiar with teaching with technologies,there is no guarantee that the integration of the iPad will succeed if teachers do not have relevant knowledge and skills to use the device in meaningful ways.

The integration of ICT is likely to encounter teacher resistance especially if they do not see the educational value of using technology and have no knowledge of how to use the technologies for teaching and learning (Niess, 2013). The British Educational Communications and Technology Agency reports that teachers who do not see why they should use technology are less likely to integrate it especially if they have not received adequate training (Becta, 2004). Churchill, Fox, King (2012) also argue that teachers' understanding of iPad affordances is paramount for this integration to transform teaching and learning.

According to Koehler, Mishra & Cain (2013) "teaching is a complex, ill-structured task requiring the application of complex domains of knowledge."(p.2) Teachers need to have the requisite knowledge so that the use of educational technologies in the classroom can yield maximum benefits. Koehler and Mishra (2006) argue that the teacher must have the "technological, pedagogical, and content knowledge" in order to integrate technologies effectively (p.2). This implies thorough professional development programs to equip teachers with the knowledge required to integrate iPads computers. Teacher-training programs must go beyond the imparting of basic technological skills. They must impart knowledge of how the content and pedagogy change because of integrating the technology into the classroom. Figure 1 bellow illustrates the requisite knowledge the teacher needs to have to teach with technology.

Figure 1: TPACK model (Kohler & Mishra, 2008)



The TPACK model has seven knowledge components that show what the teacher needs to know in order to teach with technology. The framework is based on three main knowledge components: Technological knowledge, Content knowledge and Pedagogical knowledge. The interaction of the three main knowledge components results in four additional knowledge components: Technological Pedagogical knowledge, Pedagogical Content knowledge, Technological Content knowledge and the Technological Pedagogical Content knowledge (Mishra, 2006; Angeli & Valanides, 2009; Graham, 2011; Niess, 2011).

The Content knowledge in TPACK is the "knowledge about the subject matter that is to be learned and taught" (Harris, Mishra & Koehler, 2009, p. 397). The teacher needs to be a subject expert who has profound knowledge of the nature of enquiry, concepts, theories, ideas and organisational framework of the subject (Koehler., Mishra, & Cain, 2013). In so far as this study is concerned, Life Sciences teachers need to be qualified to teach the subject. They need to be competent, dedicated and caring in order to be able to teach and assess learning effectively (DoE, 2011).

The Pedagogical knowledge is the knowledge of the "processes and practices of teaching and learning, educational purposes, goals, values and strategies" (Harris, Mishra, & Koehler, 2009, p. 15). It is also an understanding of how knowledge is constructed, how the information is processed, classroom management, how to do lesson plans and assess learning (Mishra, & Koehler, 2006).

The Pedagogical Content knowledge is an understanding of how the content can be taught to learners (Koehler et al, 2014). Particular topics need to be adapted and presented in a fashion which best accommodates the interests and intellectual abilities of the learner. It is important for teachers to know how teaching approaches and the content might change due to the context of learning.
Technological knowledge refers to the "Fluency of Information Technology " (Koehler et al, 2013, p. 15). Teachers need to know traditional and current educational technologies which can be used to improve the teaching and learning of the subject.

Technological Content knowledge is an understanding of how technological affordances can change the way the content is presented and how the content might determine the technology to be used so that content is taught in a clear fashion (Koehler & Cain, 2013). In this study technological content knowledge means making a connection between iPad's affordances and the Life Sciences content. The teacher must be able to see how iPad apps can improve mastery of Life Sciences content.

The Technological Pedagogical Knowledge is "an understanding of how teaching and learning can change when particular technologies are used in a particular way", (Koehler et al 2013, p. 16). The iPad can afford, for example simulated learning, synchronous and asynchronous learning, automated assessment, individual and collaborative learning. The teacher needs to know what pedagogical shifts will take place if these affordances are used to teach Life Sciences. This might include changing the role of the teacher, changing the format in which the information is presented, or extending of time and space for learning.

The Technological Pedagogical Content knowledge which is at the centre of the framework is aquired when the teacher thoroughly integrates technologies into teaching and learning. It is the knowledge that makes a good teacher of educational technology. It is an understanding of how technology, content and pedagogy interact to constrain or enhance the process of teaching and learning (Koehler et al, 2013).

2.7 Educational challenges of iPad integration

Research on the educational use of the iPad identified several challenges such as app selection, technical support (Alberta Education, 2011), the teachers' professional development (Hatten, 2012), learners' distraction and lack of relevant curriculum aligned apps (Chou, Block, & Jesness, 2012).

Harmon (2012) asserts that app selection is a process of trial and error. New educational apps are released each year; hence, teachers found it a daunting task to keep pace with the rapidly ever-changing landscape of educational apps. They find it extremely difficult to select apps that have educational potential to unlock learning given the availability of so many app options. The ability to adjust the content to meet

the needs of individual learners while promoting the vertical construction of the curriculum knowledge is also a serious challenge as many educational apps come with the content and activities that have a fixed sequence.

Teachers often receive one form of professional training and this does not prepare them enough to integrate iPads in their curriculum (Hatten, 2012). Hatten suggests that teachers receive multiple forms of professional development programmes including workshops, mentoring, and coaching, online and face-to-face communities and just in time videos. Such programmes should be given enough time so that teachers benefit from them (Chou, Block, Jesness, 2012).

Another challenge associated with the use of iPads in the classroom is the distraction the technology can cause. In a study done on the pedagogical integration of iPads in Midwest City in the United States (Chou, Block, Jesness, 2012), learners got off track while looking up for information on the website. Learners were using apps that were more entertaining and not central to the task. They were using iPads to take pictures or as a mirror during lessons. They also used their iPads to search the web for social content and sport sites instead of using them for the prescribed task.

2.8 Conceptual framework

The main message emerging from the review of literature is that iPads have great potential to transform teaching and learning. Meaningful use of this technology can only occur if teachers understand the padagogical need to use the technology and have relevant knowledge and skills that will best optimise use of the technology. The knowledge the teacher ought to have in order to teach with technology is explained in the TPACK framework which informed the conceptual framework of this study.

The conceptual framework used in this study has six interdependent constructs: Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Implementation Approaches, Attitude and Learner Interactions. These constructs are explained in more detail below:

The notion of Technological, Pedagogical and Content Knowledge (TPACK) underscores that understanding the relevant technology, subject content and pedagogy is a key enabling factor to using technology in any act of teaching. Lack of any one of the these three factors constrains the teacher in so far as intelligent use of ICT is concerned. In any technolgy-enhanced teaching encounter, the teacher must know the pedagogical shifts that will take place and how the content will be transformed as a result of using technology. The teacher should aim to effect this shift deliberately using technology.

Implementation approaches: This refers to whether one uses a one-to- one ubiquitous model, multiple-users model or small-group user model. The choice of the model depends on the context of teaching and learning and availability of resources.
Attitude: This is premised on the perception of teachers of how technologies affect teaching and learning.

Learner Interactions: the device can be used for independent learning or collaborative work.
Figure 2 that follows is a diagrammatical presentation of the conceptual framework described above.

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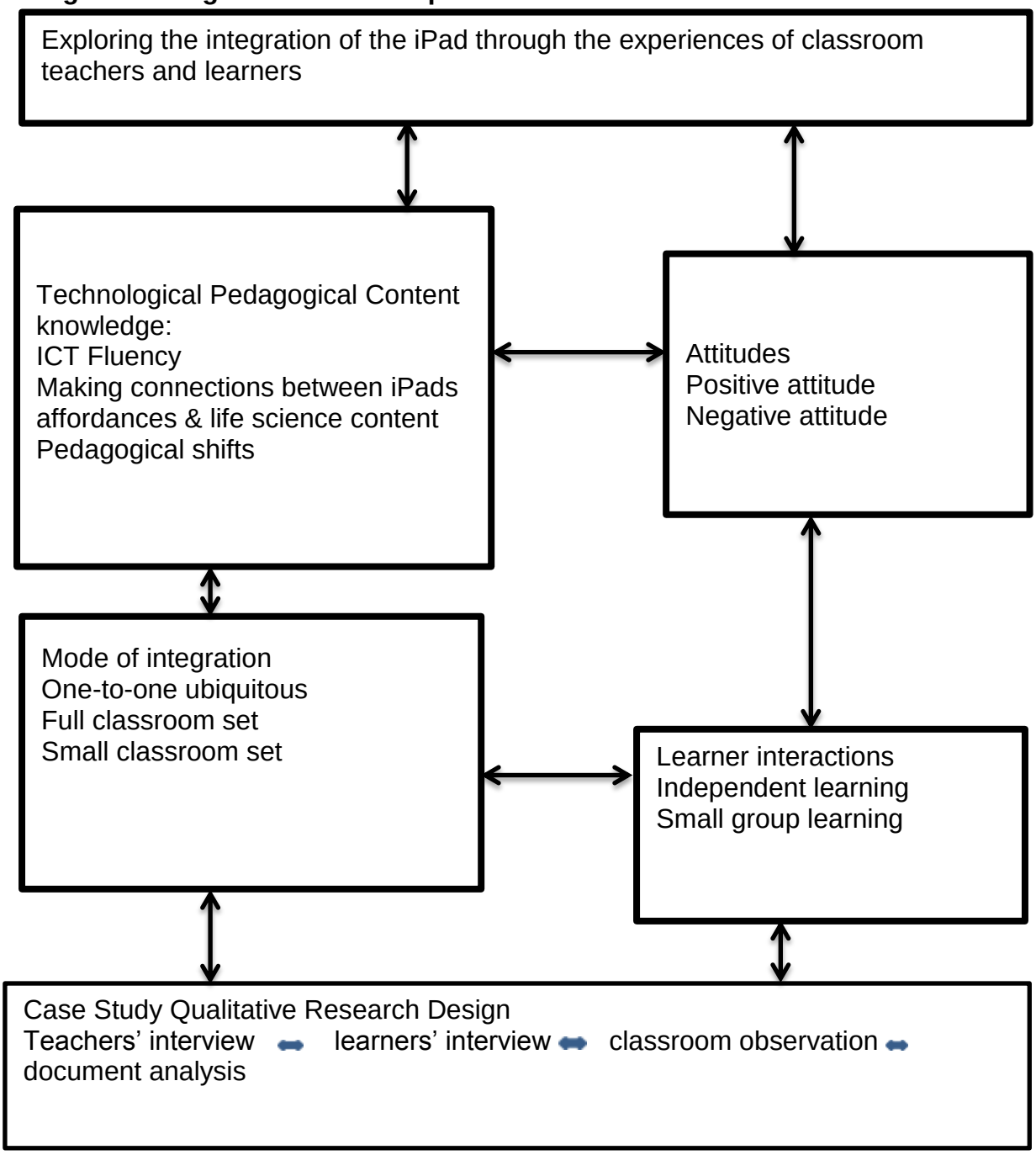
Figure 2: Diagrammatic Conceptual Framework



CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This study explored the pedagogical integration of tablet technology through the experience of Life Sciences teachers and learners in two schools situated in Gauteng. The study sought to examine pedagogical approaches that teachers are using to integrate tablet technology in their classrooms and identify the pedagogical shifts that are taking place because of using tablet technology in the classroom. It also sought to determine the educational benefits and challenges of integrating tablet technology in the teaching and learning of Life Sciences

The study was guided by three research questions:

1. How do teachers and learners use iPads to support teaching and learning of Life Sciences?
2. What pedagogical shifts, if any, take place when iPads are used for the teaching and learning of Life Sciences ?
3. What are teacher and learners' perceptions of the educational benefits of using iPads and the challenges faced?

To answer the research questions above this study used a qualitative research design. Data was collected through interviews, document analysis and classroom observations. Data was analysed using an inductive data analysis approach. This chapter describes in detail the research methodology that was used to undertake the study. It describes the research design, the research methods, as well as data collection instruments. The chapter finally describes how issues of validity and reliability were handled.

3.2 Qualitative research design

Qualitative research is defined as a means for exploring and understanding the meaning people ascribe to a social phenomenon or a human problem (Creswell, 2007). The researcher explores the problem or the phenomenon as it occurs in its natural setting. Data collected is largely textual rather than numerical and therefore

non-statistical method of data analysing data are used (McMillan & Schumacher, 2010).

A qualitative research design was the most appropriate approach to use in getting the perspectives of teachers and learners on the use of iPads for teaching and learning. There is a dearth of evidence in literature on whether and how iPads contribute to teaching and learning (Pegrum, Oakley, & Faulkner, 2013). Hence, there was a need to explore this phenomenon from the experience of teachers and learners who are using this technology in classroom settings.

3.3 Phenomenological study

Largely, this study is a phenomenological study as it reflects participants' lived experiences. Phenomenography is a qualitative research methodology, within the interpretivist paradigm, that investigates the qualitatively different ways in which people experience something or think about something. McMillan & Schumacher (2010) describe a phenomenological study as an inquiry that "describes and interprets the experiences of participants regarding a particular event in order to understand the participants' meanings ascribed to that event "(p. 346). In a phenomenological study data are collected mainly through open-ended questions and dialogue with people who live the experience. Thereafter, the researcher describes and interpretes the data to determine what the experience means to the people who have had it (Cristensen, Johnson & Tuner, 2010). Meaning is constructed from people's experiences. In this study life Sciences teachers and learners of two different socioeconomic context expressed their day to day experiences of using iPads as instructional tools.

3.4 Population and sampling

In order to obtain rich, valid and reliable data, this study used a purposive sampling method in which the research sites and participants were selected according to preselected criteria relevant to the research topic and the research questions (Maree, 2011). The aim of the study was to explore the pedagogical use of iPads to enhance teaching and learning of Life Sciences.

Two schools with significant socio-economic disparities between learners attending them were selected. School A learners come from townships while School B learners come from rich families in the country. It was important to investigate how learners coming from these socioeconomic contexts are using iPads to enhance their learning. As the study intended to investigate how iPads enhance teaching and learning of Grade 10 Life Sciences, the population from which the sample was drawn consisted of 6 Grade 10 Life Sciences teachers and 132 Grade 10 Life Sciences learners. Sixteen Life Sciences learners participated through interviews: 10 learners from School A, and 6 learners from School B. One hundred and thirty-two learners were also observed using iPads in the classroom: 90 learners in School A and 42 learners in School B. Six Life Sciences teachers (three teachers from School A and three teachers from School B) were interviewed on their experiences of using iPads to teach Life Sciences.

3.5 Data collection instruments

The study collected qualitative data using interviews, classroom observation, document analysis, and the analysis of the proceedings of a School a board meeting that I personally attended.

3.5.1 Interviews

According to Harrel & Bradley (2009), “interviews are discussions; usually one-on-one between an interviewer and a respondent meant to gather information on a specific set of topics” (p. 6). Interviews are “one of the most powerful ways in which we try to understand our fellow being “(Fontana and Frey, 2000, p. 645). In interviews the researcher asks questions from the interview guide, listens and records answers from the interviewees (Cresswell, 2012). In addition, the researcher notes non-verbal responses to certain questions as this constitutes significant research data.

Interviews were used in this study to collect information on teacher and learner perceptions of the use of iPads for teaching and learning Life Sciences. Six Life Sciences teachers and Sixteen Life Sciences learners were interviewed. Each interview was audio recorded and transcribed verbatim to facilitate the data analysis.

The learner's interview schedule consisted of eleven semi-structured questions that were designed to elicit information on the learner's experiences when using iPads to learn Life Sciences. The interview schedule was also designed to elicit information on learner perceptions of the educational value of using iPads to learn Life Sciences and the challenges faced in using this technology.

The teacher interview schedule consisted of 24 semi-structured questions. The questions were designed to elicit information on the pedagogical use of iPad to teach Life Sciences, the impact this technology has on the teaching and learning of Life Sciences, and the challenges faced.

3.5.2 Participation in the board meeting at School A

School A is fully eLearning. School leaders and educators come to this particular school to learn how to integrate iPads in their teaching curriculum. On my first day in School A, the school board had a meeting with two people sent by the Department of Education to enquire the process School A went through to become an eLearning school. As the meeting was relevant to my study, I was invited to participate. With permission from the board, I recorded the meeting proceedings so that I could use this information for my study.

3.5.3 Classroom observations

Observation is "the process of gathering open-ended, first-hand information by observing people and places at a research site" (Cresswell, 2012, p. 212). Observation as a data collecting method offers the opportunity to record information as it happens at the research site, to study actual behaviour and the behaviour of individuals who have difficulty verbalising their ideas (Creswell, 2012). I employed this method of gathering data so that I could obtain additional information to what I obtained through interviews and document analysis. Observations also enabled me to triangulate the data I collected from the field.

In School A, 90 learners were observed using iPads for four consecutive days. In School B 42 learners were also observed using iPads for four consecutive days. In

total, 13 formal lessons were observed; eight lessons in School A and five in School B.

I was a non-participant observer in the Life Sciences classrooms. A non-participant observer is “an observer who visits the site and records notes without becoming involved in the activities of the participants” (Cresswell, 2012, p. 212). I just sat at the back of the classroom and recorded field notes on the classroom setting, experience provided to students, teacher pedagogical approaches and interactions that took place among students and between students and the teacher. All the observation was done unobtrusively.

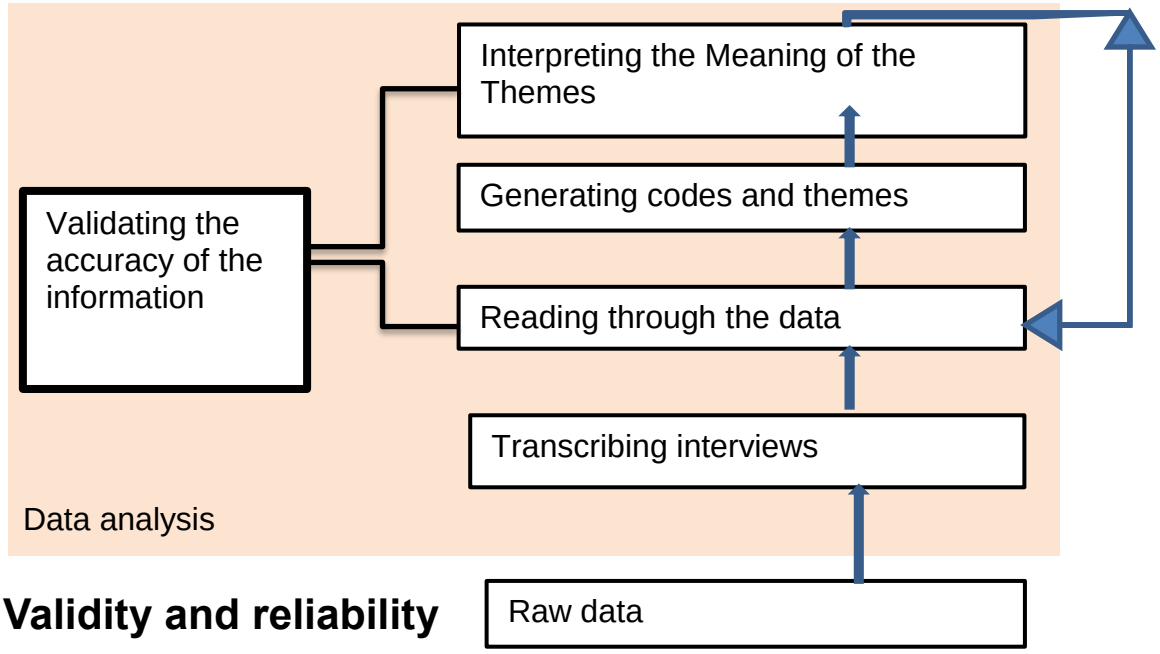
3.5.4 Document analysis

Document analysis is “a systematic procedure for reviewing or evaluating documents – both printed and electronic (computer-based and Internet-transmitted) material” (Bowen, 2009, p. 27). Analysing documents provides insights into a situation where research takes place (Koshy, 2010). To gain more insights on pedagogical approaches teachers are using, learning experiences that are created for learners, and the quality of the work produced by learners, I analysed four teachers’ lesson plans and two learners’ work samples.

3.6 Data analysis

Qualitative data was analysed following McMillan & Schumacher’ s seven steps of qualitative data analysis: collecting data, organising data, transcribing data into segments, coding data, describing data, categorising data and developing patterns, (McMillan & Schumacher, 2010). All interviews were audiorecorded using Blackberry Z10’s application called Parrot. This application allowed secure and comfortable audio recording which was served on a computer for transcription. Transcripts were typed using Microsof Office Word. The Review command in the Microsoft Word allowed coding of data into broad themes. Themes were later categorised to correspond with the research questions. An *a* priori code system derived from the literature on the use of iPad as an instructional tool was used (Benton, 2012). Figure 3 which follows illustrates the data analysis approach that the study used.

Figure 3: Steps of qualitative data analysis (adapted from Creswell, 2009, p. 189)



3.7 Validity and reliability

Validity and reliability determine whether the research truly measures what it was intended to measure and how reliable the research results are (Creswell, 2012). Validity and reliability address the question: “How can the inquirer persuade his or her audiences that the research findings of an enquiry are worth paying attention to” (Lincoln & Guba, 1985, p. 209). Triangulation is one of the approaches used to ensure the validity of qualitative research findings (McMillan, & Schumacher, 2010). Triangulation is defined as “a process of corroborating evidence from different individuals (e.g. a principal and a student), types of data (e.g., observational field notes and interviews), or method of data collection (e.g. documents and interviews) in descriptions and themes in qualitative research” (Creswell, 2012, p. 259). In addition to triangulation, researchers ask research participants to check the acuracy of the account given. They also ask an external person to do a thorough review of the study in order to provide the feedback (Cresswell, 2012).

To ensure the validity and reliability of this study’s findings, I triangulated data collected through interviews, documents, classroom observations and the board. Triangulation allowed identifying regularities and discrepancies across data, thus allowing reporting of credible and accurate findings. Furthermore, I spent enough

time within the setting, meeting, conversing and observing the research participants. I obtained the service of an external editor for a thorough review of this study.

3.8 Ethical considerations

Before going to the field, I sought and obtained permission from the GDE to do research in the public school. I also sought permission from the school principals to do research in the schools. In addition to obtaining permission from the GDE and the school principals, I sought research clearance from the Wits School of Education. Before granting the clearance, the ethics committee ensured that my research did not infringe any human rights.

All participants were informed at the beginning of the purpose of the study.

Participation in the study was voluntary. Research participants were informed of their right to withdraw from the study at any time. They were given consent forms to confirm or decline their participation in this study. Parents were also given consent forms to confirm or decline their children's participation in this study. Parental permission determined the number of learners who participated in this study.

Confidentiality and anonymity were ensured by using pseudonyms instead of participants' real names. No name of school or research participant was used in all writings about this study.

In order to minimise the inconvenience for participants, interviews were conducted on times, dates and venues preferred by the participants. Permission to record the interview was sought before any interview was recorded.

After completion of the project, raw data will go to the supervisor and be destroyed within 3–5 years. The final report on the project will be submitted to the supervisor and will only be used for study purposes.

3.9 Limitations of the study

This study had some limitations that need to be taken into account when interpreting the findings and conclusions.

The small sample size and a brief period for this study limit the generalisation and transferability of the study findings to broader contexts. Although the findings may provide useful insights into the use of iPads in educational settings, the specific study findings are unique to the studied schools. Thus, the transferability of the study findings to other schools may not be plausible.

A further issue associated with qualitative study pertains to researcher bias. According to (Wicks, & Whiteford, 2006, p. 4) “qualitative research is underpinned by subjectivist ontology and a subjectivist epistemology, which means individuals create their own subjective realities and there is an interrelated and interdependent relationship between the knower and the known”. It is possible that data collected was unwittingly misinterpreted. Due to this limitation, direct quotes from participants’ interview responses were used and cross-referenced. This enables the reader to determine the degree of the researcher’s bias.

It is also possible that data collected from observations can be attributed to the “halo effect.” Although observations were unobtrusive, teachers and learners were nevertheless aware that they were being observed. Hence, they might have altered their normal behaviour. Data collected from the field was triangulated in order to overcome this limitation.

CHAPTER 4: FINDINGS ON THE PEDAGOGICAL INTEGRATION OF IPADS TO ENHANCE THE TEACHING AND LEARNING OF LIFE SCIENCES

4.1. Introduction

This chapter focuses on the presentation of data from the study sites. Findings were obtained from six in-depth teachers' interviews, sixteen learners' interviews, thirteen lesson observations, analysis of four teachers' lesson plans, two learners' work samples, and the proceedings of the school board meeting which I personally attended.

The chapter has two sections. The first section presents the analysis of data from School A. The second section presents the analysis of data from school B.

In each section, I firstly present the findings on the context of integrating iPads in the School. Secondly, I present findings on the pedagogical integration of iPads in a Life Sciences class. These findings are grouped into six broad themes:

- the context of using iPads
- pedagogical use of iPads to enhance teaching and learning of Life Sciences
- pedagogical shifts taking place as a result of integrating iPads
- teacher planning and technological professional development,
- teachers and learners' perceptions of the educational value of iPads; and
- Teachers and learners' perceptions of challenges faced.

4.2 Analysis of data from School A

In this section I, present data collected from a one-hour board meeting, two teachers' interviews, six learners' interviews and eight lesson observations.

4.2.1 The context of using iPads in School A

School A is a public school with 90% of learners coming from disadvantaged backgrounds. The school has about 1 230 learners, the majority coming from surrounding townships. The average teacher–learner ratio is 1:35. It would be expected that the school whose learners come from deprived social backgrounds would struggle to integrate ICT in their learning. However, School A is fully eLearning

school. Learners and teachers communicate and share information with each other using iPads. All the resources have been digitalised. Subsequently, learners use iPads on a daily basis to access teaching and learning materials. IPads were integrated as a result of an ongoing process of school improvement. Prior to the integration of iPads, the school had tried other technologies such as computers, laptops, and smart boards.

4.2.1.1 On-going school improvement process

The analysis of the meeting proceedings revealed that School A implemented iPads as a result of its ongoing process of improving the quality of teaching and learning. In 2008 the school started exploring how computers could be used to enhance teaching and learning. The first desktop computers, laptops, projectors and smart boards were implemented in this regard. However, as Teacher 1A reported, the number of computers and laptops implemented at that time was so limited that priority was given to the Science Department.

> *When we started not everybody had a smart board, the school could not afford to give everybody a smart board. Priority was given to Teacher 2A and me because we are teaching important subjects. We were the first teachers to use smart boards and the first to have laptops. Now that the school has money, the number of computers and smart boards was extended to other teachers as well (Teacher 1A).*

The deputy principal pointed out that in 2010, the Peermont School Support Programme donated McBooks and a science lab with iPads. The number of iPads donated was so limited that the school had to use a booking system. The booking system frustrated teachers and iPads were never used to provide learners with enriched learning experiences.

It is in this ongoing process of trying to improve teaching and learning that iPads were implemented. In October 2012, the school decided to migrate from hard-copy textbooks to becoming an eLearning school. In this regard, iPads were implemented to support the eLearning project.

When describing how the project started the school principal said:

> *The parents are not always educated enough to help their children. Parents really rely on us. Very quickly at the end of 2012, we had a company in the KZN rural area that was bringing intranet solutions, intranet, not internet. We contacted them and said 'why don't you come to us and see if you can do something for a school like this?' This is where this project started (School Principal).*

The school already had some computers, iPads and smart boards. However, it is clear from the principal's statement that these facilities were not enough to allow teachers to provide learners with the maximum support they needed. It is in this regard that intranet system was implemented. In addition to an intranet, the school also installed WIFI hotsports in the classrooms for learners to connect. Today learners can connect to the school portal to download learning materials they need to enhance learning during and after school hours. This was strongly stressed in the deputy principal's comments when he was demonstrating how the school eLearning portal works:

"Whatever you see on the portal learners have access to them via their iPads. Whatever they want to download, they can download while they are at school" (Deputy Principal).

On the school portal there were different learning materials from different content providers such as MacMillan, Khan Academy, Siyavula and Mind Set.

4.2.1.2 Collaboration between the school leadership and the teaching staff

The analysis of data from the meeting proceedings revealed that the eLearning project became possible through collaboration between the school leadership and the teaching staff. Teachers shared in the school vision to integrate iPads. At the

beginning, the teaching staff was skeptical about the whole-school integration. They wanted the project to start on a small scale before it could be rolled out in the whole school. However, through collaboration and the ability of the leadership to convince teachers, the whole-school approach was accepted by teachers.

"Within a week or two weeks, we made a decision that the whole school is going into eLearning. People warned and I said 'first try and error'. They said 'just try with one Grade! I said, "Just try the whole school". We left the Matric out of it" (Principal).

The principal's comments show that the school leadership was determined to implement the whole-school integration. The integration started from Grade 8 to Grade 11 and then rolled out in the whole school in January 2013.

4.2.1.3 Learner and Parent involvement

Parents and learners played a very significant role in the integration of iPads in School A. The eLearning project was implemented after consensus with parents and learners: "We met parents, we met learners in a roll and we got the blessing from everyone involved to roll out iPads" (Principal). Through meetings with the school staff, parents and learners were convinced that integrating iPads could improve the quality of learning while at the same time improving access to education at reduced cost. After being convinced parents and learners endorsed the eLearning project. As it was said in the board meeting, parents are now reaping the benefits of the eLearning project "instead of paying R2 000 for textbooks and other materials, parents are now paying R300 a year for e-resources". In this regard, parents are saving R1 700, which is 85% of what they used to pay.

4.2.1.4 Moodle and Train Your Brain

In order to optimise the use of iPads and also to be able to create enriched learning experiences, the school introduced Moodle Learning Management System and Train Your Brain educational portal.

> *When we were in this whole system, we said 'there has to be more to an iPad with textbooks on it. It is as if you are replacing paper with electronic paper! What is the difference? How can we make an academic difference?' We wanted to test children daily. Therefore, we were looking for a learning management system where the teacher could work on (Principal).*

It is in this regard that Moodle Learning Management System was introduced. Teachers are using Moodle to create interactive lessons and to test learners on a daily basis. Before the lesson starts, learners take a five minute Moodle test. Moodle marks their work and gives them immediate feedback. The teacher is also able to see how learners responded to each question. Subsequently, the teacher is able to adjust the instruction to meet the learner's learning needs. Moodle also keeps records of these assessments so that the teacher can use them to make decisions on the learners' progress.

When explaining how Moodle is used for formative assessment, the principal and the deputy principal said respectively:

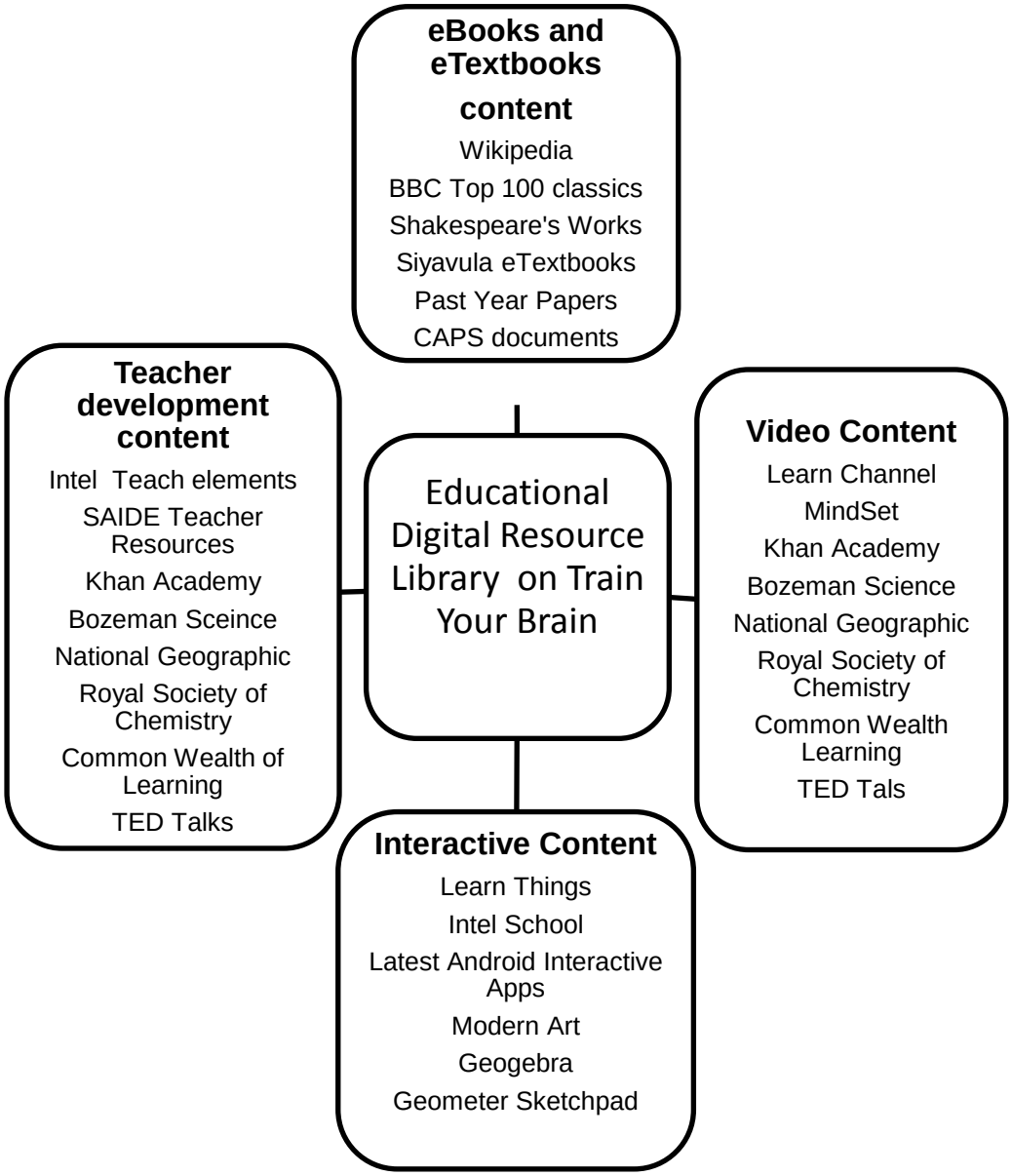
"When our kids go to class, they do five minutes tests, five questions. Moodle marks the test and gives the results. You quickly know what the children did not understand. Now there is a continuous assessment" (Principal).

> *As a teacher, you can actually see how much each child answered a question. You can see how many learners took the test, how long they spent on the test, and you can see which question they found difficult. So immediately, you can do the necessary intervention (Deputy Principal).*

It is clear from the principal and the deputy principal's comments that Moodle has been an effective tool to optimise the use of iPads. IPads have become integral part of the teaching and learning process for continous formative assessment in the school. They allow teachers to get enough information on the learners' progress and as a result they are able to adjust learning as it occurs.

In addition to Moodle, the school introduced TYB educational portal. The TYB is a host to a library resource. The library resource offers an array of ebooks, video tutorials, science experiments, educational games, past exam papers, marking memoranda on all subjects, and all the grades.The portal also brings together CAPS aligned eLearning content from Siyavula, and MacMillan. It provides a diverse range of educational resources from Mindset Learn, Wikipedia, School Net, Khan Academy, National Geographic, TED Talks, Massachusetts Institute of Technology and Royal Society of Chemistry. Figure 3 bellow illustrates the Educational Digital Resource Library on TYB.

Figure 4: Educational Digital Resource Library on Train Your Brain Portal



Adapted from http://www.mib-it.co.za/products/e-learning

Much has been done at School A to provide teachers and learners with technological resources for enhancing teaching and learning. The school is still implementing other innovative technologies as part of its ongoing process of improving the quality of teaching and learning. At the time of the field visit, three science classrooms were being refurbished to equip them with smart boards, Edu Board, smart TV, interactive tables and interactive walls. The school is also exploring the potential of these technologies to replace traditional paper-based-assessment with computer-based assessment.

> *The next step that we want to go to, learners will get homework via their iPads. Electronically, the teacher will give the homework. Learners will do the homework and submit electronically. The teacher will mark and submit the marks back to learners (Principal)*

4.2.2. Pedagogical integration of iPads in a Life Sciences classroom

This section focuses on the pedagogical integration of iPads in the Life Sciences classroom. The findings are grouped into seven broad themes: pedagogical use of iPads to enhance teaching and learning of Life Sciences, pedagogical shifts taking place because of integrating iPads, teacher planning and professional development, teacher and learner perceptions of the educational value of iPads, teacher and learner perceptions of challenges in integrating iPads. The section starts with presenting data on the profile of classroom teachers who participated in the study.

4.2.2.1 Profile of teacher participants

The table below presents data on teacher's qualifications, teaching experiences, the class, and the subject they teach, and the number of learners as recorded during lesson observation. The information on teachers' qualifications and teaching experience is relevant to this study, as these qualities might have affected the technological knowledge and pedagogical approaches used by classroom teachers to integrate iPads into their teaching. The information on the classroom size is also relevant to this study, as it might have influenced the mode of integrating iPads in the classroom.

Table 1: Profile of School A teacher participants

Teachers' names	Teacher 1A	Teacher 2A
Qualifications	Bachelor of Science in Botany, Zoology, Biochemistry, Physics and Politics	Bachelor of Education in Biology and Physical Education
Teaching experience	40 years	29 years
Classes in which lessons were observed	Grade 11 Grade 10	Grade 10
Number of students in class	28 26	36
Technological facilities in the classroom	Teacher's laptop, the projector, smart board, learners' iPads	Teacher's laptop, projector, smart board, Edu board, learners' iPads

4.2.2.2 Pedagogical use of iPads to enhance teaching and learning of Life Sciences

The analysis of teachers and learners' interview data revealed that iPads are integrated using BYOT mode of integration. IPads are used daily for readership, library research, accessing learning content on Moodle, highlighting the information pertaining to the learning objectives, continuous formative assessment and effective use of leisure time and visual learning.

4.2.2.2.1 Bring Your Own Technology Model

School A uses a BYOT mode of integration. It is compulsory for all learners to bring their own devices from home to use as a learning tool in the classroom. This is very crucial as all learning resources have been digitalised. There is not any physical library or hard-copy text books. As teacher 1A says: "We do not have a library because if we do, there are some people who are not going to go to the new, they

will keep the old – if there isn't a library, you will have to use the iPads." BYOD in this regard is a strategic approach to move all learners and teachers into eLearning.

When asked if they do not have hard-copy texbooks, Learner 1A 's response was as follows: "No, not at all, we just have textbooks for backup in case the iPads gets lost."

The BYOT approach was convenient in a Life Sciences classroom due to the big classroom size. As Teacher 2A says, "In a classroom where there are a lot of children, it is better if the child has his own technology." Teacher 2A feels that "having children share iPads might upset the learner's focus". She is also afraid that "iPads might drop down and break if learners have to move around to share the device".

As it was noticed during lesson observations, there were 36 Grade 10 learners in Teacher 2A's class. Learners sat in a traditional set up, and each learner was using his or her own device.

BYOT resulted in learners having different models of iPads for use in the Life Sciences classroom. Some learners have iPads Mini, others iPads2 and others iPads 3. Learner 5 A raised an issue that they do not get seamless learning experience due to having different iPad models. Some models of iPads are better, thus when learners do group work they choose the best iPad to use, other iPads are put aside.

4.2.2.2.2 Use of iPads for eReadership

IPads are used in a Life Sciences classroom for eReadership. Learners have all prescribed texbooks and other learning materials on iPads. When they move from class to class to change lessons, learners carry iPads and few notebooks for classroom activity. Learners feel that having the information in one place allows them to look up information with ease.

“Everything is much easier. You can access your textbooks much easier; it makes your bag lighter” (Learner3 A).

“I would say before it was difficult since most of information we had to go through internet at home at our own time. The information was not in one place but now that we have iPads, everything is in one place” (Learner 1 A).

4.2.3.2.3 Library research

In addition to having prescribed textbooks on iPads, learners use iPads to access the Resource Library on TYB portal. The Resource Library provides them with ebooks, video tutorials, 3D images, science experiments, interactive educational games and simulations. Learners feel that using the Resource Library has transformed the teaching and learning of Life Sciences. It makes Life Sciences lessons more interesting and easy to understand. Learner 2 A explained that “videos make learning more fun; we are able to download them so that we can use them to study on our own at home”. Learner 3 A affirms: “Using videos, we can understand more things now better than what we used to do when we were using actual textbooks.” And Learner 4 A said: “You can learn when the teacher is not even there.” It is very clear from the learner’s comments that they have been able to visualise Life Sciences phenomena more easily using iPads. They are also able to work independently.

The Resource Library provides learners with the educational support they need when they study at home. As the principal said, prior to the integration of iPads, learners did not have support for homework and assignments after school hours. In addition, they could not get help from their parents, as most parents are not educated enough to help for schoolwork. To date, as Teacher 1A says: “learners make sure that they download from the Resource Library, the resources they will need to do their homework and assignments before they leave the school.”

4.2.2.2.4 Use of iPads for Moodle learning

Life Sciences teachers communicate the information to learners using Moodle. They use Moodle to prepare lessons and learning content which integrate the multimedia. Then learners use their iPads to access these lessons. When asked about his experience of using iPads for Moodle learning, Teacher 1A emphasised that this integration has allowed him to organise and bring together all the teaching and learning materials he needs to teach:

> *Now that we are teaching using Moodle, everything we think we will need in a particular lesson, we link it to Moodle. Let us say there is a video from the portal site that you think you will need in a particular lesson, you just link everything so that when you are in the lesson you just click the link, and learners access them using their iPads (Teacher 1A).*

The analysis of the teacher's lesson plan also indicated that the teacher is able to organise the materials he needs to teach. In the lesson plan, the teacher had embedded a song to play as learners entered the classroom, a video that covered the previous topic, and a video to introduce the topic. After the lesson, he also provided enrichment activity, which integrated different videos and photos to visualise the functioning of the reproductive system.

4.2.2.2.5 Use of iPads to highlight important information

In the classroom, the teacher presents the lesson using the smart board. Learners have access to the same presentation using iPads. They just log on to Moodle to access the presentation. While presenting, the teacher indicates the most important information pertaining to learning objectives. Using their iPads, learners highlight and add sticky notes to the presentation for future reference. Learner 5 A says, "When the teacher says that the information is significant, we can highlight it, and then it makes it easy when we are studying." Thus, iPads help learners to focus on what is important when they are engaged in independent learning.

4.2.2.2.6 Use of iPads for continuous formative assessments

On a daily basis, Life Sciences teachers set automated five-minute Moodle tests to assess learning of the previous topic. Before the lesson starts, learners use their iPads to take the test. After five minutes, the test stops automatically. Moodle marks the work and gives the learner feedback. It also keeps a record on the learner's assessment. This ongoing assessment process allows the teacher to get continuous information on the learner's progress. The teacher can also use the Moodle record to do a statistical analysis of how learners have responded to each question. Subsequently, the teacher can adjust learning immediately before proceeding to the new topic.

"I am able to set questions, let us say today's lesson, the kid will do it tomorrow. I do not have to mark it; Moodle does the marking. Kids get the feedback and I have a record about the kid that I can show to the parents" (Teacher 1A)

"When our kids go to class, they do five minutes tests, five questions. Moodle marks it and then it gives the results. You quickly know what children did not understand. Now there is a continuous assessment" (Principal)

In addition, the following statement from Learner 1 A indicates that Moodle tests allow them to comprehend the content:

"We also do test on Moodle, which help us understand our work more. It also marks our work for us and asks questions based on certain sections in Life Sciences and it gives us the correct answers" (Learner 1).

4.2.2.2.7 Use of iPads to expand the time and space for learning

Using iPads encourages learners to spend their spare time on learning. Learners do not necessarily have to wait for the classroom to open so that they can take the Moodle test. As soon as they get to the school premises, they just connect to the school portal to take the test. Even after school hours, some learners remain in the school premises to complete their tasks and assignments before they go home. In this regard iPads are encouraging learners to have more time on task.

“After the time when the kids are still on the property, a lot of them are still doing their five minutes tests on Moodle or they are going over the work of the day” (Teacher 2A).

4.2.2.2.8 Use of iPads for visual learning experience

Life Sciences educational apps installed on iPads povide learners with visual experience of Life Sciences. The Interactive Anatomy 3D app for example, provides learners with visual and interactive content; this enhances learners’ understanding of the content. The app provides 3D images of the body systems. Using their fingers the learner touches the screen to select an organ on the system. As soon as the learner touches the organ, the name of the organ appears with additional information to describe the organ. The learner can then rotate the organ, turn it upside down, change the view back and forth, zoom in and out to study all the components of the organ.

Educational apps allow learners to view various organs of the body and to give them a better understanding of the relative size, placement and look of various organs. They also provide activities designed to support learners as they progress and master the task. The learner is asked to label an organ, and if he or she gets it right, can progress to the next level. Also as the learner progresses the task becomes more complex. Learner 1 A describes his experience of using the 3D Anatomy app;

> *You go through different levels and then they give you a figure of the human skeleton and they ask you to label all the bones. If you can label all the bones then you move to the next level. May be they will say label all the muscles. Then you carry on progressing until you label every single part of the human body. (Learner 1 A)*

It is clear from the learner’s comment that the app provides logical sequential steps to master the human anatomy. A learner who successfully completes all the levels will have a complete understanding of the human anatomy.

In one of the lessons I observed on the physiology of the circulation system, the teacher used simulation to show learners how the blood circulates in the body. Learners could see the organs involved in the blood circulation, their relative sizes, the colour and their location in relation to one another.

In another class, the teacher used a YouTube video to explain trophic levels. The video depicted impala grazing in the Kruger National Park. All of a sudden the lion came. As the impala was trying to escape the lion, it jumped into someone's car. It then passed through the car window to escape the lion. Using this video the teacher was able to bring a real life scenario into the classroom setting to explain the relationship existing between consumers and predators. Learner curiosity was also increased. Many learners asked questions on the topic after the teacher had played the video. Other learners asked the teacher to replay the video. This demonstrates how learners were interested to learn in such a simulated learning environment.

4.2.3 Pedagogical shifts

The analysis of data on the pedagogical shifts revealed that the integration of iPads provided teachers with quality multimedia to mediate the teaching and learning of Life Sciences. It has also brought about shifts from the teacher being the only source of information to providing learners with unlimited access to information. The integration of iPads has provided teachers with the opportunity to test higher-level learning. There has also been a shift from a teacher-centred to a learner-centred approach.

4.2.3.1 Access to quality multimedia

When asked to compare their teaching experiences before and after the integration of iPads, the two Life Sciences teachers conceded that the integration of iPads provided them with quality multimedia to mediate the teaching and learning of Life Sciences. Before the integration, it was not easy for the two teachers to get teaching aids, as they had to make them. In addition, the quality of the teaching aids they made was not of a quality to visualise Life Sciences phenomena.

Before the technology, we had to rely a lot on visual aids like board charts, or try to get samples of the organisms to use on our microscopes. So it was quite hands on, if we could get hold of the samples. Microscopes work was fine but board charts were not always of quality. (Teacher 2A)

Teacher 1A also emphasised that he is now able to get high quality multimedia, which he uses to mediate the teaching and learning of Life Sciences.

"Now we can use internet to find all the pictures we need. We can also scan. Unlike my transparencies that were black and white, I now scan to give learners the pictures in colours" (Teacher 1A)

It is clear from the teachers' comments that learning is now visual and more real; children can look at videos, and see for instance real footage of open-heart surgery.

4.2.3.2 The teacher is no longer the only source of information

Prior to the integration of iPads, learners relied completely on the teacher to provide all the information. Teacher 1A admits that it was a challenge for him to know everything learners needed to know. As a result, in some cases he could give them false information: "if the kid was to ask me a question that I don't know, I could give a rubbish answer or no answer. Now I say to the kid, go to Wikipedia and look for information." Teacher 1A has been relieved from having to know everything learners want to know and has been able to involve learners in their own learning.

4.2.3.3 Increased learners' involvement

The integration of iPads provided teachers with the opportunity to engage learners in the learning process. Teacher 1A said, "Before I did all the talking. Now I do not have to do all the talking. I am not the only source of information anymore. The kids have now all on the portal". In addition, as was noted during lesson observations, learners

ask many questions especially when virtual simulations are used to explain the lesson.

4.2.3.4 Opportunity for higher order thinking

Teacher 1A indicated that the integration of iPads provided him with the opportunity to develop learners' higher cognitive thinking. Learners have the information sitting on their iPads. Hence, teacher 1A does not just assess the reproduction of facts; instead, learners have to demonstrate higher levels of thinking.

> *The exams they write and tests are still old papers. Instead of learning all by heart, kids can go on internet and have all the information, and learn more. We can put higher-level questions because it is not memory that we are testing. Now we are testing understanding. (Teacher 1A)*

Higher order thinking in School A is also sharpened by cognitive engagement through social construction of knowledge and exchange of ideas. Learners have study groups after the school whereby they discuss the information taught in class. The study groups help learners to exchange ideas. In addition, learners do not merely ingest the information provided by the teacher, they critically compare and contrast it against the information they have on their tablets through TYB. By so doing, learners develop analytical and evaluative skills.

Having access to information from different content providers in different formats has become a better way to capture learners' interest and passion for learning. Unlike having one text-based reality, learners are learning from different contexts, thus boosting their imagination. Through critical engagement with content from a variety of sources, children establish their own theoretical and practical resources for enabling the development of critical literacy and thinking.

> *When we still had textbooks, we did not have a platform where we could be interactive. We had to depend on teachers to give us answers to the activities. With iPads you get different knowledge experience because you*

> *are not using one textbook, we have many resources on Train Your Brain you can go to. Therefore, we learn more* (Learner 1)

Moodle assessment and iPad applications are also contributing to the development of higher order thinking skills. Learners have a Moodle test every morning they get to school; they spend time learning in order to prepare them for the test. Just after completing the Moodle test, learners get immediate feedback so that they can reflect on their learning. Learners also have on their IPads some applications that are designed for practice. For example, the learner labels the human skeleton or answers general knowledge questions the iPad application provides.

4.2.4 Teacher planning and technological professional development

The analysis of the responses on the technological pedagogical content knowledge indicated that the technological training was a prerequisite for the two teachers to be able to integrate iPads into the Life Sciences classroom.

"Remember I come from the era, the generation of chalkboard, stencils, so I had to be taught and I am still learning today" (Teacher 1A).

"As educators we had to learn how to use the technology, we had to learn how to use the projectors and smart boards that the school had purchased. Therefore, it took a lot of training" (Teacher 2A)

It is clear from the teachers' comments that technological training was necessary to equip them with relevant technological knowledge. However, not only the technological knowledge but also the pedagogical content knowledge was necessary. Teachers needed to know educational apps that are on the learner's iPad and how to use them to enhance learning of Life Sciences. They had to be able to personalise lesson electronic lesson plans from the Department of Education to suit their learners' needs.

> *As educators, we had to know what is available on the children's iPads. We also had to know what is available on Train you brain and Moodle, so you*

can guide them to go to certain apps, to practice whatever they have learned, or to go to some interactive game on the topic (Teacher 2A).

Before we used to do our lessons plans but now the Department of Education provides them. Obviously, their lesson plans do not incorporate these technologies. What I do, I take my previous notes, my textbook and then I make my own notes on the smart board, which is a combination of all the best from our previous sources. Sometimes it can take the whole week if I want to do it seriously (Teacher 1A).

4.2.5 Teachers' perceptions of educational benefits of iPads

As mentioned earlier teachers view the iPad as an important educational tool to enhance teaching and learning of Life Sciences. It has provided them with quality multimedia to mediate the teaching and learning of Life Sciences. It has also provided them with the opportunity to test learners on a daily basis. Available Life Sciences apps on the iPads help explain the content to learners in more detail. IPads enabled them to engage learners in the learning process. They have also allowed teachers to test learners' higher-level learning.

4.2.6 Learners' perceptions of educational benefits of iPads

The analysis of data on the educational benefits of iPads indicated that learners see the iPad as a beneficial educational tool. IPads provide access to multimedia resources, subsequently, making Life Sciences lessons more interesting. IPads provide timely access to information. Learners also use iPads for interactive independent learning to practice the knowledge.

4.2.6.1 Access to multimedia resources

All learners appreciated the affordances of iPads to make Life Sciences lessons interesting. Prior to the integration of iPads, as learners said, the teacher's presentations were not rich in multimedia. Now that they are using pictures, videos and interactive activities, lessons have become interesting. The following were some of the learners' comments:

"Without technology, we could not watch videos; we could not have a clear understanding of the lessons" (Learner 2 A)

“Before, it was quite boring. IPads make school fun” (Learner 1 A)

“The presentations of the teacher were not fun. There were not a lot of pictures or videos” (Learner 4 A)

> *For me I think they gave me practical experience. When we still had textbooks, we did not have a platform where we could interact. With iPads you get different knowledge experiences because you are not using one textbook, we have many interactive resources to use (Learner 3 A)*

4.2.6.2 Easy access to information

Learners use iPads for timely access to information and as a result, they are able to work independently.

“Yes, iPads are very beneficial. If you have downloaded a textbook, it sits on your iPad. Therefore, you can use it even after school” (Learner 5 A).

“You have access to multiple sources of information. If we were using hard copy textbooks, we would not get access to all the information we need” (Learner 2 A).

4.2.6.3 Independent learning

Learners indicated that they use iPads for independent learning:

“There are videos that you can download on your iPad and watch them at home and at the end of each video, there are activities you can do for yourself” (Learner 1 A)

“It is more fun to learn. You can now download a bunch of videos so you can learn when the teacher is not even there” (Learner 6 A).

4.2.7 Teachers’ perceptions of challenges faced

The analysis of teachers’ responses relating to the challenges of integrating iPads into their pedagogies sheds light on the technological knowledge constraints, WIFI connection and power failure, lack of Moodle technical support, learners coming to school without their iPads, and theft.

4.2.7.1 Technological knowledge

Teacher 1A indicated that the biggest challenge is to know how to use technology to teach Life Sciences. He asserted that he received some technological training, yet he did not gain much from it due to limited prior technological experience.
Teacher 1A has 40 years of teaching experience and in his time digital technologies were not used for teaching and learning.

"We did receive the training. However, you know training for someone of my age you see it, you hear it, but you still need to try it yourself" (Teacher 1A).
Teacher 1A added:
"Remember I come from the era, the generation of chalkboard and stencils. Sometimes, when people are speaking, I do not know what they are talking about" (Teacher 1A).

It is clear from Teacher 1A's comment that the technological knowledge poses challenges for iPads' integration. To overcome the technological challenges Teacher 1A asks his learners for assistance.

"If I do not know, I just call up a kid and then he will help me. I have found that kids get excited if they find they know something that I the teacher did not know" (Teacher 1A).
Teacher 2A, who has 29 years of teaching experience, feels that the training she received gave her expertise to integrate the technology into her classroom.

> *We have educators that are well advanced in the technology, so they trained us on skills we needed to be able to do what we needed to do. Then we had outside presenters from different companies like Train Your Brain MIB. We also had people that sell the smart boards; they have come and trained the staff as well. Therefore, we have expertise in the products that we use (Teacher 2A).*

Teacher 2A also shared that it required time and courage to gain the technological expertise she has. In addition, Teacher 2A believes that the real technological

expertise came when she started matching the technological affordances to specific teaching and learning events.

"It took a lot of training, and you had to get over your fear of technology, but once you start finding out what you want to use it for, it gets easier" (Teacher 2A)

Teacher 2A confirmed that she has relevant technological knowledge to integrate iPads into her pedagogies. However, Learner 2 A pointed out that her teacher [Teacher 2A] is struggling to use the technology available in the class.

"Everyone knows what we are doing. It is only the teacher who is a little bit lost on what is going on; us learners, technology is not a problem" (Learner 2 A)

4.2.7.2 Power failure

Power failure occurs in the data collected as the biggest challenge disrupting the integration of iPads. When there is no power, teachers cannot access the school's eLearning portal for teaching and learning resources.

"To me the biggest challenge is the power failure. When we have power failure, I am able to stand on my feet and teach. I have seen younger teachers if they do not have the technology, they do not know how to carry on without it" (Teacher 1A).

"We often get power failure. Therefore, we have to have plan B. Plan B is sort of going back to the old way. We still have our resource files; we still have our worksheets, so we can still teach with chalkboard or use our models" (Teacher 2A).

4.2.7.3 WIFI connection

WIFI plays a major role in eLearning. When the school is offline, it is as disrupting as power failure. If there is no WIFI, learners cannot connect to the school Moodle to access the learning materials. As Teacher, 1A says "the whole period can be wasted the kids trying to connect on the WIFI." To avoid wasting the whole period, Teacher1A gives learners 10 minutes to try to connect, after 10 minutes of unsuccessful trial, he goes back to use the chalk and board.

4.2.7.4 Learners come to school without their iPads

The two teachers mentioned that some learners do not bring their iPads when they come to school. “Some learners leave their iPads at home or they do not fully charge them before they get at school” (Teacher 2A). For Teacher 1A, “it is like a learner has come to school without a textbook”. Teachers recommend that learners become more responsible as it frustrates the teaching process if they come to school without their iPads or if iPads are half charged.

4.2.7.5 Lack of Moodle Support

The two teachers are concerned that they do not have someone to fall back on when they have Moodle problems.

“The biggest challenge we have is Moodle. It seems to have limited capacity. Because we put these videos there, often the connection is steamily slow” (Teacher 2A)
“Moodle is a free source, when you buy a product you have support from the company. Moodle is free; there is no person you can go to for support” (Teacher 1A)

It was noticed during lesson observations that some of the videos uploaded on Moodle were loading very slowly when learners wanted to use them in the lesson.

4.2.7.6 Theft

Teacher 1A is afraid of possible theft. The community expects learners to be carrying iPads when they go to school and when they come from school, thus, the learners’ security is at stake.

“There can be theft, as the whole community knows that every child coming here has an iPad in his/her bag” (Teacher 1A).

4.2.8 Learners’ perceptions of challenges faced

The analysis of data relating to learners’ perceived challenges of using iPads for learning sheds lights on distractions due to social networks and games available on their iPads, iPads’ low battery life and WIFI connection.

4.2.8.1 Distraction

The majority of learners admitted to playing games in class even when the teacher is presenting. The following were some of their comments:

"When you do not feel like working in the class, you just switch off the textbook then you go to games" (Learner 4 A).

"Sometimes if you do not have work to do, you just play games" (Learner 2).

"It is easy to get distracted but you have to teach yourself how to control yourself" (Learner 2 A).

Some learners even went further to suggest that games should be deleted from their iPads in order that they might focus more in class:

"I think they should delete the games from our iPads" (Learner 4 A).

"They should not allow games on iPads because it distracts us, instead of working; we just play games" (Learner 6 A).

While the majority of learners find games to be distracting, Learner 1A and Learner 3A believe that the distraction is not caused by games; instead, learners do not discipline themselves.

"I think it is about the discipline of the learners. If you are there to learn, you have to learn even if you have games on your iPads" (Learner 1 A).

"Some learners have games on their iPads but they focus on their schoolwork. It is as if games are not a distraction to them. It depends on the learner" (Learner 3 A).

It is clear from learners' comments that iPads can be tools for attention distraction if learners do not used them responsibly and if the teacher does not monitor their learners when they use iPads in the classroom.

4.2.8.2 Low battery life

The majority of the learners raised concerns about battery life for their iPads: “The battery goes flat after a while” (Learners 1 A, 2 A, 3 A, and 5 A). It was also noticed during lesson observations that learners were asking permission to charge their iPads. Some learners could not charge because there were not enough sockets in the class to plug in.

4.2.8.3 WIFI connection

Learners have concerns about the school WIFI connection. The connection is almost always very slow. The signal is also unequally distributed. It is stronger in some classrooms and weaker in others. When the connection is weak, learners cannot access the school Moodle to do their tests or download resources.

The only challenge is the connection. It is very slow. Sometimes when we have to do our tests, it gets very slow.to load. It takes our period time (Learner 5 A)
In some classes, it is very difficult to connect. In other classes, the signal is stronger (Learner 3 A).

4.3 Analysis of data from School B

4.3.1 The context of using iPads in school B

School B is an independent school in Johannesburg catering for learners from Grade R to Grade 10. The school has about 900 learners coming from privileged families in the country and outside the country. The school has boarding facilities to cater for learners who come from far. Few learners walk to school. The rest of the learners are transported with the school buses. The average teacher-learner ratio for all the grades is 1:12.

School B introduced iPads in 2012. The school has 60 iPads kept in the administration office and managed using a booking system. When the teacher wants to teach with iPads, she collects the devices from the administrator and returns them after the lesson period. The majority of learners have also their own iPads they use for eBooks. The rest of learners are still using hard-copy textbooks.

In addition to iPads, the school has five computer centres available for learners' use. There are WIFI hotspots around the school, which learners use to connect to the internet. There are also projectors in the classrooms, which teachers use to present lessons. Table 2 that follows indicates the profile of School B Life Sciences teachers who participated in this study.

Table 2: Profile of School B teacher participants

Teachers' names	**Teacher 1B**	**Teacher 2B**	**Teacher 3B**
Qualifications	Bachelor of Science in Botany, Zoology,	Bachelor of Science in Pharmacy	Bachelor of Science in Statistics and Biochemistry
Teaching experience	18 years	19 years	10 years
Classes in which lessons were observed	Grade 10, 11 and 12	N/A	N/A
Number of students in class	16, 15 and 11	N/A	N/A
Technological facilities in the classroom	Teacher's laptop, the projector, a desktop computer, and iPads	N/A	N/A

4.3.2 Pedagogical use of iPads to enhance the teaching and learning of Life Sciences

The analysis of teachers and learners' interviews revealed that Life Sciences teachers do not use iPads on a daily basis. They use them only when there are relevant apps on the topic or when learners have a research project.

4.3.2.1 The use of the Devolve Me app

Teacher 1B uses the Devolve Me app to teach evolution. Using this app, she is able to give learners a practical experience of what they would have looked like at different evolutionary stages. Learners upload a photo of themselves in the app.

They choose any point in the evolutionary timeline to see how they would have looked like 500 000 years ago, 1 500 000 years ago and 2 900 000 years ago. As teacher 1B said when learners used this app, she heard them screaming out of excitement: “Oh my word! Is this how I am looking?” At the end of the experience, learners printed their photos in which they resembled Australopithecus afarensis, Homo habilis, Homo erectus, and Homo heidelbergensis. They shared the photos with their friends.

4.3.2.2 The use of Build-a-Body app

Build-a-Body is an educational game Teacher 1B uses to teach human anatomy and the human physiology. The learner is given organs in the organ tray. The learner chooses organs from the organ tray and places them in their correct position within the body to make an organ system. Once all systems are completed, the learner assembles them to make a complete body. A learner who masters the app has a complete understanding of human anatomy and human physiology.

4.3.2.3 The use of Visual Anatomy app

The visual anatomy app is an interactive Life Sciences educational app containing the body anatomy systems. The app has a rotational organ 3D overview, which allows the learner to view all the properties of the organ. The learner selects an organ using his finger. As soon as the learner touches the organ, the organ’s label appears with additional information to describe the organ. The app has also a search function allowing learners to make a quick search of the organs. In addition, the app contains tests and quizzes to test the learners’ understanding of the human anatomy.

4.3.2.4 The use of Genetic and Meiosis app

Genetic and Meiosis app provides fun interactive games and activities on the process of cell division. Using the app, Teacher 1B was able to transform teaching and learning of the cell division. Learners were passive and could not understand the cell division when Teacher 1B used her traditional teaching approach. However, when she used the Genetic and Meiosis app, learners became more engaged in the lesson. Subsequently, learners easily understood the process of the cell division.

These kids were passive for an hour, I am sure they found me incredibly boring. Then using the genetics and meiosis app, they could literally move the chromosomes apart. They could put them to prophase, anaphase, metaphase and telophase while answering questions. Best part of it, it marked them and I could record the marks (Teacher 1B).

It is clear from Teacher 1B's comment, that the Genetics and Anatomy app aroused the learners' motivation to learn while providing them with hands-on experience to enhance their understanding of cell division. Learners' responses on their experiences of using the Genetic and Anatomy app also affirm that they learned a lot from it. The following were some of the learners' comments to describe their experiences of using the app:

"First, they give you information on meiosis. It then goes deep into the details. They give you some questions that you have to answer based on that information" (Learner 3B).

"It is a game and at the same time, it gives information on meiosis and cell division. It gives you the information and the questions you have to answer. When the score is low, you try up until you get a high score, which means you are learning" (Learner 9B).

4.3.2.5 The use of Protein Synthesis app

Teacher 1B explained that the Protein Synthesis app exactly shows learners how the DNA unwires and how the messenger RNA forms. It provides learners with interactive and engaging activities to pair the basis in nucleic acids. It then provides tests and quizzes learners take to demonstrate their understanding of protein synthesis.

4.3.2.7 The use of iPads for research

All learners have indicated that they use iPads for research. When there is research, the teacher provides them with the school iPads. Learners also use their own iPads for further research on the information taught in the class. By so doing, learning is enhanced.

4.3.3 Pedagogical shifts

There have been pedagogical shifts due to the integration iPads including a move towards learner-centred teaching approach, social construction of knowledge, and small group instruction.

4.3.3.1 Learner-centred teaching approach

Teacher 1B mentioned that her pedagogy “absolutely changes” whenever she uses iPads in her teaching. Learners do most of the work when she uses iPads. Educational apps such Build-a-Body and Anatomy app have systematic interactive content and activities, which allow learners to learn on their own pace. In addition, the app has tests and quizzes to test the learners’ understanding of the content. Teacher 1B uses these apps to encourage learners’ independent learning. As Teacher 1B said, she just introduces the topic, and then she gives learners iPads in order to use the apps for deep learning.

Teacher 1B uses interactive Life Sciences educational games installed on iPads to provide learners with an enriched learning experience. Using these apps, learners learn while having fun. Each game has a series of tasks that learners do to win the game. The learner is compelled to understand the content in order to complete the all the tasks.

The analysis of a learner’s research project entitled “does circumcision reduce transmission of HIV/Aids” revealed that a learner was able to work independently with minimal guidance from the teacher. The learner had consulted six internet resources for the literature review. She got one hundred adult males in her community to fill the questionnaires on whether they were circumcised. The learner had also consulted the Community Clinic database for demographic information on male circumcision. The learner had written an 11-page report, which she emailed the teacher for feedback. The iPad enabled the learner to produce a work of this calibre.

4.3.3.2 Social construction of knowledge

Teacher 1B reported her learners use iPads for collaboration. If there is an experiment to be done for example, Teacher 1B asks learners to go on internet to

look for information on how to do such an experiment. Using that information, learners work together to complete the experiment.

"Kids got the information on how the experiment was to look like. While they were doing the experiment, they filmed it. They created a video, and uploaded it on YouTube so that kids who do not have access to a lab will be able to see the video" (Teacher 1B).

The four lessons observed in Teacher 1B's class, revealed that learners learned in a social learning environment. In the first lesson, Teacher 1B gave Grade 10 learners a five-minute test to match the glands with their secretions. After five minutes, the teacher asked learners to exchange papers so that they could mark each other's work. When the corrections were completed Teacher 1B asked learners to use iPads to look for information on the structure of the kidney. She divided the class into two debate groups. One group had to argue why they would donate their kidneys. The other group had to argue against kidney donation. As learners were using iPads to search for scientific facts, they were moving around to share the information they had found. In the debate, learners' involvement increased, as each learner wanted his or her view to be heard.

In the second lesson, the teacher asked Grade 10 learners to search for information on embryogenesis. Learners were to explain how the baby develops from conception to birth. As learners searched for the information, they moved around to share the information they had found. After 20 minutes, the teacher explained the embryogenesis process. Learners supplemented the teacher's explanation with the information they had found.

In the third and fourth lessons learners debated for and against abortion. Based on their positions in the debate, learners can be categorised as pro-life proponents or pro-choice proponents. Pro-life proponents argued that the foetus in the mother's womb is a human being and thus aborting it is murder, as it involves taking a life. Pro-choice proponents argued that women should have the right to decide what to do with their pregnancies.

It was clear from the lesson observations that the teacher provided learners with an environment conducive to social construction of knowledge. The analysis of two teachers' lesson plans on animal classification also indicated that Teacher 1B emphasises the social construction of knowledge. In the lesson plan, the teacher had planned that learners would work in groups of three each to research the information on animal classification. The groups would then draw mind maps, one mind map for each group, to summarise the information collected on animal classification.

4.3.3.3 Small-group instruction

The integration of the iPad allows teachers to have groups of learners work on different tasks within a lesson period. In two of the lessons, Teacher 1B divided the class into two groups, each group having a different task. The two groups sat in two different rows so that the teacher could monitor them. The first group had four learners who had a Life Sciences research project to work on. The second group had six learners who did not have a Life Sciences research project but chose to do the research project on other subjects. This group searched the information to use when writing an essay on the pros and cons of abortion.

While the latter group researched the information, Teacher 1B gave the first group feedback on their research projects. Learners used iPads to email the teacher their research project. Teacher 1B downloaded the project on her laptop in order to add feedback. After discussing the feedback with the learner, Teacher 1B emailed the project back to the learner so that the learner could make the necessary adjustments.

4.3.4 Teachers' perceptions of benefits of the iPad

The three Life Sciences teachers were very optimistic on the potential of the iPad to enhance teaching and learning of Life Sciences. Teacher 1B reported that it was very difficult for her to teach the topic of evolution, and hence, difficult for learners to comprehend it. However, when she used 3D simulations and the Devolve Me app, learners' understanding of evolution increased significantly. The following is how she described her experience:

It was so difficult to convince kids about evolution. They got convinced when I used the iPad to show them how the continents drifted. Using Devolve Me app, they also took a photograph of themselves and they looked at themselves about five hundred million years ago, five thousand million and 1.6 million years ago. (Teacher 1B)

Teacher 1B also reported that using the iPad app she was able to make the teaching and learning of exclusion more interesting. She believes exclusion was "a *boring topic to teach"* before the integration of iPads.

"For 18 years, I have been teaching exclusion! It gets boring to teach things the same now and then. Now it is so nice because I know I can find something new. Every year there is something new. Every year you can reach learners in different ways" (Teacher 1B)

Teacher 2B does not integrate iPads in his teaching. Yet he allows learners to use own iPads in the class. Teacher 2B asks learners to do a preliminary research on the topic a day before he introduces the topic, Teacher 2B believes that it makes learners think out of the box and helps them expand their horizons when he provides them with the opportunity to use their iPads to explore the topic. Consequently, it becomes much easier for Teacher 1B to teach the topic when learners have prior knowledge on the topic.

4.3.5 Learners' perceptions of benefits of the iPad

The analysis of the learners' responses on the educational benefits of the iPads indicates that iPads have a positive impact on student's engagement and enhance learners' learning. The iPad apps help them to learn the course content more than when they are involved in activities that do not involve the iPad. IPads provide them with timely and ease of access to information, practical and visual learning experience, and increased motivation to learn.

4.3.5.1 Timely and easy access to information

Students appreciated the use of iPads for research and assignments. Using the iPad, they get access to multiple online resources they need to complete their research and assignments. Apps installed on iPads also provide them with timely access to the course content. When they have forgotten something, they are able to go back to the iPad app to refresh their minds.

"IPads provide us with easy access to information. If you need to clarify something, you go directly to the internet and get your answer" (Learner 2B).

"Apps are very useful to access the information on the topic and you can always go back to them if you forget about topic" (Learner 5B).

4.3.5.2 Practical and visual learning experience

Learners reported that iPads provide them with practical and visual experience to learn Life Sciences. As a result, their level of learning and retention is enhanced. The following were some of their responses:

"When you use a textbook, you do not really see what is happening in the bloodstream. However, with the iPad you are able to visualise the endocrine system. You are able to see what is happening in the blood stream" (Learner 1B).

"The iPad explains much clearly than our textbooks and the teacher's explanation - You are able to see how chromosomes and genes look like" (Learner 6B).

"It helps you learn and remember the information for longer because learning through a game is more fun and practical" (Learner 9 B).

"The iPad gives you practical experience. We have for example Build Your Body app, which allows you to construct the organs of the body. You put the lungs, the brain, the spine and all the organs in their right positions" (Learner 4B)

Learner 8B still remembers her experience of using the app to learn the cell division:

"Once we were learning about meiosis, cells, and chromosome, we paired the chromosomes with our hands on the screen" (Learner 8B).

4.3.5.3 More convenient, lighter and helps organise the information

Some learners reported that they like the iPad because it is easy to use and more convenient to carry. It also allows organising the subject materials.

"It is lighter, so it is more convenient to use and when you have to carry it around. It is also nice to have all your books on one gadget" (Learner 1B).

4.3.6 Teachers' training and professional development

The two teachers mentioned that they have received a lot of training to prepare them to integrate the iPad into their classrooms. However, the training was not effective. Teachers were at different technological levels, yet they received the same training. Teachers who were advanced found the training irrelevant to them. Also after the training, teachers did not get the opportunity to practice what they learnt, as they did not have their own iPad.

For Teacher 1B the training was not relevant to her:

"Many people came to us to do things. I did not pay too much attention to them. They showed us things like pages, how to draw graphs, and I suppose I could do that. If something is not interesting, it does not bother me at all" (Teacher 1B).

Teacher 1B added that she developed the technological knowledge when she had her own iPad to explore

"The best thing for me was to buy myself an iPad and use it. It is much better if you find out by yourself. If someone stands in front you for an hour, you fall asleep" (Teacher 1B)

Teacher 3B felt that the training was partially effective because she did not have any prior knowledge of the iPad. However, she admits that she did not use what she learned in the training, as she did not have her own iPad to practise.

"To me the training was partially effective. It was my first time to use the Pad and I understood some of the things to an extent that I can use them in the class. However, not everything I learned I remember or I have used it. I do not have my own iPad" (Teacher 3B).

Teacher 2B has not yet received any training to integrate iPads. As a result, he does not integrate them in his teaching due to lack of relevant knowledge.

4.3.7 Teachers' perceptions of the challenges faced.

The analysis of the teachers' responses on their perceptions of challenges of integrating iPads into their pedagogies sheds light on the following perceived challenges: lack of relevant apps, lack of relevant knowledge, WIFI connection, lack of time and not being in possession of own iPad.

4.3.7.1 Lack of relevant apps on the subject

The two teachers who are integrating iPads into their pedagogies reported that they do not use them regularly due to lack of relevant apps on the subject.

"You know what; you cannot just use iPads for iPad's sake. There has to be apps that are relevant to the topic. If you do not have apps, it is irrelevant to use iPads" (Teacher 1B)
"I have to have specific app, which is specific to the topic. Then if I find that app, I will integrate it" (Teacher 3B).

Learners' responses concur with the teachers' responses that iPads are used only when they have relevant apps on the topic and when they have research to do. The following were some of the learners' responses:

"We use iPads when there is research to do or when there is an app on the iPad that we all need to use to answer the questions" (Learner 3B).

“In my school, we really do not use iPads that much but some learners have their own iPads” (Learner 1B).

During the lesson observations, learners used iPads for internet research, as there were no relevant apps on the topic of embryogenesis and excretion. Teacher 1B asked learners to use iPads to search for information on these topics. She then used PowerPoint slides to explain these topics.

Not only the lack of relevant apps but also the use of free educational apps constrain teaching and learning with iPads. When exploring the teacher’s iPads, I realised that some of the free educational apps installed on her iPad required in-app purchases to be able to use all the features. The anatomy app for example gives the information to introduce the body organs. However, if you want to explore further, it requires you to purchase the app so that all features can be unlocked.

4.3.7.2 Inflexible curriculum

Not only lack of relevant apps constrains Teacher 1B from using iPads on a daily basis. She also worries that she might not be able to prepare learners for the exam if she uses iPads daily.

“You know, if we are chasing about test and exams it is usually like once a month that we use iPads …. This is terrible...” (Teacher 1B).

4.3.7.3 Lack of relevant technological knowledge

While teachers 1B and 3B are constrained by lack of relevant apps and the curriculum, Teacher 2B is constrained by lack of relevant knowledge to implement iPads in his teaching.

“I am actually very new in the school; I do not know the procedures yet. That is why I ask you if you can enlighten me on that. I will appreciate it if you can” (Teacher 2B).

Instead of using iPads, Teacher 2B uses YouTube videos to enhance learners’ understanding of Life Sciences.

“What I always do, I just download the video from YouTube videos. I choose lecturers who have expertise and strong understanding of the concepts and then I project the lecture” (Teacher 2B).

It is very clear that mere access to iPads does not translate into use of iPads. IPads are available in the school but Teacher 2B cannot use them in his teaching due to lack of relevant knowledge to use the devices in meaningful ways.

4.3.7.4 Lack of time

Teachers indicated that they do not get time to search for available apps on the subject they teach.

“If there is an app, there is no problem. Nevertheless, I do not have the time to search, to download an app” (Teacher 3B).

4.3.7.5 Not having own iPad

Teacher 3B mentioned that she would have much more time to search and explore subject-specific apps if she had her own iPad. She said that it is frustrating to borrow the school iPad to search available apps on the subject.

Teacher 1B had to buy her own iPad so that she could have time to explore it. Not having their own iPads therefore constrains teachers in the use of the iPad in the Life Sciences class.

4.3.7.6 Learners’ distraction

The three teachers admitted that iPads distract learners if they are not well controlled. To minimise the distraction, Teacher 1B had set a rule that, “learners can use their iPads only for learning the subject”. If a learner uses an iPad for Facebook, or for taking pictures instead of using the device for learning, Teacher 1B takes the iPad away.

Teacher 3B also makes sure she moves around when learners are using iPads to minimise learners’ distractions.

“This technology is a blessing but it also has its own disadvantages. When I am teaching I walk around to see if the learners are concentrating. If I find a learner checking something on the iPad, I just ask him or her to put it away” (Teacher 3B).

As it was noticed during the lesson observations, learners get distracted easily when they are provided with iPads. Some learners were observed using iPads to take photos of themselves in the lesson. Others were on Facebook instead of using the devices to research scientific facts on the pros and cons of abortion. The following are some of the learners’ comments to describe how iPads are distractors:

“I believe iPad causes distractions. Many times in the classroom, I feel I should play games I have on the iPad” (Learner 1B).

“There are so many distractions when you are using the iPad. Sometimes the teacher does not even see that you are not doing your work. That is a big problem...” (Learner 2B)

4.3.7.7 WIFI connection

The WIFI connection is the biggest challenge disrupting the integration of iPads. Teachers reported that most of the time the internet connection is very slow. Hence, the time for learning is wasted trying to connect the devices on internet.

“Internet is very slow and very annoying” (Teacher 1B).

“Sometimes when I am searching for the apps, the connection is slow or I am blocked from those sites” (Teacher 3B).

Teacher 1B also mentioned that iPads are not always charged when she collects them from the office. It completely frustrated the learning process if they are not charged.

4.4 Summary of the findings

The first finding is that iPads were used as multifunctional instructional tools to enhance teaching and learning of Life Sciences. In School A, iPads are used to

access the course platform. Learners use iPads on a daily basis for Moodle learning, library research, continuous assessment and for accessing eBooks and multimedia learning resources. In School B, iPads are used mostly for educational apps and internet research.

There have been significant pedagogical shifts due to using iPads for teaching and learning Life Sciences. Teachers are relying less on teacher-centred models of instruction. They are using learning activities, which foster learners' active involvement and independent learning, promoting what some theorists call kinaesthetic or tactile learning – a learning style in which learning takes place by students carrying out physical activity, rather than listening to lectures or watching demonstrations. They are providing learners with opportunities for hands-on experiences. They are planning and delivering learning tasks, which foster learners to explore the subject content through group engagement and individually, during class and independently at home. They are also testing learners' higher level learning rather than the mere reproduction of facts. Teachers reported that learners' motivation and engagement in the learning process increased significantly due to using iPads for teaching and learning.

In School B, there has been a shift from whole-class instruction to small-group learning. Small-group learning is enabled by a small class size. Learners can easily move to share the information without disrupting the learning process. In School A on the other hand, whole-class instruction is used because of the big class size. Life Sciences teachers are afraid that providing learners with the opportunity for collaboration might disrupt the whole learning process.

Teachers expressed their beliefs that the integration of iPad affected teaching positively. It provided teachers with quality multimedia to enhance teaching and learning of Life Sciences. It also enabled teachers to teach topics, which were previously difficult to teach. However, some teachers expressed that they were not adequately trained to integrate the devices into their pedagogies. The professional training focused on basic skills of how to operate the device. The training was not subject specific; they all received the same training regardless of the subject they

taught. Teachers also reported that they are constrained by lack of time and relevant apps on the subject to integrate the devices effectively.

Learners reported that iPads affected them positively, in particular, the reduction in weight of the school bag, easy access to interactive multimedia resources and the ability to use the device for independent learning. However, learners reported that they are easily tempted to play games or go to social networks when using the devices in the classroom. They reported that the WIFI connection constrains effective use of iPads. School A in particular is fully eLearning. Thus, when the connection is slow learners cannot access the school portal for learning materials.

CHAPTER 5: DISCUSSION OF THE FINDINGS

5.1 Introduction

The purpose of this study was to explore the pedagogical use of iPads through the experience of Life Sciences teachers and learners. The study sought to examine pedagogical approaches that teachers are using to integrate iPads in their classrooms and the pedagogical shifts that are taking place because of using this technology in the classroom. The study also sought to determine the educational benefits of using this technology and the challenges teachers and learners face.

While the previous chapter gave an analytic presentation of the findings in an effort to expose the phenomenon as experienced by participants, this chapter distils salient conclusions from the findings reported in the preceding chapter. The discussion of the findings takes into account the context in which the school participants operate. School B is a private school with learners coming from privileged families, while school A is a public school with learners coming from disadvantaged families. The average teacher-learner ratio is 1:35 in School A, while it is 1:12 in School B. In this regard, the discussion of the findings will not seek to compare the use of iPads in the two schools or seek to generalise the findings to a broader context as the findings of the study might be unique to the studied schools. The discussion is organised around the following research questions:

1. How do teachers and learners use iPads to support the teaching and learning of Life Sciences?
2. What pedagogical shifts if any take place when iPads are used for the teaching and learning of Life Sciences ?
3. What are teacher and learner perceptions of the educational benefits and challenges of using iPads in a Life Sciences classroom?

5.2 The pedagogical use of iPad to enhance the teaching and learning of Life Sciences

How do teachers and learners use iPad to support the teaching and learning of Life Sciences?

The findings of this study are in keeping with the findings of many other studies that conducted in this field. Deaton, Ivankovic & Norris (2013) thoroughly explored the integration of the iPad in enhancing teaching and learning of Biology. From their study, the authors concluded that the iPad was used as a multifunctional instructional tool to enhance the teaching and learning of Biology. The device provided teachers with multimedia and interactive tools for demonstrating and illustrating processes in Biology. The device provided lecturers and students with timely and flexible access to course information. Students used educational apps for a deeper understanding of the course content. Likewise, the study by Alyahya & Gall (2012) on how graduate students were using iPads at the University of Northern Colorado reported six iPad affordances: access to writen materials; access to internet resources and services; note taking; organising the subject materials; presentation; and as a tool for preparing assignments.

This study also found that Life Sciences teachers and learners in the two schools are using iPads to support a diverse range of learning experiences. They are using iPads to facilitate whole-class instruction, individual and small-group instruction. They are also using iPads for demonstration, presentation, internet research, readership, accessing the courseware, accessing the digital library, and for continuous formative assessments.

In School A in particular, Life Sciences teachers and learners use iPads as fundamental educational tools for all aspects of e-Education as stipulated in the White Paper on e-Education (DoE, 2004). On a daily basis, iPads connect teachers and learners to each other and to information. They allow teachers and learners to access the Moodle platform for teaching and learning content, assessment and communication. Learners also use iPads to access the Train Your Brain educational portal. Train Your Brain has an array of downloadable resources to enhance teaching and learning of Life Sciences. These resources are in different formats like audio, video and text-based for learners to choose their preferred formats. Teacher participants felt that these resources align with the current CAPS documents and offer better information than previously used textbooks.

Most learners in School A can hardly afford hard-copy textbooks as they come from disadvantaged home backgrounds. The school integrated TYB digital library to overcome this challenge. The digital library is now providing them with equal opportunities to access Life Science learning materials. All learners regardless of their socio-economic background are now able to download from the school digital library the resources they need to enhance their understanding of Life Sciences concepts. All required readings are digital as the school has completely migrated to eLearning. They are loaded on learners' iPads at the beginning of the year. In this regard, the integration of iPads is contributing to bridging the divide among learners in terms of access to information while providing them with enriched learning experiences.

In order to meet its educational goals using iPads, School A introduced the Moodle platform for learning. Teachers use Moodle to create, manage and deliver instructional content. Learners use their iPads on a daily basis to access Moodle for the learning content and for continuous test and quizzes. While logged on to Moodle, learners send emails to the teacher and to their peers for learning support and sharing. Using Moodle, learners are also able to access and interact with the course content even when the teacher is not there. Moodle is contributing to promoting a learner-centred learning environment, thus, an environment where learners take responsibility for their own learning and are actively engaged in the learning process (Glasgow, 2004).

IPads are used in School A as an impetus to promote active and engaging pedagogical approaches. Using Life Sciences educational apps installed on learners' iPads, Life Sciences teachers are providing learners with opportunities for independent learning. Apps have instructional games and 3D multimedia and activities on the content to engage learners in independent learning. If learners need additional information on the topic, they can connect their devices on the school WIFI for internet research. From the school premises, learners also use the school WIFI to download multimedia resources and store them on their iPads for use when off line. This provides them with the support they need to complete their homework and assignments at home. As Traxler (2010) asserted, iPads are extending the time and

the space for learning. Learning does not necessarily have to take place in the classroom. Learners are now learning while being on the playground.

In School A, iPads mediate the classroom presentations. While the teacher presents using the smart board and the laptop, learners use their iPads to access the teacher's presentation by logging in to Moodle. Learners can follow the presentation on the smart board or through their iPads screens. While the teacher explains, learners are able to highlight the main information pertaining to the lesson objectives, they can add sticky notes and personalise the presentation to suit their educational needs.

The study findings indicated that iPads are used in School A for continuous formative assessment and feedback. Before the lesson starts, learners use their iPads to take the Moodle test. As soon as the learner completes the test, he or she is provided with immediate feedback. The teacher is able to keep the learner's Moodle test record for evidence during student learning.

The Moodle test removes the need for the teachers to mark the learner's work as Moodle has tools for automatic marking. It provides learners with the feedback and keeps a record for the teacher. The teacher is able to adjust learning instantly because Moodle provides an analysis of how learners responded on every single question. Sadler (1989) asserts that formative assessment is central to achieving learning outcomes, most importantly, the quality of feedback provided to learners. Life Sciences teachers in School A provide learners with descriptive individualised feedback in addition to Moodle feedback so that learners know exactly what they have done well and where they still have to improve.

In School B, Life Sciences teachers and learners use iPads for educational apps and internet research. Life Sciences teachers and learners used four educational apps to enhance teaching and learning of Life Sciences. They used the Devolve Me app to enhance teaching and learning of evolution, the Build-a-Body app to teach human anatomy and human physiology, the Genetic and Meiosis app to teach cell division and the Protein Synthesis app to teach protein synthesis. Using their iPads, learners have been able to do Life Sciences experiments, to record a movie of the experiment

and to upload it on YouTube in order to share it with other learners. This could not have been possible in a traditional classroom where learners have no access to cameras, computers and are not connected to internet.

As the White Paper on e-Education stipulates, ICT opens up new learning opportunities and provides access to resources that are well beyond those traditionally available. This study confirmed these affordances. When using educational apps, Life Sciences teachers have access to three-dimensional multimedia resources to enhance teaching of topics which were previously difficult to teach and thus difficult to learn. Evolution and excretion are typical examples of topics which were hard to teach and hard to learn prior to the integration of iPads. Teachers could not get appropriate teaching aids to demonstrate these processes. Teachers and learners are now using the Devolve Me app and Anatomy app to enhance teaching and learning of these topics.

This study identified four underlying factors affecting the way Life Sciences teachers are using iPads in the studied schools : mode of integration, access to resources, the way iPads were introduced in the school, and teachers' professional training.

5.2.1 Mode of integration

Although there is no single, accepted mode of integrating iPads (Looi, Seow, Zhang, So, Chen & Wong, 2010) this study found that the BYOT optimised the use of iPads for teaching and learning . With BYOT, every learner has his or her own iPad which is available to him/her at all times. Consequently, learners learn at any time and from anywhere. Learners have also all learning materials on their iPad, they can organise and personalise the learning content to suit their educational needs as the devices belong to them. With the multiple-user model on the other hand, there is limited use of the devices. The time for exploration is limited to the lesson period. Learners cannot personalise and organise the learning content to suit their needs as the devices do not belong ro time. It is also evident that there is less departure from traditional teaching and learning practices.

5.2.2 Availabilty of content-specific apps and resources

According to Earle in Harris (2005), “integrating technology is not about the technology. It is primarily about content and effective instructional practices. Technology involves the tools with which we deliver the content and implement practices in better ways. Its focus must be on both curriculum and learning (p. 117). Likewise, Nye (2006) suggests that technology is a combination of artefacts and the way we use them. To this, one can say that an instructional tool such as an iPad should be used in the classroom only if it provides teachers and learners with an array of tools to mediate the teaching and learning of the subject content. An iPad without subject related content and apps would be useless to the classroom teaching in this regard.

The findings of this study corroborate the view above. IPads were used extensively on a daily basis where teachers and had access to numerous educational apps, broader and more flexible learning materials to enhance teaching and learning of Life Sciences. Where there was a lack of relevant apps to the topic and lack of resources, teachers rarely taught iPads integrated lessons.

5.2.3 The way iPads were introduced in the school

In the school where iPads were introduced using the whole-school integration approach, all Life Sciences teachers integrated the devices in their lessons. In the school where the whole school integration approach was not used on the other hand, some teachers rarely integrate the devices into their teaching. They mostly use PowerPoint slides and YouTube videos.

Technology integration is meant to be cross-curricular inorder to be effective (Alberta, 2000). Whole-school integration approach has an effective impact as it compels all teachers to move at the same time without having anyone remaining behind. Teachers can therefore be able to support one another as they face technological challenges. Learners also reap the benefits emanating from using teachnologies in all the subjects.

5.2.4 Teachers' technological professional training

It is generally agreed that the integration of technology could provide teachers with highly interactive and supportive tools to enhance teaching and learning of the subject. However, it must also be realised that teachers need more than technological tools to be able to provide learners with enriched learning experiences. Teachers must be acquainted with TPACK based knowledge and skills to be able to prepare and deliver the instruction using the technology (Mishra & Koehler, 2005).

In this study, teachers with less technological knowledge did not use iPads as much as did teachers who had enough technological knowledge. Lack of technological knowledge is attributed to poor professional development programs provided to teachers. All teachers received the same training without a prior assessment of their technological needs. In addition, the training was not subject specific; teachers who taught different subjects sat together to receive the same training. Hence, teachers were not able to apply to their specific curricula what they learned in the training. According to Ferrini-Mundy & Breaux (2008, p. 437) "in the absence of professional development on instructional technology and curriculum materials that integrate technology use into the lesson content, teachers are not particularly likely to embed technology-based or technology-rich activities into their courses. Lack of relevant technological training on the use of iPads explains in this regard why some teachers did not integrate iPads.

5.3 Pedagogical shifts as a result of integrating iPads

> What pedagogical shifts, if any, take place when iPads are used for teaching and learning Life Sciences?

IPads are generally regarded as pedagogical change agents. According to Amelito (2010), iPads provide teachers with opportunities for meaningful assessment of their learners and offers the opportunity to provide learners with timely feedback to reinforce learning. IPads have the potential to shift teaching from a teacher-centred to learner-centred pedagogy, thereby providing learners with access to broader and

richer learning resources than what could be offered in a formal traditional classroom environment (NSW, 2012).

In many cases, this study produced the findings, which support the argument above. The study findings indicated that in both schools there has been increased learners' engagement in the learning events due to the multimedia resources embedded in educational apps. The multimedia resources enhance learners' understanding of Life Sciences as it allows demonstrating and visualising Life Sciences concepts. When learning the human anatomy for example, learners are able to see what happens in the bloodstream. The visual experience of Life Sciences phenomena together with interactive activities embedded in educational apps motivate learners to engage in the learning process.

Learners remember 75% of what they see, hear and get involved in. However, they only remember 40% of what they see and hear (Lindstrom, 1994). The use of iPads enables learners to significantly retain and remember more of what they learn as they are highly engaged when interactive simulation games and videos are used to teach the content. In turn, better educational gains are expected when apps are used to engage learners. The following Chinese proverb says it all: "Tell me, I'll forget. Show me, I will remember. Involve me, I'll understand."

Teachers reported that the pedagogical approach shifted from teacher-centred to becoming more learner centred due to using iPads. Learners have become more responsible for their own learning. Instead of learners having to wait for the teacher to provide them with all the information, learners are using their devices to access a range of resources on the subject

The integration of iPads sharpened higher order thinking skills in the Life Sciences classroom. Higher order thinking skills are skills relating to critical, logical, reflective, metacognitive and creative thinking (King, Goodson, & Rohani, 1998). Dede (1990) asserted that learners develop higher order thinking skills when teachers create a learning environment where:

1. learners construct knowledge rather than passively ingest information;

2. sophisticated information-gathering tools are used to stimulate the learner to focus on testing hypotheses rather than on plotting data;
3. there is collaborative interaction with peers, similar to team-based approaches underlying today's science; and
4. Evaluation systems measure complex, higher-order skills rather than simple recall of facts.

The characteristics above were observed in both schools. In School A, learners have study groups after school hours to discuss and reflect on what the teacher taught them. They compare and contrast the information the teacher presented against the information they get from different sources available on TYB. Teachers also ask them questions that probe their understanding rather than the reproduction of facts. In School B, the teacher gave learners tasks that required them to apply Life Sciences knowledge to real life problems. Issues of kidney donation and abortion were debated and learners got the opportunity to explain their different views. The teacher asked learners to research information on internet and to write an essay on these issues.

Teachers also promoted learners' higher order thinking by giving them authentic projects to do over a long period. One learner had a research project entitled "*Would circumcision reduce HIV rate in males?*" This project required the learners to conduct interviews, to hand out questionnaires and to consult the community hospital database. On another occasion, learners were asked to research information on how to dissect a kidney. Learners used that information to design their own experiment and to carry it out. While doing the experiment, learners recorded it and uploaded it on YouTube, in order to share it with other learners.

Learners' collaboration on the learning task increased due to the integration of iPads. Learners are using iPads to alternate between whole-class activities and diverse individual, pair and group tasks aimed at getting learners to take the responsibility for working together, building knowledge together, thus developing together.

The class size affects learners' collaboration in the classroom. In the school where the class size was small, learners had much opportunity to work in groups. In the school where the class size was big, learners did not have enough opportunities to

work together; teachers worried that leaners will be noisy and disrupt the whole learning process.

Educational theorists such as Vygotsky promote the importance of the pedagogy of alternating individual learning task and collaboration tasks. Learners learn at higher intellectual level when they are involved in collaborative tasks. This is evident because when learners are actively engaged in exchanging, debating and negotiating ideas within their groups, they are faced with different interpretations, ideas and understanding of what they are learning. It is therefore important for teachers to provide learners with the opportunity to collaborate despite the challenges that they might be encountering especially when they have big class sizes.

5.4 Benefits and challenges of the integration of iPads on the teaching and learning of Life Sciences

> What are teacher and learners' perceptions of the educational benefits of using iPads to teach and learn Life Sciences?

Studies on the use of iPads for learning indicate that iPads yield a number of benefits to teachers' teaching and students' learning (Melhuish, & Fallon, 2010; Amelito, 2010; Li, & Pow, 2011). IPads enhance learners' motivation to learn and allow them to share information. Furthemore, they provide teachers with quality visual teaching aids to mediate the teaching and learning of the subject.

Similar findings were produced in this study. The study participants explicitly expressed their beliefs that iPads have the potential to enhance teaching and learning of Life Sciences. They provide teachers with quality teaching aids to mediate the teaching and learning of Life Sciences. Some educational apps and Moodle assessment tools provide learners with scores or levels of achievement. In turn, learners are encouraged to improve their performance. This may also account for the learners' increased levels of engagement and motivation to learn when iPads are used.

Learners explicitly appreciated the value of iPads for convenience, its lightweight and quick access information. They strongly believe that being able to download educational resources and save them on their iPads provides them with instant learning support especially when they are at home. They all believe that educational apps are appealing to them and provide them with interactive learning content and activities richer than what is provided by the teacher in a traditional classroom. Educational apps also provide them with the opportunity for auto evaluation and therefore improve upon it.

5.5 Challenges of using iPads for teaching and learning Life Sciences

> What are teachers and learners' perceptions of challenges of using iPads for teaching and learning?

The study identified challenges, which are similar to those occurring in the literature (Wilson, Goodman, Bradburu, & Gross, 2013: Becta, 2004: Harmon, 2012: Hatten, 2012). WIFI connection, inflexible curriculum, lack of technological knowledge and technical support, lack of time and learner distractions were the most overriding challenges. Other challenges include power failure, theft and learners who leave their devices at home or bring them uncharged.

5.5.1 WIFI connection

Limited wireless network affects negatively the integration of iPads in both schools. The WIFI signal is strong in some classrooms and weak in others. This is very disruptive especially in School A where teachers and learners need WIFI on a daily basis to access Moodle and Train Your Brain.

5.5.2 Curriculum

Teachers in both schools felt restricted to some extent by the curriculum in the process of integrating iPads. In School B, Teacher 1B felt that if she provided

learners with the opportunity to collaborate, she would not have enough time to cover the curriculum content and to prepare learners for the exams. Teacher 1B also affirmed that she does not use iPads when exam periods are approaching because she has to complete the curriculum and prepare learners for the exams. The curriculum has much content to cover. Consequently, when exams approach, teachers rely on direct instruction instead of providing learners with opportunities to engage using iPads.

5.5.3 Lack of time, lack of content-specific apps

Teachers are unable to make full use of iPads because they lack the time needed to fully explore and test out educational apps. Lack of relevant educational apps on some topics also constrains teachers from maximising the use of iPads. Teachers felt that the iPad is irrelevant if it has no content-specific apps.

5.5.4 Lack of technological knowledge and technical support

Lack of the relevant knowledge to integrate technology is likely to constrain teachers from using the technology in the classroom. The study found out that teachers who did not receive adequate technological training did not integrate iPads as much as those that received training and therefore well prepared. Teachers also admitted to relying on learners for technical support. Teachers do not have anybody to fall back on for support when they are confronted with complex technical problems such Moodle.

5.5.5 Distraction

Most participants reported that learners get easily distracted when they are using iPads in the classroom. Games and social networks were reported to be the greatest distractors to learning in the classroom.

5.5.6 Low battery life and learners leaving their iPads at home

Most iPads rely on their batteries. If the battery runs out of power, it interferes with the learning process especially in School A where learning occurs through iPads. It was also mentioned that some learners leave their iPads at home or bring them at school half charged or non-charged. Furthermore, some participants had concerns about iPads screens cracking. They also articulated concerns about possible theft. The whole community is aware that learners are learning through iPads and this tends to expose learners to robbery attacks.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

The main purpose of the study was to explore pedagogical approaches used by Life Sciences teachers to integrate iPads in their teaching and the impact this has on the teaching and learning of Life Sciences. Based on the findings, the following conclusion and recommendations for developing best practices in using iPads are made.

6.1 Conclusions

One of the more significant findings to emerge from this study is that iPads have great potential to transform the teaching and learning of Life Sciences. IPads provide teachers and learners with quality multimedia to enhance the teaching and learning of topics, which were previously difficult to teach and learn. They provide learners with timely access to information; as a result, learners engage with content and learn any time and from anywhere. The integration of iPads promoted a shift towards learner-centred teaching approaches. It allows alternating between the whole classroom instruction, individual instruction and small-group instruction. It further promoted a shift from memory-based testing towards the testing of higher-order thinking.

In School A, iPads in conjunction with Moodle and Train Your Brain educational portal offer the opportunities to learn independently or collaboratively. Learners use it to access the courseware and interact with the course content; as a result, learners are spending more time on learning than before. Thus, iPads increase time on task, which in turn leads to more learning gains. Learners are able to send emails and messages to the teacher or peers at any time they need support for homework and assignments as long as they have access to the internet. In schools, learners' engagement and motivation to learn increased when the teacher used interactive games and simulations to teach the content. Educational games in particular provide learning activities aimed at motivating learners to auto-evaluate their learning. Due to this potential, learners in this study were able to produce work that was indicative of higher-order thinking and deep learning.

As this study illuminated, teachers in the studied schools play a central role in the integration of iPads. They align the subject content, the pedagogy and technology through the design and implementation of individual, collaborative and engaging learning experiences. The success or failure of this integration depends on their ability to use this technology to design and deliver enriched learning experiences aimed at promoting higher-order thinking skills.

The study showed that when teachers in the studied schools attempt to optimise the use of iPads, they are constrained by lack of relevant knowledge, subject-specific apps and resources, technical support; power failures, WIFI connections and inflexible curricula. In some cases, iPads devices also become distractors as learners use them to play games, also for social network during classroom instruction.

The study showed that the BYOT model optimises the use of iPads and promoted ubiquitous learning. It allowed learners to maintain the locus of control of their devices and to have greater opportunities for personalised independent learning. However, due to this model learners brought to class different models of iPads devices. Learners got different learning experiences, as some iPads were quicker to connect and offered more options than others offer.

6. 2 Recommendations

1. Teachers also need to alternate between independent and collaborative learning pedagogies so that learners are provided with the opportunity to develop higher level knowledge both individually and collaboratively.
2. Teachers need to have subject specific professional technological training to enable them to use iPads effectively in their respective curricula. In addition, there has to be relevant subject-specific apps and resources inorder to optimise the use of iPads.
3. Teachers need to be provided with their own iPads so that they can search and test out subject-specific apps in their own time and have enough time to familiarise themselves with the technology.

4. In order to achieve the desired level of iPads usage, the school needs to pay adequate attention to the following major barriers identified by this study: wireless connection, technical support, power failure, and distraction. The school needs to provide high speed wireless connectivity in all areas within the school so that the time for learning is not wasted while trying to connect. The bandwidth should also be reasonable to facilitate speedy connection. Teachers also need to be provided with sustainable technical support, especially with trouble-shooting.

Recommendation for further research

5. Given the brief time frame for the study and the small sample of schools and research respondents used in the current study, there is a limit to which generalisations can be made to the wider school system in the province and indeed in the country. Further research involving a larger sample of teachers and learners is therefore recommended in order to determine if similar conditions prevail at national level and to facilitate wider generalisation.
6. Further research that explores how learners respond to various educational apps is also needed to determine the impact of educational apps on student engagement and learning.

APPENDICES

Appendix A: Teacher's interview schedule

A. Content knowledge
   1. Please describe your experience of teaching Life Sciences. What preparations did you have to go through in order to be able to teach this subject?
   2. How would you describe your teaching experience before the use of iPads in your classroom?
   3. How is easy or challenging was it to teach Life Sciences before the use of iPads?

B. Technological knowledge
   1. How much preparation or training would you say you had before the integration of iPads?
   2. What kind of professional training or support did you receive in order to implement iPads in your teaching?
   3. How was the professional training facilitated? How effective was it?
   4. How do you go about getting Life Sciences educational apps?
   5. How well suited are the apps utilised to the Life Sciences Curriculum content?
   6. What challenges do you face when using this technology?

C. Pedagogical knowledge
   1. Please describe your teaching experience after implementing iPads in your teaching.
   2. Please describe how you use iPads to teach Life Sciences.
   3. What planning process is required in order to teach a lesson, which incorporates iPads?
   4. How easy or challenging is it to get information using iPads?
   5. In your opinion, how has your pedagogy been influenced since you began using iPads?

D. Learners' learning

1. How does the use of iPads improve learners' knowledge of Life Sciences?
2. How does the use of iPads support collaboration between learners?
3. How does it support individual learner's learning needs?
4. What new learning opportunities for students does the iPad afford?
5. How easy or challenging is it for learners to get the information using iPads?
6. Please describe how you use iPads to help learners outside the school hours

E. Challenges

1. What challenges you are likely to encounter when implementing iPads in your teaching?
2. What challenges do learners face?
3. What hints would you give other teachers wishing to implement iPads in their teaching?
4. Anything else that you would you want me to know about use of iPads in the classroom?

Appendix B: Learner's interview schedule

1. Please describe your experience of learning Life Sciences using iPads.
2. How would you describe your experience of learning Life Sciences prior to the integration of iPads?
3. What new learning opportunities did you have after you started using iPad for learning?
4. What are some of the activities you have done using iPads?
5. How do you think iPads enhanced your understanding of Life Sciences?
6. How do you think iPads enabled you to collaborate with your teacher and your classmates?
7. Please describe how you use iPads to learn after school.
8. In your opinion, what do you see as benefits of using iPad for learning?
9. What challenges do you encounter when using iPad for learning?
10. What further support do you need in order to enhance your learning with iPads?

Anything else that you would want me to know about use of iPads in the classro

Appendix C: Ethics clearance

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

06 August 2014

Student Number: 749566

Protocol Number: 2014ECE032M

Dear Rafiki Meschac

Application for Ethics Clearance: Master of Education

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

Pedagogical Integration Of Ipads To Encance Teaching And Learning Of Grade 10 Life Science

The committee recently met and I am pleased to inform you that clearance was granted.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

M Mabefu

Wits School of Education

011 717-3416

cc- Supervisor: Dr Ephraim Mhlanga

Appendix D: GDE research approval letter

GAUTENG PROVINCE
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no: D2015 / 059

GDE RESEARCH APPROVAL LETTER

Date:	13 May 2014
Validity of Research Approval:	13 May 2014 to 3 October 2014
Name of Researcher:	Rafiki M.
Address of Researcher:	P.O. Box 627 Cresta 2118
Telephone Number:	011 624 1195; 073 882 3889
Email address:	meschac@gmail.com
Research Topic:	Pedagogical integration of iPads to enhance teaching and learning of Grade 10 Life Science
Number and type of schools:	ONE Secondary School
District/s/HO	Gauteng East

Re: Approval in Respect of Request to Conduct Research

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

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

24/4/05/14

1. *The District/Head Office Senior Managers concerned must be presented with a copy of this letter that would indicate that the said researchers have been granted permission from the Gauteng Department of Education to conduct the research study.*

Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel. (011) 355 0509
Email: David.Makhado@gauteng.gov.za
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