

# Title

Intermediate phase mathematics teachers' integration of ICT  
within a blended learning environment

By

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## Ethical clearance certificate



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## Abstract

Interventions to address South Africa's mathematics educational crisis are ample, but little to none of them integrate Information and Communication Technologies (ICTs) within a blended learning environment (BLE) (Padayachee, Boshoff, Olivier, & Harding, 2011). Teaching within a BLE has a positive impact on the learning experiences of learners and it can be independent of traditional time constraints. The internet, as an integral part of Information and Communication Technology, makes it easier than before to reach rural communities that were previously isolated from current and best practices. In effect improving equity to high quality mathematics education.

This study aimed to explore the experiences of three intermediate phase mathematics teachers' experiences while integrating ICT within a BLE. This contributed to the larger pool of academic literature and the Department of Basic Education's vision of developing citizens who are critical and active lifelong learners.

This study is qualitative in nature and follows an interpretivist paradigm to understand the subjective experiences of the participants and to create new understandings within a specific context (Cohen, Manion, & Morrison, 2007). Through purposive sampling three intermediate phase mathematics teachers were selected from a rural school in the Northern Cape to capture the uniqueness and complexity of the case. Data from semi-structured interviews and scheduled observations were analysed deductively according to the four main variables of the Unified Theory of Acceptance and Use of Technology framework, namely facilitating conditions, performance expectancy, social influence, and effort expectancy (Venkatesh, Morris, Davis, & Davis, 2003).

This study found that all three teachers believe that the integration of ICT within a BLE will enhance the teaching and learning experiences within the mathematics classroom. Two of the more experienced teachers successfully integrated ICT in their lessons taught within a BLE whereas one of them experienced several difficulties. The teachers who integrated ICT successfully within a BLE planned their individual lessons to not be too heavily dependent on ICT contrary to the teacher who experienced teaching difficulties who relied too heavily on ICT.

### Key terms

Blended learning, ICT, professional development, Mathematics, UTAUT

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## Title of dissertation

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11 August 2021

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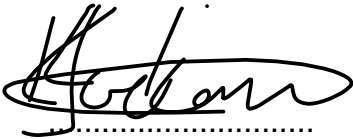
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## List of Acronyms

OLE – Online Learning Environment

BL – Blended Learning

BLE – Blended Learning Environment

TLE – Traditional Learning Environment

4IR – Fourth Industrial Revolution

UTAUT – Unified Theory of Acceptance and Use of Technology

DoBE – Department of Basic Education

NGO – Non-governmental Organisation

CAPS – Curriculum Assessment Policy Statement

IoT – Internet of Things

VR – Virtual Reality

AI – Artificial Intelligence

SA – South Africa

HoD – Head of Department

SGB – School Governing Body

Wi-Fi – Wireless Fidelity

# CHAPTER 1: INTRODUCTION AND CONTEXTUALISATION

## 1.1 Introduction

Mathematics is a key subject for a developing country like South Africa (SA) to grow economically (Bosman & Schulze, 2018; Siyepu, 2013; Tseng, Kano, & Hsu, 2014). Poor mathematics performance in South African schools, within the senior phase (Grades 7-9), is well-reported (Reddy et al., 2016; Spaul & Kotze, 2015). This can partially be attributed to poorly qualified teachers (especially in mathematics), lack of appropriate learner support, and not having the facilities to promote effective teaching and learning (Juan & Alex, 2017). Interventions attempting to aid the mathematics education crisis in SA do exist (Padayachee, Boshoff, Olivier, & Harding, 2011), but till that time none of the interventions made use of Information and Communication Technologies (ICTs) integration in the teaching and learning of mathematics within a blended learning environment (BLE).

Blended learning is a mixture of online and face-to-face learning (Bowyer & Chambers, 2017). Sound, technology based pedagogy, such as blended learning, has the potential to improve and reform education as it improves “the scale, speed and efficiency of the teaching and learning processes”, as argued by Van der Merwe et al. (2015, p. 11). The problem is that even though blended learning is proven to enhance the teaching and learning experience in the mathematics classroom, its dependence on ICT will most likely cause it to fail in the South African context (Stols et al., 2015). Stols et al. (2015, p. 12) found that the reason for the likeliness to fail is that teachers often “refrain from using available online resources to improve the quality of their own teaching”, finding the use of ICT overwhelming.

The first white paper on e-Education was released in 2004 by the Department of Education (DoE) (currently known as the Department of Basic Education (DoBE)). The purpose of the paper was to drive policy making to integrate ICT in all schools in order to close the digital divide and to prepare South African learners to participate in the knowledge economy (DoE, 2004). The DoBE failed to actualise their strategic plans to ensure that all teachers and learners are ICT literate by 2013, despite emphasising the importance thereof in the white paper on e-Education (Vandeyar, 2015). It is clear that the DoBE cannot achieve this goal on their own and communities and private



stakeholders have an integral role in conjunction with the DoBE to help improve SA's education performances. ICT forms part of a BLE and I am of the believe that when the learning of mathematics takes place in a BLE, then the DoBE's vision for an ICT literate generation can be actualised and at the same time mathematics education can improve.

## 1.2 Background

The company I am working for started a new blended learning project at the end of 2017 in an attempt to address the poor mathematics performance especially in the rural areas of SA. The blended learning project is built on a website that serves as an online learning environment (OLE). Learners who are signed into the OLE have immediate access to high quality micro lessons, assessments, GeoGebra applets <sup>1</sup>and worksheets. The purpose of this website is to serve learners in rural communities with subject content and resources and to assist teachers who want to adapt new teaching strategies to improve their teaching.

The OLE is the brainchild of a non-governmental organisation (NGO) situated in Gauteng. The OLE supports the NGO's vision which is to support schools through the language medium of Afrikaans, and to build new schools, where necessary, in an attempt to support learners' constitutional right to receive education in their mother tongue. The project has previously been launched in 2016 but did not achieve great success as the project developers lacked proper research on developing and implementing such a project. Funding has been obtained to run a research project at two schools on a voluntary basis in order to gain valuable design and implementation insights such as users' experiences and learners' mathematics performances. This dissertation forms part of the larger research project and will only explore the teachers' experiences of ICT integration into a blended learning environment.

The OLE is currently running at two rural schools in SA. The one school is a primary school consisting of approximately 400 learners coming from diverse backgrounds. The other school is a secondary school, with approximately 350 learners, and the majority of the learners come from poor socio-economic backgrounds. Private companies in and around the town invest in these two schools by supplying them with

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<sup>1</sup> GeoGebra is a dynamic software the integrates geometry and algebra and is used to explore mathematical concepts.

the necessary ICTs. These companies ensure that both schools are equipped with an ICT laboratory consisting of tablets and a stable internet connection. Although both schools were selected for this research project, I only used the primary school since they are situated in a rural area, they are open for experimentation and it provides an opportunity to explore the possibilities of communities and private companies working together.

### **1.3 Rationale**

Being a mathematics teacher, my keen interest and love for mathematics and the teaching profession drives me to contribute to finding solutions for the specified educational crisis. When I was still teaching mathematics in a secondary school, I realised that my learners' performances in mathematics improved as my own content knowledge improved. It is however concerning if you read empirical research indicating that 79% of Grade 6 mathematics teachers do not have the necessary content knowledge as prescribed in the Curriculum Assessment Policy Statement (CAPS), that is required to teach Grade 6 learners (Venkat & Spaul, 2015). When I was a novice teacher, my class and I used to watch online videos explaining content I myself did not fully understand.

Providing the aforementioned as some background, I discovered a teaching approach called blended learning during my honours degree and I immediately saw some correlations with the approach I used intuitively. Learning from the blended learning approach that integrating online videos into my own teaching enhanced my lessons, and it did not only improve my learners' performance, but it also gave me confidence as a teacher. The active participation of my learners due to blended learning (henceforth referred to as BL) through the online video integration was a positive teaching experience for me.

Several researchers (Caravias, 2018; Jeffrey, Milne, Suddaby, & Higgins, 2014; King & Cerrone-Arnold, 2012) support the positive aspects of teaching within BLE, such as time for reflection, less dependence on time constraints, meeting different student needs and improving learner engagement. One further advantage, particularly in this study, is that teachers partaking in the blended learning project received training from an educational specialist regarding the OLE. Training is extremely important as the success of the blended learning project is dependent on whether the educators will be able to successfully integrate ICT and the OLE in line with blended learning pedagogy.

The role of my research in the larger research project is to observe intermediate phase teachers in their mathematics classrooms and to conduct interviews with them in order to report on how intermediate phase mathematic teachers experience blended learning. As a researcher, I wanted to explore how teachers integrate ICT, especially the OLE, in their teaching within a BLE, more specifically teachers in rural districts since they have to teach with limited resources. I agree with Brewer who argues that BL may be a scalable and financially sustainable education model for the South African mathematics crisis (Brewer, 2011).

#### **1.4 Problem statement**

South Africa is on the verge of a mathematics educational crisis if not addressed (Pournara, Hodgen, Adler, & Pillay, 2015; Siyepu, 2013; Spaul & Kotze, 2015). The Trends in International Mathematics and Science Study (TIMSS) creates a set of international benchmarks to provide countries with more meaningful descriptions of what learners know (Reddy et al., 2016). In 2015 the TIMSS was conducted in 39 countries from which South Africa was ranked second to last. Although there are many reasons, this crisis can be attributed to poor socio-economic circumstances, weak learner support and teachers' lack of content knowledge resulting in trivial instruction (Bosman & Schulze, 2018; Siyepu, 2013). Tseng et al. (2014) argue that the mathematical content knowledge of teachers cannot be changed as easily as teachers' instructional skills and design. In their empirical study, Tseng et al. (2014) found that learners experience BL as a more efficient way of teaching mathematics, contributing significantly to their desire to learn. This resonates with Bosman and Schulze (2018) who found that BL offers learners the ability to tailor their learning and can be used as an alternative teaching approach to motivate learners (Ahmad, Shafie, & Janier, 2008). Thus, integrating ICT into day-to-day mathematics lessons within a BLE appears to be beneficial for both the learners and the educators (Fisher, Perényi, & Birdthistle, 2018). Apart from the problem that learners perform poorly in mathematics, learners are also not adequately prepared for the 21<sup>st</sup> Century workplace within traditional classroom settings where ICT integration is absent. As seen from the abovementioned research, BL is a more efficient way of teaching mathematics and the presence of ICT alone during instruction is not enough. ICT should be integrated into lesson plans so that learners have maximum opportunities to learn.

## **1.5 Purpose of the study**

The objective of the study is to explore the experiences of intermediate phase mathematics teachers' ICT integration within a BLE. Data for this case study were gathered through observing and interviewing teachers. The teachers teach in a rural primary school in the Northern Cape Province. The findings from the data will be used to address the research questions guiding this study.

## **1.6 Research Questions**

Following from the discussion above, the primary research question is:

How do intermediate phase Mathematics teachers' experience ICT integration within a BLE?

The primary research question will be addressed once the following secondary research questions (SRQ) are answered:

SRQ1: What is the performance expectancy when teaching with ICT within a blended learning environment?

SRQ2: What is the effort expectancy when teaching with ICT within a blended learning environment?

SRQ3: How do social influences affect teaching with ICT in a blended learning environment?

SRQ4: What are the facilitating conditions when teaching with ICT within a blended learning environment?

## **1.7 Methodological considerations**

The research will follow an interpretivist paradigm because I, the researcher, am interested in the complexity of the participants' views. Cohen, Manion, and Morrison (2007, p. 21) state that the interpretive world view's central endeavour is "to understand the subjective world of human experience". This world view will enable the researcher to address the research questions. The ontological assumption of the paradigm underpinning the research is relativism as it assumes that multiple realities exist as experienced by participants. Cohen, Manion, and Morrison (2007) point out that the epistemological assumption of a qualitative study is subjective as I became an 'insider'

by spending time in the field with the participants, attempting to reduce the distance between myself and the participants.

This study's methodological assumption is qualitative in nature, studying the participants within a bounded context. Savenye and Robinson (1996) highlighted that qualitative research studies typically include ethnographies, case studies, and generally descriptive studies. The research design for this study is a case study. Cohen et al. (2007) highlight that a case study's purpose is to portray, analyse and interpret the uniqueness of situations, giving a sense of 'being there'. Creswell, Hanson, Clark Plano, and Morales (2007) state that a case study is a qualitative approach where the researcher explores a case over time through in-depth data collection involving multiple sources followed by a descriptive report of the case.

The participants, three mathematics teachers (one teacher for every grade of the intermediate phase (Grade 4-6)), were all teaching at the same rural primary school in the Northern-Cape province of South-Africa at the time of this study. An observation schedule and semi-structured individual interview schedule were used as data collection instruments. The data from the audio recorded interviews were transcribed. Deductive data analysis was used since the data were explored and the discussions were related to literature (Saunders et al., 2016, p.74)".

## **1.8 Concept clarifications**

There are various definitions of the concepts in literature as discussed in the literature review. It is therefore necessary to clarify the relevant concepts in the context of this research and how they are used within this study:

- **Blended Learning Environment (BLE):** BLE is a combination of two modes: face-to-face and online learning (Horn & Staker, 2014). The online learning mode, as part of ICT integration, can either be utilised in a classroom setting or at home. For this study only the classroom setting is applicable.
- **Traditional Learning Environment (TLE):** TLE resembles a factory system and it is a remnant of the industrial era. This system groups students by age, promotes them from one grade to the next in batches, and offers all students in each cohort a single, unified curriculum that is delivered based on the time of the year. The instructional format is predominantly face-to-face and materials are

presented through teacher-led lectures or demonstrations (Horn & Staker, 2014).

- Information and Communications Technologies (ICT) in education: ICT in education includes any form of digital tool that is used within the educational landscape. This includes, hardware, software, online devices and offline devices and is used in various learning environments (Fitri & Zahari, 2019; Padayachee, 2017).
- Online Learning Environment (OLE): OLE is a learning environment that creates an opportunity to share educational materials with the learners via the web whether in class or elsewhere (Moore, 2016; Muniasamy, 2019). For the purposes of this study it will form part of ICT integration.

### **1.9 Possible contributions of the study**

This study aims to contribute firstly to the BL research project; secondly to the larger pool of academic literature regarding BL and ICT integration and lastly to the vision of the DoBE regarding an ICT literate educational platform. Integrating ICT into lesson plans without adapting better teaching pedagogies can be counterproductive. Van der Merwe et al. (2015) argue that BL is an extremely useful teaching pedagogy, because it improves the teaching and learning experiences of both teachers and learners. This research is current and context specific addressing the realities of South-African rural schools on a large scale.

Knowing how teachers experience the integration of ICT into their own teaching, especially within the OLE, this study will contribute to improve the BL project and may ultimately improve teaching and learning processes. Current and context specific research on ICT integration within BLEs may contribute to the DoBE's (2004) long term objective of improving our educational system by integrating ICT into everyday teaching.

### **1.10 The structure of the study**

The dissertation consists of six chapters. Chapter 1 gives an overview of the study. The chapter starts with an introduction, background, rationale, and problem statement. These sections are followed by the purpose of the study, research questions, methodological considerations, and concludes with the clarification of concepts that emerged from the literature review, and the possible contributions of the study. Chapter

2, consists of the literature review and a conceptual framework. Furthermore it provides an in-depth analysis of the relevant literature and the conceptual framework on which this study is based. In Chapter 3, the methodology used in this study is explained. This chapter also includes a discussion on the selection of the participants, data collection instruments and the data analysis procedures, the trustworthiness of the instruments and the ethical considerations. In Chapter 4, the data are presented and the findings from the analysed data are discussed. Chapter 5 presents the findings taking into consideration the reviewed literature and the conceptual framework, followed by a cross-case analysis and a summary. Finally, Chapter 6 contains a discussion of the research questions, conclusions, recommendations for further research, limitations of the study and some final reflections.

## CHAPTER 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

### 2.1 Introduction

The fourth industrial revolution (4IR) is prevalent in the 21<sup>st</sup> Century and learners need to be equipped with 21<sup>st</sup> Century skills to remain relevant to the work force. Naidoo (2019, p. 37) highlights that the 4IR is ICT dependent where “robotics, the Internet of Things (IoT), virtual reality (VR) and artificial intelligence (AI) are transforming the way we live and work”. Naidoo (2019) argues that learners’ ability to solve problems based on critical thinking must be enhanced within the 4IR and subjects like mathematics address this need the best. The drive for rapid transformation, compelled by the 4IR, within the educational landscape is disrupting the TLEs present in every country (Naidoo, 2019).

The TLE is under tremendous scrutiny. Horn and Staker (2014) label the current education environment as a “factory system”. They describe this environment as a model of education that takes on a one-size-fits-all approach that is ineffective for the majority of children. Other researchers (Bowyer & Chambers, 2017; O’Byrne & Pytash, 2015; Van der Merwe et al., 2015) define the “factory system” inherited from the industrial era as a “traditional environment” with “face-to-face” learning experiences with a fixed schedule, location and pace. Horn and Staker (2014) point out that this learning environment was not a concern in the past, but that it has become problematic in the 21<sup>st</sup> Century, calling for a reform.

Anthony (2019, p. 28) suggests that the reform in education “entails a shift in instructional design” away from TLEs with a single learning pathway and learning objectives that are the same for all the learners in a specific grade. This shift in instructional design administers a shift in the teachers’ role in the 21<sup>st</sup> Century classroom where ICTs are becoming more and more prominent (Adu and Galloway, 2015).

The important role of ICTs in education in terms of addressing the call for reform cannot be over emphasised. Adu and Galloway (2015) argue that ICT has the ability to promote modern methods of teaching that is deemed necessary for the 21<sup>st</sup> Century classroom. South Africa has well developed national policies supporting the integration



of ICT, but in reality, the implementations thereof are not happening (Adu & Galloway, 2015).

Developing countries like South Africa has to address the need for reform in education, especially in subjects like mathematics, if they want to remain economically relevant. Naidoo (2019) points out that mathematics as a subject opposes unemployment and stimulates socio-economic growth especially viewed within the context of the 4IR and its ICT dependence. Bray and Tangney (2017) suggest that integrating ICT with appropriate pedagogy into traditional mathematics classrooms has the potential to address some of the issues in mathematics education. According to Bray and Tangney (2017) one example of such an issue is the lack of learner engagement which can be addressed by integrating ICT as it has the capacity to facilitate realistic and problem-solving approaches to teaching and learning. Fitri and Zahari (2019) argue that integrating ICT in a traditional landscape based on sound pedagogy supports the learning of mathematics.

## **2.2 Mathematics education in South Africa**

Mathematics education is of national interest and the improvement thereof is a national priority (Stols et al., 2015). Graham, Stols, and Kapp (2020) highlight that the majority of mathematics teachers do not integrate ICT to optimise their teaching. They ascribe it to various reasons including teachers' lack of support and professional development opportunities. ICT, as a resource, improves productivity, curriculum integration, delivery, communication and collaboration between teachers and learners (Herselman, Botha, Mayindi, and Reid, 2018). Herselman et al. (2018) point out that rural schools (quintile 1 – 3) in South Africa fail to implement national policies regarding ICT integration and this to the detriment of the learners.

South African policy makers need to rethink the strategies to get rural schools to integrate ICT optimally in their day-to-day lessons in order to address the dire state of South Africa's mathematics education. Spaul and Kotze (2015) concluded from their analysis of the Trends in International Mathematics and Science Study (TIMSS) that learners from quintile 1 – 3 schools are three years behind their Quintile 4 – 5 counterparts. Spaul and Kotze (2015) make the point that the learners from these rural schools are not equipped with the necessary skills to become contributing members of the 21<sup>st</sup> Century economy.

### **2.2.1 The Trends in International Mathematics and Science Study**

The TIMSS is an assessment of the mathematics and science knowledge of fourth and eighth grade students around the world but South Africa participates with fifth and ninth grade students (Reddy et al., 2016). TIMSS has been administered every four years since 1995. The 2019 TIMSS results are produced from a study where 300 SA schools were sampled of which 297 agreed to participate. A total of 11903 Grade 5 learners and 294 Grade 5 mathematics teachers participated in the study. South Africa, together with two other countries, who participated in the study with Grade 5 learners opted for a less difficult assessment. According to a report by Reddy (2021) SA's Grade 5 learners showed no improvement compared to 2015. Studies like TIMSS are necessary so that countries can benchmark their performance against other participating countries.

Isdale et al. (2018) note that three-fifths of South African learners (61%) do not exhibit the minimum competency in basic mathematical knowledge required at Grade 5 level. The same is true for the TIMMS assessment of Grade 9 learners in South Africa. Spaul (2013) highlights that even though the improvement level is noticeable, the average South African Grade 9 learners still perform between two and three grade levels lower than the average Grade 8 learners from other middle-income countries. Spaul (2013) advocates that this is cause for a reform of the educational landscape in South Africa.

### **2.3 Information and Communications Technology (ICT)**

This section explores what ICTs are and the role it plays in education to adhere to the call of reform. Furthermore, ICTs' importance in a subject like mathematics, as well as the role mathematics teachers play when it comes to integrating ICT into their day-to-day practises are examined. In developing countries like South Africa with a unique educational landscape, it is also necessary to investigate several factors and barriers regarding ICT integration in order to teach for 21<sup>st</sup> Century skills.

#### **2.3.1 Defining ICT**

A concern that needs to be raised regarding the literature is the conflation of diverse forms of educational technologies under the umbrella term 'ICT' (Livingstone, 2012). Digital tools cited with respect to ICT include word processors, data projectors, presentation, spreadsheets, search engines, interactive whiteboards, mobile technologies, smart phones (e-mails, blogs, videos, etc.), tablets, instant messaging,

podcasts, CD-ROMs, wiki's, simulations, animations and e-books (Padayachee, 2017). Fitri and Zahari (2019) also include the use of computers both for online and offline use, internet and virtual classes whilst the policy indicates that e-Learning may involve the use of the "Internet, CD-ROM, software, other media and telecommunications" (DoE, 2004, p. 15).

In summary: ICT in education includes any form of digital tool that is used within the educational landscape. This includes hardware, software, online devices and offline devices.

### **2.3.2 ICT in education**

Incorporating good practices of ICT into education has the potential to transform the educational landscape. Good practices incorporate a structured approach to activities that are transformed by the use of ICT (Bray & Tangney, 2017). Bingimlas (2009) points out that ways of teaching can be transformed by integrating ICT. Hernandez (2017) claims that ICT has become the catalyst for opportunities, allowing the potential to innovate in education. Hernandez (2017) further suggests that ICT has become an indispensable element of the educational environment.

However, the presence of ICT in education is not a guarantee for improvements. Livingstone (2012, p. 12) states that the "... increase in ICT provision does not guarantee enhanced educational performance". Bray and Tangney (2017) point out that the transformation of education will not occur if ICT is only substituting traditional educational practices. Bray and Tangney (2017) argue that transformation can only take place when ICT integration is used in a constructivist, team-based, and project-based pedagogic manner.

Criticism towards the mere integration of ICT into education is substantial. Commercial enterprises tend to praise ICT for it has improved basic skills of reading, writing and arithmetic, but some researchers argue that it is only linked to the traditional approach of teaching namely: drill-and-skill education (Livingstone, 2012). Other researchers (Bray & Tangney, 2017) have found that most ICT integrations are simply augmentations of traditional practices.

The overall current research suggests that the presence of ICT in education has no positive impact on educational performance and in some cases it may even have a negative impact. Researchers (Comi, Argentin, Gui, Origo, and Pagani, 2017) found

that ICT use in education is not more effective than traditional teaching methods. They ascribe it to the difficulty that schools face, namely to actually integrate ICT into their day-to-day teaching. Research done by Eickelmann, Gerick, and Koop (2017) imply that more frequent ICT use in an educational environment correlates with lower achievement. The findings of Eickelmann et al. (2017) are supported by Skryabin, Zhang, Liu, and Zhang (2015).

The negative correlations of ICT use in education does not imply causality. Drijvers (2015) highlights that ICT is not the answer to the educational crises and argues that its effectiveness depends on implementing it properly. ICT, when used properly, can influence learning experiences and outcomes (De Witte and Rogge, 2014). Skryabin et al. (2015) found that when learners use ICT at home for school-related tasks their performance tend to improve. Voogt, Knezek, Christensen, and Lai (2018) conclude that if education is to be transformed through ICT, it must be approached differently to how it has been done thus far.

### **2.3.3 Integrating ICT into the mathematics classroom**

Integrating ICT in the mathematics classroom may support and improve mathematics education. Research (Comi et al., 2017; Joshi, 2017; Mlotshwa & Chigona, 2018) indicates that ICT integration has no statistically significant effect on students' general performance except for their mathematics achievement, particularly where ICT transforms traditional instruction. However, this transformation does not take place automatically and it needs to be linked with changes in teacher practices (Voogt et al., 2018). ICT supports mathematics in various ways namely: composing, calculating, making connections, visualising data, finding importance, synthesising and problem solving (Joshi, 2017).

Drijvers (2015) argues the opposite, stating that the effect of ICT integration is negligible as evidence of ICT integration benefiting mathematics education, is not very strong. An analysis of the 2012 Programme for International Student Assessment (PISA) results in 137 schools in the Netherlands found that ICT integration is not a statistically significant factor of mathematics performance (Eickelmann et al., 2017). Saal, Van Ryneveld, and Graham (2019) confirm the negative impact that ICT integration can have in the mathematics classroom, if ICT is only used to search for mathematical principles, concepts, and used to practise mathematics skills and procedures.

### **2.3.4 Mathematics teachers' role in ICT integration**

Teachers play a central role in the transformation of the educational landscape through ICT integration. The roles of teachers have changed in societies that yearn for ICT integration in the mathematics classroom (Hernandez, 2017). Hernandez (2017) defines the role of a teacher, within ICT driven societies, as one that can provide access to ICT and generate the necessary skills required to thrive in such a society. Teachers who integrate ICT require a set of skills where they internalise methodologies to best use ICT in lessons, argues Hernandez (2017).

Hernandez (2017) states that continuous professional development deems to be a key factor in the transformation process. De Witte and Rogge (2014) propose that the efficiency of ICT in the classroom depends on the skills of the teachers. Clearly, the potential of education to be transformed depends solely on the presence of teachers who are adequately trained to integrate ICT so that learning and teaching are enhanced (Bray & Tangney, 2017; Voogt et al., 2018). Drijvers (2015) points out that ICT integration into the mathematics classroom is not the panacea that can replace the role of an educator, but rather change the role of the educator as one who orchestrates learning by synthesising ICT-rich activities.

The ample support that ICT gives the mathematics teachers may lead to improved achievement. Saal et al. (2019) found that learners who are taught by teachers that integrate ICT into their lessons outperform the learners who are taught purely in a TLE. Saal et al. (2019) also found that in addition to the teachers who integrate ICT, the teachers who attend professional development courses on ICT integration in mathematics education, outperform those who do not attend professional development opportunities.

Mathematics teachers need to undergo a mind shift regarding the teaching and learning of mathematics. Stols et al. (2015) argue that the reason for the difficulty in transition is due to the fact that teachers not only have to change their methodological practices, but also their beliefs regarding how mathematics can be learned. Teachers' beliefs regarding their own competency and the value of ICT for learners' learning outcomes intersect with their established pedagogical beliefs (Prestridge, 2012). Prestridge (2012) argues that this intersection can either be a collusion or a collision, both having implications on ICT's ability to transform the educational landscape.

Teachers therefore need to undergo a mind shift when it comes to integrating ICT in their teaching (Stols et al., 2015).

Teacher competency and ICT literacy are fundamental when it comes to integrating ICT into the mathematics classroom. Eickelmann et al. (2017) found that teachers' ICT competences which are relevant to mathematics education have a significant impact on learner performance. Teachers experience extensive problems with the adequacy of ICT use and integration (Saal et al., 2019). Despite teachers' positive view regarding the transforming abilities of ICT integration, they still experience ICT integration as overwhelming, partly due to their lack of ICT skills (Stols et al. (2015).

ICT integration within the mathematics classroom may contribute to a better learning and teaching experience. Comi et al. (2017) highlight that teachers can make lessons more personal and attractive due to the fact that textual and audio-visual content is found in abundance. They also argue that ICT integration might push teachers to plan lessons more effectively. Teachers that integrate ICT successfully free up time spent on lecturing in a TLE to focus on authoritative problems, flexible strategies, exploration and sense making with manifold representations, and in the end teach mathematics better and teach better mathematics (Joshi, 2017). It is imperative to point out that ICT integration only yields efficiency if teachers are properly trained and the educational environment promotes cooperative learning (Eickelmann et al., 2017).

### **2.3.5 Factors and barriers influencing ICT use in the mathematics classroom**

The mere presence of ICT is no indication whether it will be used frequently or not. Gil-Flores, Rodríguez-Santero, and Torres-Gordillo (2017) argue that greater or lesser amounts of ICT infrastructure in schools are not related to the frequency thereof in classroom use. The aforementioned researchers used the data of 3 339 teachers from the 2013 Teaching and Learning International Study (TALIS) and found that the most significant variable explaining teachers' classroom ICT use is the need for professional development. This correlates with findings from other researchers (Li, Yamaguchi, & Takada, 2018) stating teachers' professional competency is affecting their use of ICT for student-centred education.

Babić (2012) reviewed ample literature regarding the factors that influence the acceptance of ICT use within the classroom, and found six common themes which are: teacher competence, attitude and values, teacher personality, the characteristics of

the learners, acquisition of knowledge and skills, and lastly institutional factors. Howie and Blignaut (2009) found six factors that influence the acceptance of ICT use within the classroom when they studied 666 mathematics teachers, and they are: access to computers, the availability of technology, the obstacles to realise pedagogical goals, the location of the ICT, staffing, and the channels for teachers to acquire skills and knowledge. Parallels can be drawn between the factors that Babić (2012) identified and those found in the study by Howie and Blignaut (2009) making use of South African teachers.

Teachers' lack of computer literacy is among the most prominent barriers regarding the successful integration of ICT in the mathematics classroom. Howie and Blignaut (2009) conducted an international cross-sectional survey focusing on the integration of ICT into mathematics and science classrooms and found that the main constraints of ICT integration in education are budgetary constraints and a lack of ICT literacy among teachers. Primary barriers to successful ICT integration, as identified by Gil-Flores et al. (2017), are summarised here: the lack of infrastructure (hardware and software), the lack of digital competency among teachers, resistance to the changes that ICT incorporation involves, the ineffectiveness of teacher training, the lack of time in the school bureaucracy to learn to teach with ICT, and the lack of technical support staff who can assist the teachers in their use of ICT. The aforementioned barriers resonate with barriers mentioned in another study namely, the lack of resources, time, access, and technical support (Prestridge, 2012). Stols et al. (2015) found that teachers will use ICT on a personal level but refrain to use online resources to improve the quality of their teaching. They argued that the teachers experienced their perceived lack of ICT skills and their hesitance to move from a TLE to an ICT integrated environment as factors that have a negative impact on their use of ICT.

The rapid development of technology demands much from teachers. Teachers with fairly good ICT skills often talk about the tiring experiences of trying to keep up with the frequent changes in the ICT environment (Lindberg, Olofsson, & Fransson, 2017). They argue that trying to keep up with the newest technology, is demanding for teachers. These high demands together with pitfalls such as the distractions of social media and games could result in teachers refraining to integrate ICT into their lesson plans. The complexities, like the abovementioned barriers and the aforementioned

demands, that accompany the integration of ICT within the educational landscape led to teachers being reluctant to accept it (Babić, 2012).

### **2.3.6 Teaching mathematics in the 21<sup>st</sup> Century and the implementations of ICTs**

TLEs came under scrutiny over the last decade or two. Livingstone (2012) highlighted the contrasts between teaching during the industrial era (traditional) versus teaching during the information age (21<sup>st</sup> Century), by pointing out that teaching mathematics in the 21<sup>st</sup> Century includes values such as process over outcome, collaborative learning over individual achievement, peer-based over hierarchical teacher/pupil relations, and flexible modes of discovery over subject specific knowledge. Hernandez (2017) notes that the transition from traditional education to the knowledge-based education has been no easy task.

The industry demands for the 4IR have changed since the second industrial revolution where soft skills, like problem solving, creativity and collaboration are rated amongst the highest soft skills internationally. Li et al. (2018) found that ICT can be used effectively to nurture learners' ability to think critically. This is what the focus should be when it comes to ICT integration, because if education wants to equip learners to thrive in the knowledge era, it must evolve to ensure they are equipped with the necessary skills to make effective use of ICT solving a wide variety of problems (Voogt et al., 2018). Meyer and Gent (2016) argue that when ICT is used to mediate learning, higher order skills are fostered which is essential for creativity, a highly rated 21<sup>st</sup> Century soft skill. Integrating ICT into lessons lead to a pedagogical shift bringing forth new teaching practices that support conceptual understanding of learners, building a good foundation for 21<sup>st</sup> Century skills (Joshi, 2017).

### **2.3.7 ICT in the South African context**

In his State of the Nation address on 7 February 2019, the president of the Republic of South Africa, Mr. Cyril Ramaphosa, stated that the government would provide digital workbooks and textbooks to every school child in South Africa by 2025. In 2004 the Department of Education released a white paper that presents a framework of strategic, political, pedagogical and developmental facets of implementing e-education in South Africa. The main purpose of this framework was to transform teaching and learning through ICT with the strategic objective that every South African teacher and



learner would have been ICT literate by 2013 (DoE, 2004). The white paper's framework was envisaged in three phases: The enhancement of a system-wide and institutional readiness to use ICTs for learning, teaching and administration (2004–2007); A system-wide integration of ICTs into teaching and learning (2007–2010); and ICTs that should be integrated at all levels of the education system. The rollout was aimed for 2010–2013. Meyer and Gent (2016) highlighted their concerns by stating that even though policy for ICT integration is defined at a high level, the implementation of it is slow and uncoordinated and no real change is documented since the release of the white paper.

South African mathematics teachers have not yet adopted and integrated ICT into their daily practices. Saal et al. (2019) listed several initiatives to support teachers' attempts to answer the call of the 2004 white paper which include the Teacher Laptop Initiative (TLE) (2010) and the Gauteng Online Initiative (2001), but they conclude by expressing their concern that South African mathematics teachers do not integrate ICT in their lessons.

### **2.3.8 Summary**

ICT is any form of digital tool consisting of hardware, software, online devices and offline devices. Moreover, ICT has an important role in the reforming of mathematics education in an attempt to improve the overall mathematics performance of learners in South Africa. However, South African teachers are far behind in terms of ICT competencies as the majority of the teachers have not received any formal training regarding ICT integration. Integrating ICT into lessons lead to changes in teaching practices that support conceptual understanding, building a good foundation for the 21<sup>st</sup> Century skills required in the 4IR. Nonetheless, the reality is that the majority of South African mathematics teachers have not yet adopted and integrated ICT into their daily practices.

### **2.4 Blended learning (BL) and blended learning environment (BLE)**

There is an urgency to adopt 4IR technologies like artificial intelligence (AI), robotics and the Internet of Things (IoT) in education (Ally & Wark, 2019). Ally and Wark (2019, p. 4) argue that the 4IR will lead to “the demise of the traditional educational paradigm”. Education within the 4IR will adopt a blended learning approach enabling learners to set personal learning goals and free them to engage with rich problems during class

time. The BLE can offer personalised learning by providing constant feedback to teachers, learners and parents about the learners' progress through utilising the capabilities of 4IR technologies (Ally & Wark, 2019).

Jeffrey et al. (2014) state that evidence of the effectiveness of teaching and learning within a BLE yields mixed results. Researchers derive their case for actively promoting BL from the observations that teaching within a BLE enhances the learning experience in ways that TLEs, like face-to-face teacher-led instruction fail to do. Krasnova (2015) highlights that BL transforms ordinary transfer of knowledge into cooperative learning, and this is made possible by ICT integration in the BLE allowing the interactions between teachers and learners to be organised differently. Watson (2008) made the case that BL is likely to emerge as the predominant model of the future when it comes to education.

#### **2.4.1 Defining BL**

There is no generally accepted definition of BL. Caravias (2018) points out to the fact that BL has been defined in a number of ways over the last few decades. The term itself causes numerous problems as it is so open that it is merely impossible to purely define BL. Contrary to the rise in popularity regarding BL, some feel that there is little merit in keeping the term "blended learning" as it is currently understood (Oliver & Trigwell, 2005). They argue that the term is defined inconsistently throughout literature and that some definitions are redundant as it describes general practice.

Definitions of BL evolved over the last two decades despite the controversies regarding attempts to discredit the term. Blended learning describes a learning environment that combines teaching methods, delivery methods, media formats or a mixture of all of these (Ahmad et al., 2008; Babić, 2012; Bowyer & Chambers, 2017; Collopy & Arnold, 2009). Other researchers strictly define BL as instructional conditions in which at least 50% of the total course time is face-to-face and the remainder of the time is spent online (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014). Blended learning is a dynamic and co-evolving complex environment that seamlessly integrates traditional face-to-face learning with ICT (Fisher et al., 2018).

The main idea behind BL is to merge the best practices of both worlds (Güzer & Caner, 2014). Blended learning integrates synchronous and asynchronous Virtual Learning Environments (VLE) to enhance the learning and teaching experience and adds value

to collaborative learning and individual learning needs (Tseng et al., 2014). Van der Merwe et al. (2015) define the term as the thoughtful integration of classroom, face-to-face experiences with ICT enhanced learning and teaching experiences. Horn and Staker (2014) define BL as, any time a student learns, at least in part, at a supervised traditional location away from home and, at least in part, through online delivery with some element of student autonomy. From all these definitions it can be concluded that BL is defined as learning from a combination of face-to-face teaching and teaching through an integration of both online and offline ICT media such as computers, multimedia and the internet (Fitri & Zahari, 2019).

In summary: BL is not merely adding ICT to traditional face-to-face teaching and learning modes. BL consist of ICT that is thoughtfully integrated into day-to-day learning experiences based on sound pedagogical approaches promoting collaborative learning.

#### **2.4.2 Modes of BL**

Different modes of blended learning promote different learning modalities, some promote asynchronous learning (ICT integrated online) and others synchronous learning (traditional). The true power of BL comes from the manipulation of time, space, and place to support and improve learning (O'Byrne & Pytash, 2015). Graham (2006) categorises blended learning systems into three categories:

- a) Enabling blends: The main focus of an enabling blend is to address issues of access and convenience.
- b) Enhancing blends: It allows for incremental changes to pedagogy but not too radical in the way teaching and learning occur.
- c) Transforming blends: It allows for the radical transformation of pedagogy. These types of blends support cognitively challenging activities that were not practically possible without ICT.

These BL systems as defined by Graham (2006) can be applied to the various modes of BL where the enabling blends will fall more on the traditional end of the blended learning spectrum, and the transforming blends on the online end (Pulham & Graham, 2018). Horn and Staker (2014) published a book, *Blended: Using disruptive innovation to improve schools*, defining the different modes of BL. Figure 2.1 illustrates their latest attempt in defining and categorising the BL modes.

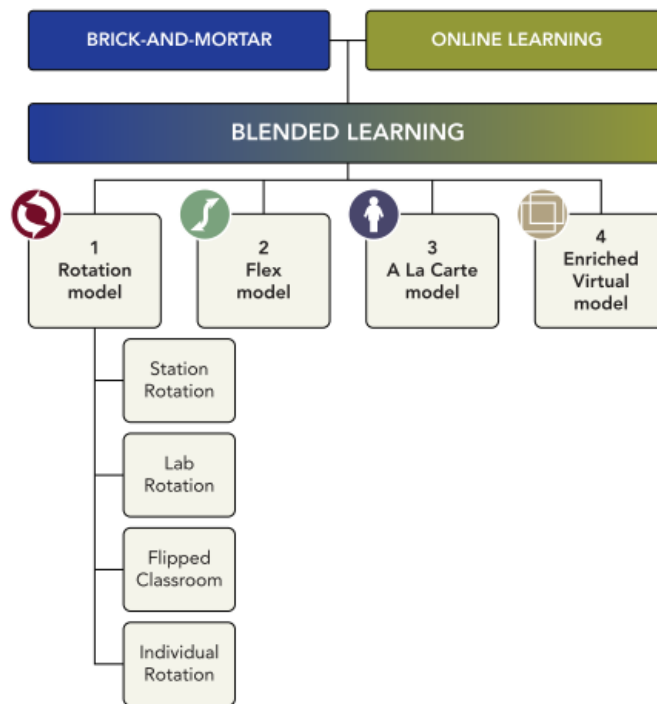


Figure 2.1: Modes of blended learning (Horn & Staker, 2014)

The modes are defined as follows:

- a) Rotational mode: Learners within a rotation mode will rotate on a fixed schedule between learning in an online, self-paced environment and sitting in a traditional classroom setting, face-to-face with a teacher (Horn & Staker, 2011; Powell et al., 2015).
  - i. Station rotation: The rotation between face-to-face and online learning takes place within the same classroom setting (Horn & Staker, 2014; Powell et al., 2015).
  - ii. Lab rotation: The rotation between face-to-face and online learning takes place between different classrooms. Usually, the one classroom is a computer lab (Horn & Staker, 2014; Powell et al., 2015).
  - iii. Flipped classroom: Learners have access to learning material and consume the lessons independent of scheduled class time. Classroom time is used to work on rich problems (Fisher et al., 2018; Horn & Staker, 2014; Powell et al., 2015).

- iv. In class flipping or “in-flipping”: In-flipping is a blended learning mode where the teachers provide the instructional material from an OLE in class (Ramirez & Diaz Munevar, 2018; Tucker, 2016)
  - v. Individual rotation: Learners’ daily schedules are customised and learners can rotate between modalities as they choose (Horn & Staker, 2014; Powell et al., 2015).
- b) Flex: The majority of the content is delivered via an online platform and teachers are on-site to provide support on a one-to-one basis (Fisher et al., 2018; Horn & Staker, 2011, 2014; Powell et al., 2015).
  - c) A La Carte: Learners can take online courses while attending brick-and-mortar schools. This is a popular mode when it comes to taking extra courses outside of the school curriculum (Horn & Staker, 2014; Powell et al., 2015).
  - d) Enriched virtual model: During these courses learners are compelled to attend some form of face-to-face meetings, being it tutorials or workshops, but the rest of the course is taken online (Horn & Staker, 2014; Powell et al., 2015).

Knowing the different modes of BL will hopefully lead to more effective blended learning environments. Schools should, together with selecting the correct mode of BL, undertake innovative pedagogical approaches through the integration of ICT in teaching and learning (Kintu, Zhu, & Kagambe, 2017).

### **2.4.3 ICT and BL**

Integrating ICT into a BLE has a modest yet significant impact on the learning experience (Bernard et al., 2014). Merely integrating ICT without a sound pedagogical approach will have no positive impact. Bernard et al. (2014) provide numerous examples of failed attempts of ICT integration partly because the design principles are not grounded in good research. Evidence from Jeffrey et al. (2014) suggest the potential of blended learning, but also highlight the considerable evidence that most BL programmes fail to fulfil this potential.

Integrating ICT into BLE has the potential to transform education, but it is not enough to just “integrate” ICT into traditional face-to-face classrooms (Tseng et al., 2014). Tseng et al. (2014) argue that a successful BLE must rethink TLEs, firstly practices that include ICT and secondly practices that exclude it, and take the best practices of both delivery modes. Van der Merwe et al. (2015, p. 11) summarise the role of ICT within the BLE stating that, “Technology has the potential to improve the scale, speed

and efficiency of the teaching and learning processes if the focus remains on thoughtful and appropriate pedagogy (teaching approach) and not the technology as such”.

#### **2.4.4 Educational advantages of BL**

The benefits for BL surpass the benefits of online learning and traditional face-to-face learning respectively (Livingstone, 2012). Ahmad et al. (2008) report on three potential benefits of BL, namely BL provides learners with more autonomy over their learning experience, BL helps to foster critical thinking, and it improves time management with the effectiveness of online assessment systems. Blended learning accommodates the curious learning needs of a diverse audience in any subject (Collopy & Arnold, 2009). Blended learning has the potential to drive positive learner experience which leads to learner satisfaction and retention (Fisher et al., 2018). Learners in a BLE improve continuously and even though the improvements are negligible, they are still noticeable (Pertwi, Kariadinata, Juariah, Sugilar, & Ramdhani, 2019). The potential a BLE has when it comes to delivering cost effective education on a scalable model makes it a subject that deserves interest (Brewer, 2011; Fisher et al., 2018).

Teaching within a BLE has a positive impact on the learning experiences of learners. Bernard et al. (2014) did a meta-analysis from literature pertaining the effects of BL and found that learners studying in a collaborative interactive learning environment and even in a teacher-directed one, outperforms the learners that are only engaged in self-study. On the one hand, learners have access to the TLE which learners feel serves as a support structure within the BLE and on the other hand learners have access to the online environment that gives them time to think and process outside of scheduled class time (Collopy & Arnold, 2009). The main conclusion of Collopy and Arnold’s (2009) study is that BL improves achievement even though the improvement is low it is still significantly greater than zero.

Blended learning can be independent of the time constraints that traditional settings face. Some of the advantages include, having more time for reflection, meeting more learners’ needs, improving active learning, and adding flexibility in teaching and learning leading to lower dropout rates (Caravias, 2018; Collopy & Arnold, 2009; Fitri & Zahari, 2019; King & Cerrone-Arnold, 2012).

#### **2.4.5 Educational disadvantages and barriers of BL**

Blended learning is a heavily dependent teaching and learning environment. Fitri and Zahari (2019) listed three possible disadvantages when it comes to teaching in a BLE, namely a dependency on infrastructure that is cumbersome especially in cases where the infrastructure is absent, internet access which is not equally spread over geographical landscapes, and facilities that are not owned by the participant. Powell et al. (2015) listed ICT constraints, such as access, infrastructure, hardware and software issues (the number one barrier), and financial limitations (another barrier especially when it comes to the maintenance of ICT).

#### **2.4.6 Learners' experiences within a BLE**

Learners generally have a positive learning experience when they are exposed to a BLE. It should also be noted that simply by integrating ICT into TLEs does not mean that all learners will be motivated or engaged to participate in the learning process (O'Byrne & Pytash, 2015). O'Byrne and Pytash (2015) argue that integrating ICT into the classroom should not drive instructional decision making; pedagogical goals and objectives should rather determine whether a BLE is best suited. Results obtained from a study involving the BL approach indicated that students demonstrated a positive learning experience within a BLE (Ahmad et al., 2008). Learners in a BLE feel more competent with course content due to the fact that there is a face-to-face component (Collopy & Arnold, 2009). Learners favour learning online and learning through the use of ICT integration, but they are reluctant to give up on traditional face-to-face modes (Güzer & Caner, 2014). Wong, Tatnall, and Burgess (2014) surveyed a group of learners and found there is a strong support for face-to-face teaching among these learners even though they are using OLEs. This positions BLEs perfectly as a mode of instruction. Findings by Fisher et al. (2018) support the notion that learners have a positive experience towards BL. They argue that BL contributes to the perceptions of student engagement, performance and satisfaction. This can be due to BL having the ability to address learners' need for face-to-face contact time whilst exposing them to ICT.

Bowyer and Chambers (2017) suggest that there is some evidence showing that learning in a BLE leads to an improvement of outcomes. They argue however that learners from non-traditional backgrounds only improve their course retention, but not necessarily improve the course outcome when learning in a BLE. Caravias (2018)

found that learners within a BLE develop higher order thinking skills due to ICT integration. Blended learning does not necessarily yield different results when achievement is the measuring variable, but positive changes are observed when measuring variables like motivation, satisfaction, attitude and knowledge retention (Güzer & Caner, 2014). Güzer and Caner (2014) found in a meta-analysis of recent literature that BL is perceived as useful, supportive, flexible and a motivator for learners.

There are several factors that lead to the successful experiences of learners within a BLE. Learners within a BLE have resilient learning strategies and a strong sense of self-motivation (Bowyer & Chambers, 2017). Teachers' expertise and the support they give learners emerge as influential factors on students' perceived achievement (Diep, Zhu, Struyven, & Blicek, 2017). Other factors that lead to successful BLEs are computer self-efficacy, system functionality and content features (Yuen, 2011).

#### **2.4.7 Teachers' experiences within a BLE**

Mathematics teachers can use a BLE to free up time for more efficient learning experiences. Teachers within a BLE can share material, lessons, opinions and assessment and also make use of shared online calendars, e-mail, discussion boards and blogs in conjunction with traditional activities such as tutorials and lectures (Caravias, 2018).

Successfully integrating ICT into a BLE is a complex task for teachers. Babić (2012) found that teachers tend to adapt slowly to the integration of ICT within a BLE due to its complexity. Babić (2012) argues that teachers need to redefine their existing competencies to understand the characteristics of high-quality education. This however is a daunting task when it comes to the role of the teacher within a BLE. Comas-Quinn (2011) argues that the success of any BLE depends largely on how well teachers adapt to the new roles that BL requires. The number of roles that a teacher takes on in a BLE surpasses that of a teacher in a TLE. In a qualitative study, Jokinen and Mikkonen (2013) interviewed three focus groups, each with four to six participants and found that the teachers experienced BL positively. They found that teachers who had no prior experience with teaching within a BLE were willing to teach according to BL principles, but quite easily defaulted back to the traditional approaches.



However, it was a challenging task to plan and design their teaching effectively. All the benefits of BL and ICT integration come at a risk of over worked teachers (Collopy & Arnold, 2009).

A quantitative study, with 138 participants, conducted by Diep et al. (2017) found that the success of any BLE depends on the teachers' academic expertise and ICT competence. Findings by Diep et al. (2017) are supported by recurring themes within the literature that indicate the success of any BLE depends on whether teachers are continuously and comprehensively trained and evaluated and whether learners have equitable access to the integrated ICT (Bowyer & Chambers, 2017). The opportunities for professional development must be ample and continuous (King & Cerrone-Arnold, 2012). Caravias (2018) argues that even though BL has numerous advantages, simply placing ICT in a classroom will have minor impact on learners if the teachers are not trained on how to integrate the ICT into their lessons. Therefore, schools' governance should make ICT skills training courses available so that teachers can integrate ICT effectively into the BLE. Teacher training with the purpose to develop teachers professionally cannot be undertaken by a one size fits all approach as teachers within a school environment generally differ in technology literacy from being experts to novices (Comas-Quinn, 2011).

Besides training on ICT integration in a BLE, teachers who actively teach within a BLE continuously develop professionally. O'Byrne and Pytash (2015) argue that BL has the potential to transform the teaching experience of any teacher and provide opportunities to challenge one's own practice in an attempt to create the best possible learning environment.

#### **2.4.8 Professional development and BL**

Teaching within a BLE is different than teaching in a TLE and teaching in an OLE. Teachers within a BLE must have more autonomy over course design, and this autonomy can be frightening if teachers are not professional and not exposed to best practices (Powell et al., 2015). Professional development for teachers within a BLE is the most influential success factor and if not addressed properly the BLE will most possibly not reach its full potential as teachers will not change their teaching practices (Jeffrey et al., 2014).

The study of Moodley (2018) implies that more room should be created for professional development workshops that will equip teachers with skills necessary for ICT integration. When considering these skills in terms of education, Kruger (2018) found that learner achievement in mathematics is linked to the access that their teachers have to professional development and ICT support.

#### **2.4.9 BL in mathematics education**

The integration of ICT in the teaching and learning of mathematics within a BLE must be planned strategically so that the capabilities of a well thought-out BLE can enhance the way learners and teachers learn, experience and do mathematics (Pertiwi et al., 2019). Pertiwi et al. (2019) found that learning mathematics within a BLE enhances learners' mathematical proving ability as well as their achievement. Tseng et al. (2014) found that learners' attitudes towards learning is enhanced when learning and teaching take place within a BLE and the effectiveness of learning mathematics improves. Findings like this indicate that most learners feel that learning in a BLE is a more efficient way of learning mathematics compared to traditional instruction (Tseng et al., 2014).

Pertiwi et al. (2019) warn about the potential disadvantages when ICT is not purposefully integrated within a BLE. These disadvantages may include less interaction between teachers and learners, facility availability (especially the lack of internet connections), difficulties to get learners to engage in productive discussions, and not positively contributing in terms of soft skills development during the learning process.

As stated, BL has the potential to transform education as a whole, but especially mathematics education. Van der Merwe et al. (2015) listed four strategies that can be used to introduce BL into the mathematics classroom in order to transform the teaching and learning experiences:

- a) Moving assessments online: Moving assessments like tests online is not only a great way to assess learner competency, but it also lightens the workload of the teacher. This will free up time that can be spent on enriching problems.
- b) Accessing resource materials: Many learners do not have access to books via libraries. Teachers can make reading material such as projects available online.

This will give learners access to a wider variety of content, enriching their horizons.

- c) Online tutoring: Tutoring online gives learners the ability to gain access to assistance outside of the normal classroom. This opens up a whole new world of learning opportunities.
- d) E-mail and messaging: E-mail is most probably one of the oldest tools for blending in the mathematics classroom. Teachers can inform and communicate with learners and their parents, keeping everyone informed.

#### **2.4.10 Teaching mathematics in the 21<sup>st</sup> Century and the implementations of BL**

Blended learning built on sound pedagogy and integrated with current ICT is what the 4IR is all about. A mixed methods study by Fitri and Zahari (2019) found that BL is urgently needed because education must prepare learners to be ready to work in the global market. Mlotshwa and Chigona (2018) argue that teaching in the 21<sup>st</sup> Century demands the thoughtful integration of ICT into curriculum delivery and BL can offer just that.

#### **2.4.11 BL in the South African context**

The South African education landscape has many challenges which BL offers solutions to, such as poor performance in international studies which measure mathematics achievements. Mlotshwa and Chigona (2018) studied the integration of ICT into two Grade 10 classes within a BLE and reported that learners were more engaged and it enhanced learner autonomy where learners showed the ability to take charge of their own learning. They argue that the reason for these findings is that tasks can be performed in a simpler yet more enhanced manner.

South Africa needs more BL projects to enhance the efficiency and effectiveness of teaching and learning experiences. Joubert (2013) notes that despite decades of research regarding the effectiveness of ICT in mathematics education, the degree to which the research has changed the educational landscape is questionable. One research project by Padayachee et al. (2011) is an example of how BL can contribute to the efficiency and effectiveness of teaching and learning experiences. Padayachee et al. (2011) started a BL project where they integrated digital video disk (DVD) technology with relevant course content and distributed it to 184 Grade 12 mathematics learners. The results were extremely positive, and they concluded that BL is a workable

teaching approach with definite advantages. These types of examples should provide teachers with the necessary insight to change the educational landscape in South Africa.

#### **2.4.12 Summary**

Blended learning as a pedagogical approach combines the best practices of online learning and face-to-face learning, promoting 21<sup>st</sup> Century skills like collaboration and problem solving. There are several modes of BL, making it scalable and possible to overcome barriers like time and space constraints. Well thought-out integration of ICT and BLEs has the potential to improve education.

There are numerous documented advantages and disadvantages of BL, but the main point of interest is the fact that learners experience learning within a BLE more positive. The main critique against BL is the additional preparation time required by teachers to successfully teach within a BLE. This criticism can be addressed if teachers are continuously developed professionally. BL has the potential to transform education especially in subjects like mathematics. Furthermore, BL offers possible solutions like efficiency and effectiveness of teaching mathematics and can possibly address the challenges in South Africa regarding poor performance in international studies like TIMSS.

### **2.5 Conceptual framework**

This study explores intermediate phase mathematics teachers' ICT integration in their teaching within a BLE by attempting to address the research questions stated in Chapter 1. In an effort to best address the research questions, I propose a conceptual framework that is an adaptation of the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003).

#### **2.5.1 The Unified Theory of Acceptance and Use of Technology framework**

Educators are generally slow to adapt to new technologies. BL is dependent on ICT and its integration into the teaching process. This lead me to the Unified Theory of Acceptance and Use of Technology framework (UTAUT) developed by Venkatesh et al. (2003). Venkatesh et al. (2003, p. 426) proved that the UTAUT framework can “assess the likelihood of success for new technology introductions and helps them understand the drivers of acceptance in order to proactively design interventions” with great accuracy.

The UTAUT framework “captures the essential elements of eight previously established models” and surpasses each of them (Venkatesh et al., 2003, p. 467). The eight models encompassed within the UTAUT framework are The Theory of Reasoned Action, The Technology Acceptance Model, The Motivational Model, The Theory of Planned behaviour, a model combining the Technology Acceptance Model and The Theory of Planned Behaviour, The Model of PC utilization, The Innovation Diffusion Theory, and The Social Cognitive Theory (Venkatesh et al., 2003).

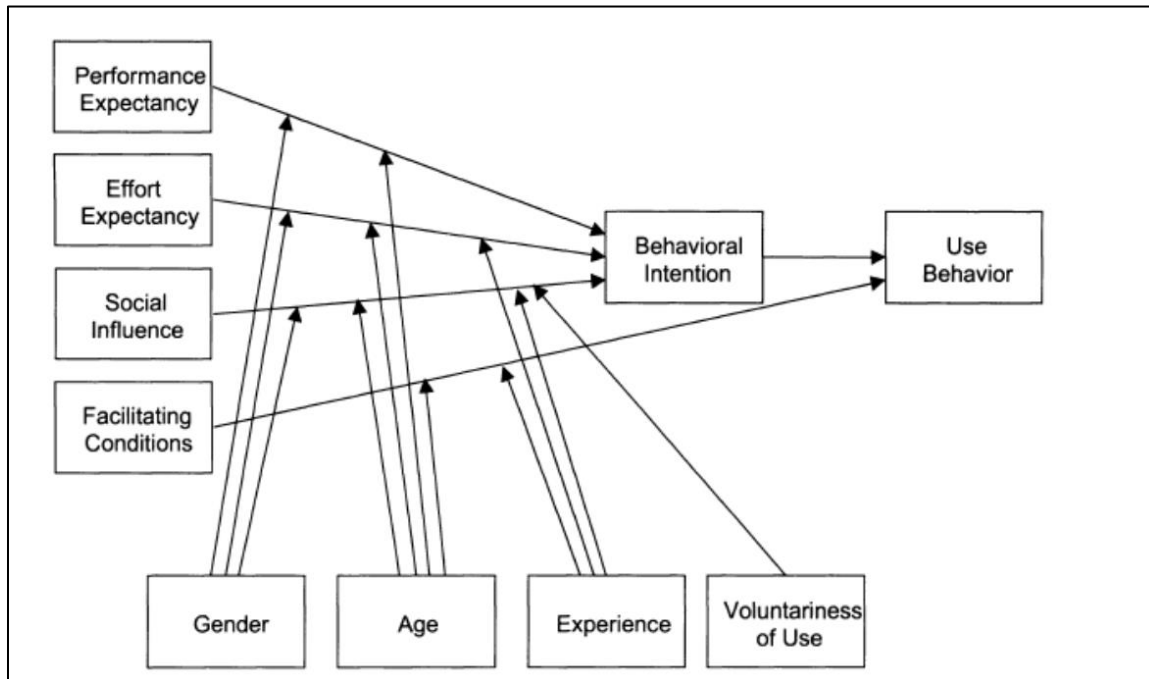


Figure 2.2: Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003, p. 447)

The UTAUT model was selected as the basis of the conceptual framework for this study due to its track record when it comes to explaining human behaviour. The four independent variables of the UTAUT model are performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC) (Venkatesh et al., 2003). Venkatesh et al. (2003) argue that these four constructs have a direct influence on whether people will accept and integrate ICT. Venkatesh et al. (2003) found that the UTAUT model explains as much as 70% of the variance in intention, thus it is an acceptable model to account for experiences by users, in this case experiences of mathematics teachers. The effects of the moderators (Gender, Age, Experience, and Voluntariness of Use) in UTAUT were excluded in this study, since

the study focussed on teachers already integrating ICT within a BLE, and were the constructs from the moderators' effects therefore not applicable.

Each of the four components, namely PE, EE, SI and FC of the UTAUT model depicted in figure 2.2 will be discussed in more detail in the following sections. Next, the adapted version of the UTAUT model that is used in this study will be discussed. This is not uncommon, as amended versions are often proposed and utilised (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2019).

### **2.5.2 Conceptual framework: An adaptation of the UTAUT framework**

The aim of this study is to explore intermediate phase mathematics teachers' ICT integration within a BLE and the root constructs together with their subconstructs are good indicators thereof. Venkatesh et al. (2003) theorised that PE, EE and SI affect the behavioural intention (BI). In this study BI refers to intermediate phase mathematics teachers' intention to integrate ICT within a BLE for teaching and learning. The subconstructs of PE, EE and SI were explored using an observation schedule and a semi-structured interview. The teachers' BI together with the FCs are indicators of teachers' behavioural use (BU) as depicted in Figure 2.3 (Venkatesh et al., 2003). The BU in this study refers to the actual integration of ICT within a BLE. The root constructs together with their corresponding subconstructs will be examined in more detail in the paragraphs that follow.

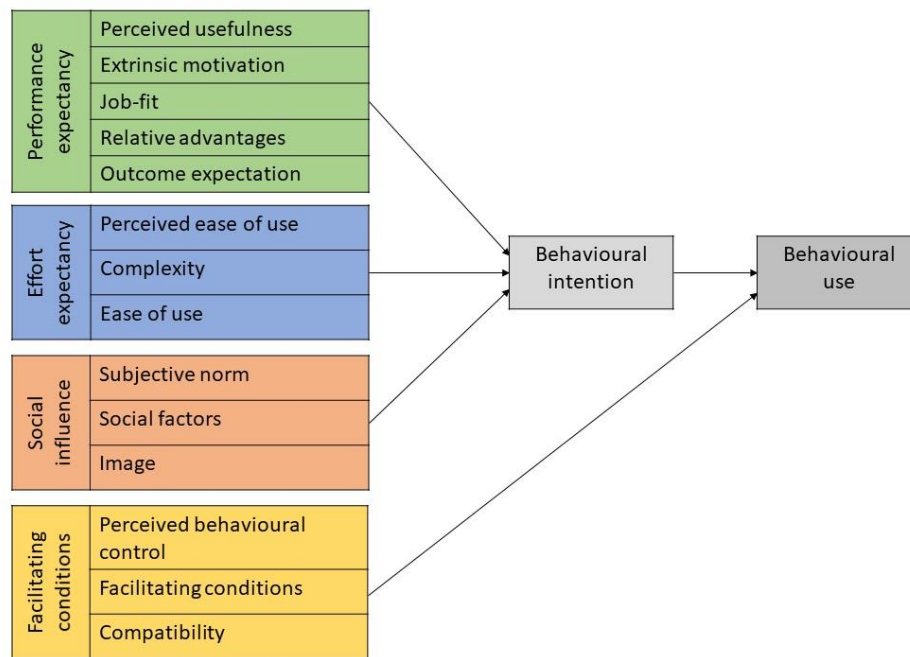


Figure 2.3: Conceptual framework: Adapted UTAUT framework (Venkatesh et al., 2003)

### 2.5.2.1 Performance Expectancy (PE)

Venkatesh et al. (2003) defines PE as the degree to which an individual believes that integrating ICT will help him or her to gain vocational performance. In this study, PE will be defined as the degree to which intermediate phase mathematics teachers' integration of ICT within a BLE will enhance the teaching and learning experiences. This might influence their intention to integrate the ICT in their classrooms.

Venkatesh et al. (2003) grouped five constructs from the various models under PE, namely perceived usefulness, extrinsic motivation, job-fit, relative advantages, and outcome expectation. Venkatesh et al. (2003) state that PE is the strongest predictor of ICT integration success both in voluntary and involuntary settings. The five root constructs of PE are defined by Venkatesh et al. (2003) as follows:

- Perceived usefulness refers to the degree to which intermediate phase mathematics teachers believe that by integrating ICT into their lessons, it will enhance their teaching experience and the learners' learning experiences.
- Extrinsic motivation refers to intermediate phase mathematics teachers' perception that by integrating ICT within a BLE may lead to learners' engagement in the lesson.

- Job-fit refers to how intermediate phase mathematics teachers' teaching experiences and learners' learning experiences are enhanced by the integration of ICT.
- Relative advantages refer to the degree to which integrating ICT within a BLE is better for the teaching and learning experiences of learners than it is not.
- Outcome expectation relates to the positive teaching-related consequences of integrating ICT within a BLE. The outcome expectations are personal, thus only observable through the data collected with the semi-structured interviews.

### **2.5.2.2 Effort Expectancy (EE)**

Venkatesh et al. (2003) define EE as the degree of ease associated with the integration of ICT. In this study EE will be defined as the ease associated by teachers with regard to integrating ICT into a BLE which might influence teachers' intention to integrate the ICT.

There are three constructs from existing models captured in the concept of EE. These constructs are perceived ease of use, complexity, and ease of use. Venkatesh et al. (2003) argue that if the integration of ICT into a BLE is perceived too challenging, then teachers will not do it. The three root constructs of EE are defined by Venkatesh et al. (2003) as follows:

- Perceived ease of use is the extent to which individuals believe that using ICT will be free from effort (Venkatesh et al., 2003). Venkatesh et al. (2003) propose that the perceived ease of use will directly influence the perceived usefulness since ICTs that use less effort will lead to higher performance. In this study perceived ease of use refers to the intermediate phase mathematics teachers' beliefs that the integration of ICT will be free from effort.
- Complexity is the inverse of perceived ease of use and suggests that when the use of ICT is perceived as too challenging, teachers will not integrate it in their lessons (Graham et al., 2020). In this study complexity refers to the complexity of navigating the OLE and integrating the relevant ICT.
- Ease of use is similar to perceived ease of use but contrasting to complexity, and in this study it refers to the degree to which ICT is easy to learn and use.



### **2.5.2.3 Social Influence (SI)**

Venkatesh et al. (2003) define SI as the importance an individual gives to the perception of others on his/her ICT integration. For the sake of this study, SI is defined as the degree to which intermediate phase mathematics teachers believe that stakeholders like the School Governing Body (SGB), school principal, department head, colleagues, parents and learners believe he/she must integrate ICT into a BLE.

SI is composed of three main constructs, namely subjective norm, social factors, and image. According to Venkatesh et al. (2003) none of these constructs are significant on voluntary contexts, but becomes significant when ICT integration is mandated. The three root constructs of SI are defined by Venkatesh et al. (2003) as follows:

- Subjective norm refers to the intermediate phase mathematics teachers' perceptions that learners, parents, the Head of Department (HoD), the principal and the School Governing Body (SGB) think it is important to integrate ICT, especially within a BLE.
- Social factors refer to what intermediate phase mathematics teachers think they ought to do, as set out by the work culture of the other intermediate phase mathematics teachers. For example, if everyone does it and it is the subjective culture of all the intermediate phase mathematics teachers.
- Image are also referred to as social approval and refers to the degree to which intermediate phase mathematics teachers see the integration of ICT as an improvement of social status which may include popularity among peers.

### **2.5.2.4 Facilitation conditions (FC)**

Venkatesh et al. (2003) define FC as the degree to which an individual believes that an organisational and technical infrastructure exist to support the integration of ICT. In the case of this study FC would be defined as an intermediate phase mathematics teacher's belief that the school infrastructure and the OLEs infrastructure exist and will support if any technical difficulties occur.

There are three main constructs embedded within FC and are listed as perceived behavioural control, facilitating conditions, and compatibility (Venkatesh et al., 2003). The effect of FC decreases as teachers gain more experience integrating ICT within a BLE as they discover multiple avenues for help and support. The three root constructs of FC are defined by Venkatesh et al. (2003) as follows:

- Perceived behavioural control reflects perceptions of internal and external constraints on behaviour and encompasses self-efficacy, resource facilitating conditions, and technology facilitating conditions. Perceived behavioural control directly influences behavioural intention and consequently behavioural use and in this study refers to the perceived ease or difficulty to integrate ICT within a BLE.
- Facilitating conditions refers to the support available to the intermediate phase mathematics teachers when they would experience ICT difficulties.
- Compatibility of ICT integration within a BLE refers to the extent to which the ICT complies with the intermediate phase mathematics teachers' established values regarding ICT integration and their teaching needs.

#### **2.5.2.5 Behavioural intention (BI) and behavioural use (BU)**

The constructs PE, EE and SI of the UTAUT model influence BI (Venkatesh et al., 2003). BI in this study would be defined as a teacher's intention to integrate the ICT within a BLE. Due to the nature of the context, it will not be directly measured in this study as all the teachers already integrate various forms of ICT into different modes of BL.

The construct FC of the UTAUT model is the only construct that directly influences the BU of ICT integration while the other constructs indirectly influences the BU of an individual (Venkatesh et al., 2003). BU in this study refers the integration of ICT within a BLE or a TLE.

## **2.6 Conclusion**

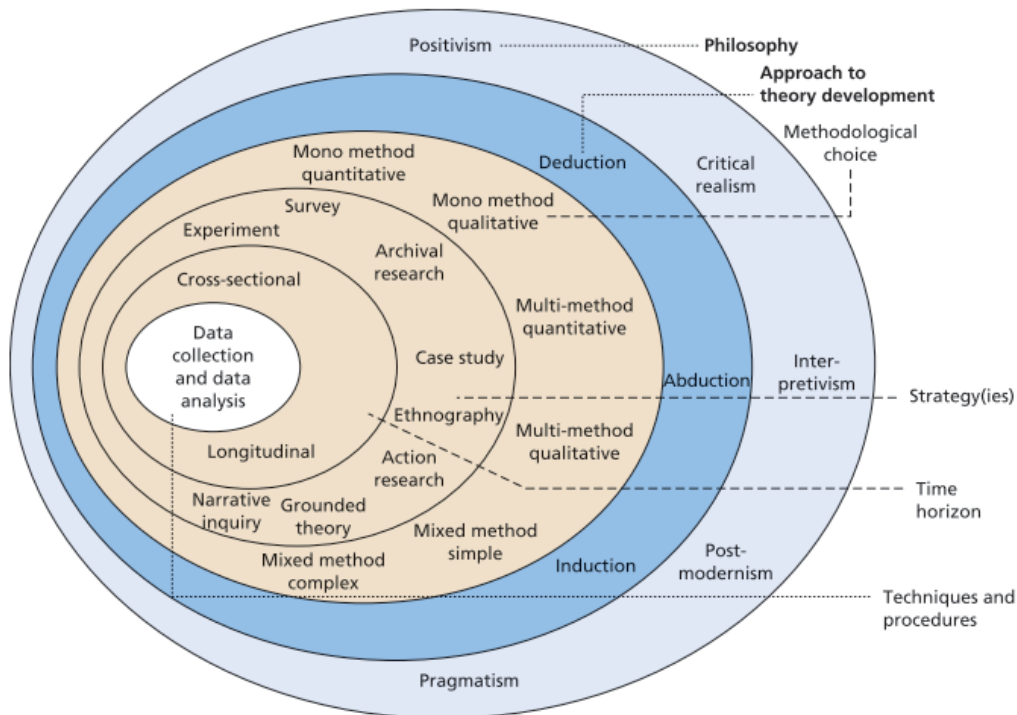
Chapter 2 provided an overview of all the literature consulted prior to the start of this study. An overview of the current educational landscape in the South African context were given together with arguments that support the call for reform. The call for reform stems from the notion that the current education environment, a traditional learning environment, is not equipping South African learners with the 21<sup>st</sup> Century skills that they need to flourish in the 4IR. Blended learning as a pedagogical teaching approach in conjunction with the integration of ICT, especially within the mathematics classroom, were examined. Lastly the development and discussion of a conceptual framework were presented that served as a guide in gathering the necessary data in order to address the research questions.

The following chapter, Chapter 3, will provide the necessary background and a discussion on the research methodology used for the purposes of this study.

## CHAPTER 3: RESEARCH DESIGN

### 3.1 Introduction

This chapter explains the research design of the study. The research design is explained in terms of a research design model proposed by Saunders, Lewis, and Thornhill (2016), depicting the process of data collection as the centre of a layered process. The model is known as the research “onion” (see Figure 3.1 below) due to the different layers of the research process, namely research philosophy, approach to theory development, methodological choice, strategies, time horizon, and techniques and procedures.



**Figure 3.1: The research "onion" (Saunders et al., 2016, p. 123)**

This chapter is structured according to the different layers of the research onion and it also includes discussions about ethical considerations and quality criteria. Firstly, considerations regarding the outer layer, the research philosophy, is presented below.

### 3.2 Research philosophy, paradigmatic assumptions and approach to theory development

This research will follow an interpretivist philosophy because the researcher is interested in the complexity of the participants' views and experiences. Cohen et al.

(2007, p. 21) stated that the interpretive world view's central endeavour is "to understand the subjective world of human experience". The main purpose of interpretivist research, according to Saunders et al. (2016), is to create new understandings and interpretations of specific contexts. Thus, the interpretivist paradigm will enable me, the researcher, to meaningfully address the research questions.

This study aims to explore the experiences of three participants who were intermediate phase mathematics teachers integrating ICT within a BLE. Interpretivist researchers (Saunders et al., 2016) also acknowledge that different people under different circumstances and at different times make different meanings, and in this way they create and experience different realities. Although the three participants were all from the same school, their personal contexts differed and an interpretive paradigm ensures that the richness of the differences between the participants are not lost (Saunders et al., 2016). As an interpretivist researcher in this study, I did not attempt to reduce findings of the research to generalisations of the three participants, but rather attempted to gain rich insights into the uniqueness and complexity of each participant.

An interpretive researcher sees meaning as something that emerges from observations and social interactions (Saunders et al., 2016). In the case of this study, data collection was done in the form of classroom observations and semi-structured interviews with the participants. Although the focus of the study is on participants' integration of ICT in a BLE, the participants were observed in both a TLE and a BLE to see if there are any noticeable differences in behaviour in terms of ICT integration when teaching within the two different learning environments. The reason being, that I believe that the integration of ICT within a BLE can be better understood against the backdrop of a TLE and will therefore provide richer data.

The paradigmatic assumptions of this study rely on the description provided by Creswell et al. (2007). They refer to ontological, epistemological and methodological assumptions (Creswell et al., 2007). The ontological assumption of the paradigm underpinning this research study is relativism as it assumes that multiple realities exist as experienced by the participants. The epistemological assumption is subjective as I became an 'insider' by spending time in the field with the participants, attempting to reduce the distance between the teachers and myself. Finally, this study's

methodological assumption is qualitative in nature as I studied the participants within a bounded context and deductively analysed the phenomenon.

Deductive data analysis was used in this study. Deductive data analysis was used as the data was analysed and related against the available literature (Saunders et al., 2016, p.74)".

### **3.3 Methodological choice**

The research approach taken in this study was qualitative in nature because I had to explore the subjective experiences of the participants within a specific context (Creswell & Poth, 2017). The reason for choosing a qualitative research approach was that it enabled me to explore the participants' experiences, collecting data based from a small sample, in order to have insight into their unique worlds and views. The specific methodological choice of this research design was "multi-method qualitative" as data was gathered from a semi-structured interview and an observational schedule (Saunders et al., 2016, p. 168). The intention was not to control the context but to experience it first-hand with the participants as they integrate ICT within a BLE, with no interference from my side. Table 3.1 provides an outline of the research methodology design of this study.

**Table 3.1:** Outline of the research methodology design

Research method	Multi-method qualitative			
Research strategy	Exploratory case study			
Primary research question	How do intermediate phase mathematics teachers' experience ICT integration within a BLE?			
Secondary research questions	Question 1: What is the performance expectancy when teaching with ICT within a blended learning environment?	Question 2: What is the effort expectancy when teaching with ICT within a blended learning environment?	Question 3: How do social influences affect teaching with ICT in a blended learning environment?	Question 4: What are the facilitating conditions (FC) when teaching with ICT within a blended learning environment?
UTAUT model's root constructs	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions
Participants	Three intermediate phase mathematics teachers were chosen through purposive sampling.			
Data collection techniques	<ul style="list-style-type: none"> <li>Semi-structured interviews: One individually conducted semi-structured interview which was recorded using an audio tape recorder.</li> <li>Observation schedules: Observational notes were captured with a schedule according to the conceptual framework. Video recordings were also made of the lessons to assist the note taking process. and The observation schedules were triangulated with the interview data to ensure validity.</li> </ul>			
Techniques per questions	Question 1: Semi-structured interviews Observation schedules	Question 2: Semi-structured interviews Observation schedules	Question 3: Semi-structured interviews	Question 4: Semi-structured interviews Observation schedules
Data analysis	<p>A deductive approach to analysing the data was used (Creswell &amp; Poth, 2017; Saunders et al., 2016). This includes the following:</p> <ul style="list-style-type: none"> <li>Managing and organising the data</li> <li>Reading texts and making notes</li> <li>Grouping the data according to root constructs</li> <li>Transcribing the data verbatim from the audio recording</li> <li>Assigning codes to the data according to the conceptual framework</li> <li>Relating data to the research questions</li> </ul>			

### **3.4 Research strategy and time horizon**

An exploratory case study is a qualitative approach where the researcher explores a case over time through in-depth data collection involving multiple sources followed by a descriptive report of the case (Cohen et al., 2007). Cohen et al. (2007, p. 253) argue that case studies can “establish cause and effect, indeed one of their strengths is that they observe effects in real contexts, recognising that context is a powerful determinant of both causes and effects” where the causes relate to the intentions of the participants and the effects to their actual integration of ICT. The small sample size of this case enabled me to capture the uniqueness and complexity of the particular case (Cohen et al., 2007; Yin, 2002) consisting of one Grade 4, one Grade 5, and one Grade 6 teacher, teaching mathematics at a rural primary school in South Africa.

This case study is a cross-case analysis. Creswell and Poth (2017) point out that when multiple cases are chosen, then a detailed description of each case (within-case analysis) is provided followed by a cross-case analysis. A cross-case analysis involves examining themes across cases to discern themes that are common and different to all the cases (Creswell & Poth, 2017).

Case studies are considered to be “a step to action” (Cohen et al., 2007, p. 257). This is advantageous, because it contributes to the real life of the participants and the community as participants’ insights may be directly interpreted and put to use (Cohen et al., 2007). The main limitation of a case study is its inability to generalise across a larger population due to the small sample size (Saunders et al., 2016). I, the researcher, can therefore not assume that the reality of one participant reflects the reality of the others. The aim of this study is not to generalise to a population but to generalise to an existing conceptual framework. Saunders et al. (2016, p. 185) describe this type of case study as a “case study [which] is likely to use a deductive approach, using theoretical propositions to test their applicability in the case study, to build and verify an explanation”.

### **3.5 Research techniques**

The following section explains the sampling procedures, research site and the participant selection together with the instruments used to collect the data and the data collection process.



### 3.5.1 Sampling procedures, research site and selection of participants

This research followed a purposive sampling technique when selecting three intermediate phase mathematics teachers. As Cohen et al. (2007, p. 114) pointed out, purposive sampling is a “feature of qualitative research, researchers handpick the cases to be included in the sample” on the basis of their own judgment. Table 3.2 below lists the criteria for inclusion and exclusion as part of the purposive sampling.

**Table 3.2:** Inclusion and exclusion criteria for schools and teachers

Criteria	
Inclusion	<ul style="list-style-type: none"> <li>• The medium of instruction at the school for the subject of mathematics must be Afrikaans. The reason is that the OLE is only available in Afrikaans.</li> <li>• The school must have uncapped access to the internet.</li> <li>• The school must have ICT infrastructure to support the programme.</li> <li>• The school must have ICT to communicate with the researcher either via e-mail or via Skype.</li> <li>• The teachers must be qualified mathematics teachers teaching in the intermediate phase.</li> </ul>
Exclusion	<ul style="list-style-type: none"> <li>• Private schools</li> <li>• Urban schools</li> <li>• Temporary teachers</li> </ul>

The teachers are from a single medium public school in a rural district of the province of the Northern Cape. This school was chosen because the funders of the BL project (see Chapter 1) specified the criteria of where the project needs to be piloted. Rural schools face numerous challenges and the funders of the BL project believe that the project will uplift the educational standard of rural schools in South Africa. The reason for selecting a single medium school is due to the funders’ firm belief in mother-tongue education. Furthermore, the OLE that forms part of the BL project is only available in the single medium of Afrikaans.

In this study the instructional practices of three intermediate phase mathematics teachers, teaching different grades, were observed and analysed. Intermediate phase teachers were chosen as the participants, because the BL project has developed useful content for the OLE in the intermediate phase. There is only one mathematics teacher per grade for the intermediate phase at the selected school, thus, by default, I selected one teacher from Grade 4, one teacher from Grade 5 and one teacher from Grade 6 for the case study.

### 3.5.2 Data collection process

The data collection took place in the fourth quarter of 2019. The data collection was done at a rural public school in the Northern Cape province. Before the commencement of the data collection process, the school principal, teachers and School Governing Body (SGB) were contacted to discuss the study and to request participation. After permission was granted, all further communication during the data collection process were made directly with the participants.

Two forms of data collection instruments were used during the data collection period, namely an observation schedule and a semi-structured interview. Four scheduled observations per participant were done in the fourth school term of 2019, two in which the teacher taught in a TLE and two where the teacher taught in a BLE. The observation schedule was used to capture data during observations through means of note taking on pre-determined categorical codes. For the purposes of the semi-structured interview an audio recorder was used to capture data during these interviews. Interviews were scheduled throughout the academic day between breaks, to nullify the impact on formal teaching time. The one-on-one interviews were conducted in the staff room and lasted a maximum of 50 minutes. Table 3.3 below gives a timeline indicating the dates on which the participants were observed and interviewed.

**Table 3.3:** Timeline of the data collection process

Participant	Data collection instrument	Date in 2019
Teacher A	Observation schedule – BLE	15 October
	Observation schedule – BLE	15 October
	Observation schedule – TLE	17 October
	Observation schedule – TLE	17 October
	Semi-structured interview	18 October
Teacher B	Observation schedule – TLE	14 October
	Observation schedule – TLE	14 October
	Observation schedule – BLE	16 October
	Observation schedule – BLE	16 October
	Semi-structured interview	18 October
Teacher C	Observation schedule – TLE	14 October

	Observation schedule – TLE	14 October
	Observation schedule – BLE	17 October
	Observation schedule – BLE	17 October
	Semi-structured interview	18 October

### **3.5.3 Data collection instruments**

Data were collected via two different data collection instruments. More details regarding the instruments are explained in the following section.

#### **3.5.3.1 Observation schedule**

An observation schedule (See Appendix E: Observation Schedule) was used to allow for information to be documented in class during observation. During this data collection period, the participants integrated the ICTs into their lessons and I observed and took notes. I observed four lessons of each participant over a period of one full academic week (5 days). The four lessons were separated into two lessons taught in a TLE and two lessons in a BLE. The BLE consisted of ICT integration using one of the modes of BL (see section 2.4.2) and the other was a TLE where ICT integration was used within the traditional teaching styles like teacher-led instruction.

#### **3.5.3.2 Semi-structured interviews**

During the second part of the field visit, I spent about 30-60 minutes with each participant in a semi-structured interview (See Appendix D: Interview schedule). The questions asked during the semi-structured interview were structured around the variables of the conceptual framework using an interview schedule. The semi-structured interviews were audio recorded and stored for later coding and analysis.

#### **3.5.3.3 Data analysis procedure: transcribing the data and assigning codes to root constructs**

A deductive approach toward data analysis was used according to a set of pre-determined codes based on the conceptual framework of this study and related to literature (see Figure 2.3). The data were sorted into the four categories based on the four root constructs, namely performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). The behaviours, gestures, and responses of the participants during the classroom instruction and the semi-structured

interview were recorded via an observation schedule and interview schedule respectively. Each one of the four root constructs were analysed and interpreted separately and all three participants' data from the observation schedules and semi-structure interviews were grouped together.

Participants were asked to comment on the observation and semi-structured interview transcripts as a form of member checking. At the end of the data collection process, time was allocated for comments by the participants so that the participants can check the data.

### **3.6 Quality criteria**

One method to ensure quality research is to make use of data validation. Triangulation is a validating technique making use of multiple and different sources (Creswell et al., 2007). The data gathered with the observation schedule was corroborated with the data from the semi-structured interviews and vice versa to ensure that my bias does not surface.

Another measure that can be taken to ensure quality research, Cohen et al. (2007) suggest that all interviewees should receive the exact same interview questions in the same order, and they should be interviewed within the same context. Each one of the participating teachers were interviewed in the school staffroom during a free period and they received the exact same questions in the same order as per interview schedule. Lastly, credibility was achieved by allowing the participants to intentionally assess their responses in order to correct factual errors as proposed by Cohen et al. (2007).

### **3.7 Ethical considerations**

Ethical clearance was requested and received from the Ethics Department of the University of Pretoria and the Northern Cape Department of Education. Informed consent was obtained from the participants for the recording of classroom instruction and semi-structured interviews. Consent was also obtained from all relevant stakeholders for the recording of classroom instruction this includes consent from the principal, the teachers, the learners and the legal guardians of the learners. All participants were participating on a voluntary basis and were free to withdraw at any stage of the study. All the collected data are now in the possession of the University of

Pretoria as it is the institutional property of the university and will be in safe keeping at the university.

Participants were informed about the study's rationale and purpose and their role within the study. The participants signed a letter of consent approved by the Ethics committee of the University of Pretoria (see Appendix 7.1 and 7.2). The letter of consent confirms that each participant's anonymity and confidentiality is guaranteed.

Participants' confidentiality, anonymity and privacy was upheld during the data collection process. The name of the school is not mentioned in this study and the participants were allocated pseudonyms to ensure that confidentiality, anonymity and privacy are adhered to.

### **3.8 Conclusion**

Chapter 3 explained the research methodology of this study and is structured according the "research onion". Explanations for the study's interpretivist world view were given and its qualitative nature is explained. Thereafter, reasons for the use of a case study as the appropriate research strategy was discussed. The study's research techniques were given in terms of sampling procedures, research site description and selection of participants followed by the data collection process and the instruments for data collection. The chapter concluded with the study's approaches towards data analysis, quality assurance and the ethical considerations that were taken into account.

In the next chapter, the data are presented and analysed.

## CHAPTER 4: ANALYSIS AND PRESENTATION OF DATA

### 4.1 Introduction

This chapter presents a discussion on the data collected, grouped according to the root constructs of the conceptual framework. An overview of the process for data collection and data analysis will follow this introduction, followed by the coding of the data and the presentation of the three participants' data according to the four root constructs.

### 4.2 Process for data collection and data analyses

Although the complete data collection process is discussed in Chapter 3, I just want to remind the reader that the data collection started with four lesson observations of each participant. Two of these lessons were taught within a BLE and two within a TLE. The lesson observations were followed by one individual semi-structured interview per participant.

Data from the observations were recorded using an observation schedule (see Appendix E: Observation Schedule) and video recordings were made to have a clear record of what happened in class. The observation schedules were completed during the observed lessons and the video recordings were used to verify whether the observation schedules were accurately recorded or whether important observations were missed.

All captured data from both the observations and interviews were captured using a Microsoft Word template of an observation schedule and interview schedule (See Appendix D: Interview schedule and Appendix E: Observation Schedule). The data captured from the audio recordings of the semi-structured interviews were transcribed, translated and then tabulated in Microsoft Word (See Appendix F: Collected data of all participants). Interview questions correlated to the root constructs were grouped together and colour coded in the same manner. In-class observations were noted on the observation schedule (See Appendix E: Observation Schedule) in as much detail as possible and corroborated with the video recordings.

### 4.3 Coding of data

The following table connects the sub-constructs of each of the root constructs as proposed by Venkatesh et al. (2003) to the different items in both the data collection

instruments, namely observations and interviews. Each of the root constructs and sub-constructs of the UTAUT model is also specifically defined to make it applicable to this study.

**Table 4.1: Data collection instruments related to the conceptual framework**

Root constructs	Sub-construct and assigned code	Summary of sub-constructs	Observation scheduled	Semi-structured interviews
Performance Expectancy	Perceived usefulness (PU)	The participants' belief that the integration of ICT will improve teaching and learning experiences.	1.1 1.2 1.4	1.1 1.3 1.4 1.5 1.6
	Extrinsic motivation (EM)	The participants' perception that the integration of ICT will lead to learner engagement.	NA	1.1 1.6
	Job-fit (JF)	The enhancement of the teaching and learning experiences due to ICT integration.	1.3 1.4	1.1 1.3 1.5
	Relative advantage (RA)	The degree to which it is better to integrate ICT than to not integrate it.	1.4	1.2 1.6
	Outcome expectations (OE)	This refers to the positive teaching related consequences of ICT integration.	1.3	1.2 1.4
Effort Expectancy	Perceived ease of use (PEU)	The degree to which ICT integration will be free from effort.	2.1	2.2 2.3 2.4
	Complexity (CP)	The complexity of navigating the OLE and integrating ICT in conjunction with the OLE.	2.2	2.1 2.2 2.4 2.5
	Ease of use (EOU)	The degree to which it is easy to learn and use the OLE and ICTs.	2.3	2.3 2.6 2.7 2.8
Social Influence	Subjective norm (SN)	The participants' perception that important stakeholders think it is important to integrate ICT in a BLE.	NA	3.1 3.2 3.3
	Social factors (SF)	The degree to which the participants feel compelled to integrate ICT and use the OLE due to the work culture of their immediate colleagues, that is other teachers.	NA	3.2 3.5
	Image (IM)	The degree to which the use of the OLE and the integration of ICT will lead to improvement in social status.	NA	3.4
Facilitating Conditions	Perceived behavioural control (PBC)	The difficulty to integrate the OLE and ICT within a BLE.	4.2 4.3	4.1-4.7
	Facilitating conditions (FS)	The availability of support to assist participants when they experience difficulties with either the ICT or the OLE.	4.1	4.8 4.9
	Compatibility	The degree to which the integration of the ICT and OLE complies with the participants' values.	4.2	NA

In order to present the data for each participant, pseudonyms were used. From this point onwards the participants will be referred to by their pseudonyms: Teacher A (TA), Teacher B (TB), and Teacher C (TC).

#### **4.4 Presentation of the data**

A summary of the contexts of the observed lessons of the three participants is presented in Table 4.2. The grey shaded blocks, in all the tables, represent lessons taught within a BLE. The information is provided in terms of four constructs: The learning environment which was either a BLE or a TLE; the ICT integrated in the lesson; the number of learners (NOL) present during the lesson; and the topic presented by each participant. For example, Lesson 1 of Teacher A was conducted within a TLE by means of teacher-led instruction. TA integrated several forms of ICT, such as a projector, laptop, printer, and presenting a PowerPoint presentation. The number of learners (NOL) present in the lesson was 46 and the lesson topic revolved around two-dimensional forms as described within the Curriculum Assessment Policy Statements (CAPS). This information about the lessons is useful to provide the context of the research setting.



**Table 4.2: Summary of the three participants' lessons**

Information / Participant		TA	TB	TC
Lesson 1	Learning environment	TLE with teacher-led instruction	BLE with "in-flipping" as mode of instruction	TLE with teacher-led instruction
	ICT integrated	Projector, laptop, printer, and PowerPoint	Projector, laptop, the OLE, internet, and speakers	None
	NOL	46	43	33
	Topic	2-D forms	Measurement	3-D forms
Lesson 2	Learning environment	TLE with teacher-led instruction and group work	BLE with "in-flipping" as mode of instruction.	BLE with "in-flipping" as mode of instruction
	ICT integrated	Projector, laptop, and PowerPoint	Projector, laptop, the OLE, internet, and speakers	Projector, laptop, the OLE, internet, and speakers
	NOL	46	43	33
	Topic	2-D Forms	Measurement	3-D forms – Nets
Lesson 3	Learning environment	BLE with Rotation as mode of instruction	TLE with teacher-led instruction and group work	BLE with "in-flipping" as mode of instruction.
	ICT integrated	Projector, laptop, the OLE, internet, tablets, and speakers	Projector, laptop, the OLE, internet, and speakers	Projector, laptop, the OLE, internet, and speakers
	NOL	46	43	33
	Topic	Fractions	Surface area and volume	3-D forms - Nets
Lesson 4	Learning environment	BLE with Rotation as mode of instruction	TLE with teacher led instruction	TLE with teacher led instruction
	ICT integrated	Projector, laptop, the OLE, internet, tablets, and speakers	None	None
	NOL	46	43	33
	Topic	Fractions	Surface area and volume	Circumference

#### 4.4.1 Teacher A

At the time of the study, TA was a 23 year old female teacher with a Baccalaureus Educationis (BEd) degree. She was in her second year as a registered professional

teacher with one year of teaching experience in mathematics. TA teaches mathematics to Grade 4 learners. TA is a self-taught ICT user.

#### 4.4.1.1 Performance Expectancy (PE)

The data regarding the PE of TA exhibiting the integration of ICT within the different learning environments is tabulated below. The data presented in Table 4.3 was gathered from the observation schedule. Data from the semi-structured interview relating to the five sub-constructs of PE are presented after the table. Data for the outcome expectations are personal, thus only explored through the data collected from the semi-structured interview. The same is true for extrinsic motivation, as it could not be observed through the observation schedule, it was only explored through the interview.

**Table 4.3: Exhibition of ICT integration of TA's PE within two different learning environments**

	<b>Traditional Learning Environment</b>	<b>Blended Learning Environment</b>
Perceived usefulness	<p>TA integrated presentation software to present lesson content on a white board situated in the front of the classroom. Even though she integrated ICT into the lesson she frequently reverted to the black board to draw 2-D models instead of using presentation software. It appears that TA do not integrate ICT in a supporting manner when teaching within a TLE.</p> <p>TA did not integrate ICT into the lessons to assist with routine tasks. For example, TA made use of a teaching assistant to record the marks of learners' assessment onto a paper recording sheet and to calculate the marks by hand. Routine tasks like these can easily be done with spreadsheet software.</p> <p>TA used the black board to illustrate explanations and appeared to be calmer when making use of the "chalk-and-talk" approach teaching within a TLE.</p>	<p>TA made use of the rotational BL mode because there were not enough tablets for all the learners. Rotational BL mode allows for the differentiation of tasks. She grouped the learners in five groups. Three of the groups worked at their own pace on the OLE with school tablets. The other two groups worked with material provided by TA. This strategy did not work as the majority of the learners were not familiar with the OLE's user interface nor with the operating system of the tablets. This resulted in frequent questions about ICT instead of mathematics problems. The classroom discipline deteriorated as the lesson progressed.</p>

Job-fit	There is no observable enhancement of TA's teaching experiences within a TLE as the learners are not engaged and are demonstrating ill-discipline. This is despite TA integrating ICT into the lesson.	TA made use of the rotational BL mode and had several tasks that were differentiated. In theory TA's plan was very good as it was supposed to make learning accessible to everyone, but she struggled to manage all the groups efficiently which led to ill-disciplined learners.
Relative advantage	There was no visible indication that the teaching and learning experiences were improved when TA integrated ICT in the lessons taught within a TLE.	Due to the nature of a BLE, the ICT integration frequently led to unnecessary troubleshooting and worsened the quality of the teaching and learning experiences. For example, in Lesson 4 the integration of ICT within a BLE led to disengaged learners and led to wasting valuable teaching and learning time. The ICT usage caused several problems and complicated the teaching strategies used by TA.

During the semi-structure interviews TA argued that the learners normally retain information better when content is presented by means of PowerPoint presentations and video material. She based this claim on comparing her classes' results with the results of the previous year when it was taught within a TLE with little to no ICT integration. It should be mentioned that this is the first year TA integrated ICT within a BLE and even though she has acute experience she affirms that integrating ICT improves the quality of the learning experiences of the learners.

TA expressed the belief that the use of videos and sound captured learners' attention and interest and leads to greater learner participation. TA emphasised that information retention also improved when teaching with ICT, and this leads to improvement in learner performance. She pointed out that the integration of ICT gets the attention of the learners and kept them engaged.

The main reason why TA integrates ICT is that "it saves time". All typed-out work can be saved and re-used in the coming years. She highlighted that the videos and sound that accompanies the ICT integrated lessons, are of great interest to the learners. TA

found that the learners that experienced ICT rich lessons, outperformed learners of the previous year who did not have the same access to ICT.

TA argued that she must integrate ICT into their lessons seeing that “kids are growing up with it”. She highlighted that learners get bored with textbook content and that ICT integration increased learner participation. TA also mentioned that the integration of ICT is necessary to remain competent in the eyes of the learners because if one does not keep up with ICTs, “you are not going to be of interest to them”.

TA did not explicitly mention the possibility of extrinsic motivations serving as the driving force behind ICT integration when asked what she thought the main reason is why individual teachers should integrate ICT.

#### 4.4.1.2 Effort Expectancy (EE)

The following table compares the relevant sub-constructs regarding EE of TA within the two different learning environments.

**Table 4.4: Comparison of the teaching experiences of TA's EE within two different learning environments**

	Traditional Learning Environment	Blended Learning Environment
Perceived ease of use	TA integrated ICT effortlessly in the first lesson by using presentation software and in the second lesson she did not interact with the ICT at all.	TA struggled to integrate the ICT in both the lessons within a BLE. During these lessons she struggled to connect the tablets to the Wireless Fidelity (Wi-Fi) and there were frequent failures like tablets' batteries depleting and connection issues to the OLE.
Complexity	TA integrated presentation software with ease and appeared to be familiar with using it.	To integrate ICTs like tablets that must be connected to the internet and logged on to an OLE appeared to be challenging especially taking into consideration that the periods are only 40 minutes long.

TA did not get stressed despite some of the time that was wasted on struggling to integrate the ICT seamlessly within a BLE. The interview supported the observation when TA was asked whether there are any aspects of ICT integration that makes her uneasy and she replied, “No, not really”. TA confessed that her lesson plan does not always work out and that everything does not always go according to plan. She

experienced the integration process as time consuming. She was not intimidated by ICT, used ICT with confidence, and believed in her own knowledge and skills regarding ICT to such an extent that she claimed she can “do quite a few stuff and I must always help the other teachers.”

In her opinion, the most challenging part of ICT integration is to assist 40 Grade 4 learners to navigate the OLE correctly especially in a rural community where some of the learners “do not even have electricity at home”. This statement is in contradiction to a statement she made that “a teacher needs to bring technology into the classroom as the kids are growing up with it”.

Learning to integrate the OLE and the different ICTs appears to be easy for TA, although she had no formal training, and everything she knows is self-taught or knowledge gained during high school. TA expressed a great ease of use in terms of ICT integration.

#### **4.4.1.3 Social Influences (SI)**

The sub-constructs of SI are not compared separately between the different learning environments as there was not enough visible data collected within the observation schedule. This I believe is due to the subjective nature of this construct.

Learners seemed to enjoy the BLE more as their levels of enthusiasm increased within the BLE. This remains true as long as there is no ICT failure for which the discipline of the learners decreases, but in spite of this, TA’s confidence did not appear to be affected. However, the level of enthusiasm deteriorates as ICT issues, such as learners forgetting their login details and tablets not being charged, emerged. TA mentioned that she thinks that learners enjoy learning mathematics more when taught within a BLE, because “you include those learners with different learning preferences, those who are more visual and those who are more concrete”. She stated that the ICT integration within a BLE engaged the learners better despite ICT failures that led to ill-discipline amongst the learners.

The integration of ICT within a BLE improved the engagement between TA and parents in the social context outside of the school. She stated that parents will come up to her in town and give her positive feedback about how their children experienced the lessons within a BLE. She pointed out that the SGB members whose children attend the school can see the positive contributions that the integration of ICT within a BLE

has to their children’s upbringing. TA did not feel compelled by any role player to integrate ICT within a BLE but she did so to keep the learners engaged.

TA felt that the integration of ICT did not currently make her a good teacher as she is still inexperienced and she stated, “There is still a lot that I need to learn”. She did, however, feel that it will contribute to her teaching practices in the future.

#### 4.4.1.4 Facilitating Conditions (FC)

The following table compares the relevant sub-constructs regarding FC of TA within the two different learning environments.

**Table 4.5: Comparison of the teaching experiences of TA's FC within two different learning environments**

	Traditional Learning Environment	Blended Learning Environment
Perceived behavioural control	<p>It appears that TA integrated ICT with great ease during her TLE lessons. The ICT integrated was an overhead projector, speakers, presentation software, and a laptop. The PowerPoint presentation was visible to all the learners in the class and no ICT failures were experienced in both the lessons within a TLE.</p> <p>The TLE followed a teacher-led instructional mode even though ICT was used making it a TLE.</p>	<p>Contrary to the lessons within a TLE the BLE lessons were observed as problematic. The main reason was the dependence on a stable internet connection. TA frequently experienced internet connection problems. Another reason is the fact that not all the learners had access to the integrated ICT and the OLE. Some learners struggled to log into their OLE accounts as they forgot their usernames and password.</p> <p>When a learner asked why they could not connect to the Wi-Fi, TA complained that more than 20 devices cannot connect simultaneously.</p> <p>Lastly, the software needed to view the worksheets from the OLE were not installed on all the devices resulting in some learners not having access to all the content.</p>
Facilitating conditions	<p>There is ICT support for the whole school on a district level. The ICT support is run from the DBEs head office and are available on request. It is an hour’s drive for the technical support making it a cumbersome solution. This results in educators taking responsibility for their own problems. There were no on-site</p>	<p>There were no online technical support if TA had troubles with the OLE. She could have called the developers after school hours or could have sent them an e-mail but that is time consuming and she did not do it.</p>

	assistance seeing that the school is situated in a rural setting and does not have the funds to afford an on-site technician.	
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TA attended one short professional development course presented by her teacher’s union on how to teach within a BLE. She also partook in training presented by the OLEs training team and found the experience to be “really good”. She stated that the training helped her to teach in a more creative manner by integrating the OLE within a BLE. TA pointed out that teaching during load shedding, where communities are only supplied with electricity at certain stages of the day, is not possible except if she used her phone. Teaching by integrating ICT within a BLE is dependent on stable internet connections and electricity supply. Integrating ICT within a BLE complied to the TA’s need to remain popular amongst her learners and she stated, “[I] have to keep up otherwise [I] [am] not going to be of interest to them” she also claimed, “Everything in teaching is technology based.”

**Table 4.6: Teacher A (Summary of collected data)**

Root constructs	Sub constructs	Observations		Interviews
		BLE	TLE	
Performance Expectancy	Perceived usefulness	Yes	Yes	Yes
	Extrinsic motivation	Yes	Yes	Yes
	Job-fit	No	Yes	Yes
	Relative advantage	Yes	No	Yes
	Outcome expectations	Yes	No	No
Effort Expectancy	Perceived ease of use	Yes	Yes	No
	Complexity	Yes	No	No
	Ease of use	Yes	Yes	Yes
Social Influence	Subjective norm	Yes	NA	Yes
	Social factors	No	NA	Yes
	Image	Yes	NA	No
Facilitating Conditions	Perceived behavioural control	No	Yes	No
	Facilitating conditions	No	No	No
	Compatibility	Yes	Yes	Yes

#### 4.4.2 Teacher B

TB was a 54 year old male teacher at the time the study was conducted. He has a Bachelor of Science in Agriculture and a Baccalaureus Educationis degree. At the time of the study, TB had 12 years of teaching experience with 7 years' experience in teaching mathematics in the intermediate phase.

##### 4.4.2.1 Performance Expectancy (PE)

The data regarding the PE of TB, exhibiting the integration of ICT within the different learning environments are tabulated in Table 4.7: Exhibition of ICT integration of TB's PE within two different learning environments as observed below. The data from Table 4.7 was gathered from the observation schedule. Data from the semi-structured interview relating to the five sub-constructs of PE will be presented after the table. Data for the outcome expectations are personal, thus only explored through the data collected with the semi-structured interviews. The same is true for extrinsic motivation, as it could not be observed through the observation schedule, it was only explored through the interviews.

**Table 4.7: Exhibition of ICT integration of TB's PE within two different learning environments as observed**

	<b>Traditional Learning Environment</b>	<b>Blended Learning Environment</b>
Job-fit	<p>TB taught the lesson using teacher-led instruction together with working on problems. There were no ICT integrated in the lesson.</p> <p>Discipline of the learners deteriorated as the lessons progressed. This is a negative experience for both the teacher and the learners.</p>	<p>TB uses the pause-play function of the OLE's video content effectively during the lessons. This allowed time for the learners to engage with the content better.</p> <p>Worksheets downloaded and printed from the OLE correlated and the learners received immediate feedback as they completed their work.</p>
Relative advantage	<p>The learners were less engaged during the lesson taught within a TLE compared to the lessons taught within a BLE.</p>	<p>Content illustrated with the OLE was rich in colour and appealing to the eyes in contrast to the work done with white chalk on a black board.</p>



Outcome expectation	There were no ICT integrated in the lesson and thus no positive teaching related consequences could be observed.	The Grade 5 learners, in terms of the OE, were more engaged during the lessons where the OLE was integrated.
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TB believes that the integration of ICT is beneficial to him as an educator. He argued that the reason being is that “kids today are technologically driven”. TB believes that by integrating ICT into lessons, it will result in a greater variance in the presentation of the lesson content which ultimately improves learners’ learning experience.

According to him the integration of ICT alone is not sufficient when it comes to keeping learners engaged. He argued that learners will eventually lose attention and that the learning environment wherein one teaches makes the difference. TB perceives a BLE as a “close to perfect” learning environment where learners are active participants.

TB argued that ICT integration enhances the learning and teaching experience as it makes the content accessible to learners with different learning styles. Content can be presented visually with audio, and even kinaesthetically, resulting in an increase in probability of reaching a common understanding regarding the content.

Rural schools are generally very isolated. In contrast with the isolated environment of rural schools, TB highlighted that ICT is a “useful tool” bringing creativity to the classroom, and even introducing new teaching methodologies to teachers.

#### 4.4.2.2 Effort Expectancy (EE)

Table 4.8 compares the relevant sub-constructs regarding EE of TB within the two different learning environments.

**Table 4.8: Comparison of the teaching experiences of TB's EE within two different learning environments**

	Traditional Learning Environment	Blended Learning Environment
Perceived ease of use	This is not applicable as TB did not integrate any ICT within the TLE.	It appears as if it took no effort to integrate the OLE into the lesson. Even when the internet connection got disrupted TB continued without breaking the flow of the lesson.
Complexity	This is not applicable as TB did not integrate any ICT within the TLE.	TB seamlessly navigates through the content of the OLE in conjunction with the integrated ICT.

Within this school's context teachers rotate between classes instead of the learners. TB found this problematic as the setup process of the ICT integration was time consuming. He also found the logistical part "cumbersome" as there were always difficulties with cables and plugs.

The integration of the OLE and ICTs came naturally according to TB. He stated, "It did not suddenly happen nor was there any drastic changes". He just started to integrate ICT into his day-to-day teaching. This can be ascribed to the OLE's graphical user interface being user-friendly. TB stated, "The platform is straightforward and logically designed."

#### **4.4.2.3 Social Influences (SI)**

Teacher B remarked that parents support the fact that their kids are engaged with technology. According to TB, parents will "embrace" new technologies as they "want what is the best for their kids".

TB did not feel obligated against his own will to integrate ICT and the OLE in his lessons. He enjoyed integrating the ICT and positively sees it as a challenge.

As TB integrated ICT he mentioned that it made him "a better teacher" as it broadened the possibilities of what he can do as a teacher. He pointed out that teaching within a BLE enhanced learners' enjoyment of learning mathematics, because learners can see and hear the conveyance of content in a different manner which made the learners feel more comfortable.

#### **4.4.2.4 Facilitating Conditions (FC)**

Table 4.9 compares the relevant sub-constructs regarding FC of TB within the two different learning environments.

**Table 4.9: Comparison of the teaching experiences of TB's FC within two different learning environments**

	Traditional Learning Environment	Blended Learning Environment
Perceived behavioural control	This is not applicable as TB did not integrate any ICT within the TLE.	TB had no difficulty to integrate the OLE with the available ICT. He used in-flipping as a mode of instruction, and therefore he did not need to register all the learners on the OLE. Thus, he did not have to waste time on helping learners that struggle to register.

Facilitating conditions	This is not applicable as TB did not integrate any ICT within the TLE.	There was no on-site technical support for any ICT related queries. The OLE also did not have an active helpline at the time the study was conducted.
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At the time of this study, there were no support available to assist teachers, like Teacher B, when they encounter difficulties while integrating ICT within a BLE. TB did not receive formal training in pedagogical approaches like BL or training with regard to the OLE. He stated that he is currently “winging it” [attempting it without training].

TB was very impressed that the OLE is available in Afrikaans. The reason for this was that he did some research on similar programmes, but all of them were only available in English. This was considered to be a problem as the school where he teaches is situated in a predominantly Afrikaans rural community.

**Table 4.10: Teacher B (Summary of data collected)**

Root constructs	Sub constructs	Observations		Interviews
		BLE	TLE	
Performance Expectancy	Perceived usefulness	Yes	No	Yes
	Extrinsic motivation	Yes	No	No
	Job-fit	Yes	No	Yes
	Relative advantage	Yes	No	Yes
	Outcome expectations	Yes	No	Yes
Effort Expectancy	Perceived ease of use	No	NA	No
	Complexity	No	NA	No
	Ease of use	Yes	NA	Yes
Social Influence	Subjective norm	Yes	NA	Yes
	Social factors	Yes	NA	No
	Image	Yes	NA	Yes
Facilitating Conditions	Perceived behavioural control	No	NA	No
	Facilitating conditions	No	NA	No
	Compatibility	Yes	NA	Yes

### 4.4.3 Teacher C

Teacher C was a 57 year old male teacher at the time the study was conducted. He has a higher education diploma. TC has 32 years of teaching experience with 32 years' experience in teaching mathematics in the intermediate phase.

#### 4.4.3.1 Performance Expectancy (PE)

The data regarding the PE of TC exhibiting the integration of ICT within the different learning environments are tabulated in Table 4.11. The data presented in Table 4.11 are gathered from the observation schedule. Data from the semi-structured interview relating to the five sub-constructs of PE is also presented following Table 4.11. Data for the outcome expectations are personal thus only explored through the data collected through the semi-structured interviews. The same is true for extrinsic motivation as it could not be observed through the observation schedule, it was only explored through the interviews.

**Table 4.11: Exhibition of ICT integration of TC's PE within two different learning environments**

	Traditional Learning Environment	Blended Learning Environment
Job-fit	<p>TC taught the lesson using teacher-led instruction together with working on problems. There was minimal ICT integrated in the lesson.</p> <p>Learners were engaged despite the minimal use of ICT. TC used physical models of 3-D forms to illustrate different nets.</p>	<p>The integrated ICT seemed to support the teaching and learning experiences. The learners were actively participating in the lesson. The videos from the OLE kept the learners engaged through games.</p> <p>TC used PDF-view in the OLE to present the memorandum instead of writing it down and wasting time that resulted in faster feedback.</p>
Relative advantage	<p>The second lesson that was observed converted into a lesson taught within a TLE. The reason is that the OLE did not load due to a poor internet connection. In cases like this it does not appear to be better to integrate ICT.</p>	<p>The memorandum of the completed work was presented through the PDF-viewer of the OLE. This saves a lot of time compared to writing out the answers of homework problems.</p>

Outcome expectation	There was minimal ICT integration in the lesson and thus no positive teaching related consequences could be observed.	Learners expressed enjoyment when being taught within a BLE especially when TC integrated video content into the lesson.
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Teacher C expressed the belief that integrating ICT can represent the abstract ideas of mathematics in a more concrete manner by means of visual representations. TC said that he believes that by integrating ICT into his lessons, he prepares his learners for the “real world” which is technology based.

TC affirmed that his learners are more engaged when he integrated ICT than when he omitted it. He pointed out that it may be because the learners find it new and fascinating.

Exposing learners to technology when they are at school not only contributes to the learning experiences of the learners but also “to the success of the subject”. TC stated that learners would come up to him and say that the integration of the OLE “is a fun way to do mathematics”. He also mentioned that the OLE enables him to support the “stronger” learners where he previously had to slow them down.

TC highlighted that he got “more out of the lesson as what I would’ve in a normal lesson”. A “normal lesson” in this case refers to a lesson taught within a TLE. TC pointed out that teaching with ICT, especially on topics like geometry, is beneficial for the learners as they see the figures in colour compared to white chalk on a black board.

Learners coming from rural communities rarely have any experience with ICT. TC noted that schools are obliged to introduce learners to ICT and “slowly make the [learners] used to technology”. He stated that three quarters of his learners do not have access to any ICT at home and that “they come and see it at school”. This prepares the learners well as they become computer literate citizens being able to “take care of themselves” by means of acquiring work after school. Another positive consequence of integrating the OLE with ICT is that teachers are motivated to go through content and structure lessons regarding a specific topic resulting in a better teaching and learning experience.

#### 4.4.3.2 Effort Expectancy (EE)

Table 4.12 compares the relevant sub-constructs regarding EE of TC within the two different learning environments.

**Table 4.12: Comparison of the teaching experiences of TC's EE within two different learning environments**

	Traditional Learning Environment	Blended Learning Environment
Perceived ease of use	TC could not continue with the lesson as planned due to poor internet connection during the second period. Even though it did not appear to hinder the flow of his lesson it was still a struggle as he attempted to reconnect to the internet.	Technical difficulties were frequently present during the lessons taught by TC. TC struggled to locate the lessons within the OLE but kept the learners engaged by alternating between traditional teaching practices and teaching with the integration of the OLE.  The struggle was only visibly present during the first lesson he taught with the OLE, during his second lesson he seamlessly navigated through the content.
Complexity	This is not applicable as TC did not integrate the OLE within the TLE.	TC struggled to navigate the OLE and he struggled to locate the video material of the lesson pertaining to 3-D forms and nets.

Integrating the OLE into lessons was a “daunting” experience for TC. The main reason for this was the amount of administration that had to be completed before the OLE could be integrated successfully. This includes, but are not limited to, setting up devices, registering online profiles for the learners on the OLE and creating e-mail addresses for the learners. TC pointed out that the most challenging aspect of ICT integration and teaching is the preparation time for lessons taught within a BLE. This outweighs the time spent for preparing tradition lessons.

Integrating the OLE and ICT into lessons was mastered relatively quickly in spite of frustrations experienced in the beginning by TC. Lessons taught within a BLE requires more preparation time compared to traditional lessons. TC mentioned that he had to watch all the video content he wanted to use the night before he conducted the lesson.

#### 4.4.3.3 Social Influences (SI)

Teacher C indicated that the SGB has a positive view on ICT integration. He claimed that “Parents want to see that they kids are exposed to technology”.

The subject advisor of TC evaluates him yearly and the advisor frequently suggests that he should integrate ICT, sponsored to the school, into his lessons. TC also feels compelled to integrate the ICT as he feels pressured by the sponsors of the ICT.

Teacher C does not believe that ICT integration will make him a better teacher. He sees ICT integration as an additional resource he can use to connect with his learners.

#### 4.4.3.4 Facilitating Conditions (FC)

Table 4.13 compares the relevant sub-constructs regarding FC of TC within the two different learning environments.

**Table 4.13: Comparison of the teaching experiences of TC's FC within two different learning environments**

	Traditional Learning Environment	Blended Learning Environment
Perceived behavioural control	ICT's used in lesson 4 included a projector and a PC. TC projected the memorandum of a homework assignment on the whiteboard. The ICT integration was not free from effort, because the memorandum struggled to load. ICT kept failing during the lesson which led the teacher to revert back to teaching using the “chalk-and-talk” mode of instruction.	There were some difficulties during the first lesson taught within a BLE where TC integrated the OLE.  One advantage of teaching using the in-flipping mode is that all the learners do not need access to the OLE, they only need to be able to see the projected content and that was done without trouble.
Facilitating conditions	There were no on-site support for teachers.	TC did not have access to an on-site technician but mentioned that the Department of Basic Education can be contacted and they will send technicians if needed. This is not efficient as the technician usually arrives 2-3 working days after the complaints have been logged.  He also mentioned that the online support of the OLE is not always responding in time.

Some of the difficulties identified by TC when it comes to integrating the OLE and ICT, is the battery life of the tablet devices. He mentioned that sometimes one wants to use them, but they have not been charged.

TC did, however receive once-off training in terms of how to integrate the sponsored tablets. This training was specifically focused on the integration of tablets into lessons. TC has not received any training in terms of the OLE. He mentioned that he makes use of the learners' technological inclination when he experiences difficulties. TC finds comfort in the fact that he "can just call on the kids to help".

TC believes that ICT cannot replace teachers, because "[t]eaching is an art not a science". The BLE is aligned with the values of TC and the ICT integration is supplementary. He feels that the OLE "fell from heaven".

**Table 4.14: Teacher C (Summary of data collected)**

Root constructs	Sub constructs	Observations		Interviews
		BLE	TLE	
Performance Expectancy	Perceived usefulness	Yes	Yes	Yes
	Extrinsic motivation	Yes	Yes	Yes
	Job-fit	Yes	Yes	Yes
	Relative advantage	Yes	Yes	Yes
	Outcome expectations	Yes	Yes	Yes
Effort Expectancy	Perceived ease of use	No	No	No
	Complexity	No	No	No
	Ease of use	Yes	Yes	Yes
Social Influence	Subjective norm	Yes	Yes	Yes
	Social factors	Yes	Yes	Yes
	Image	Yes	No	No
Facilitating Conditions	Perceived behavioural control	No	No	Yes
	Facilitating conditions	No	No	No
	Compatibility	Yes	Yes	Yes



In summary, all three participants showed a difference in their teaching strategies when they taught within different learning environment with Teachers B and C showing the biggest difference in their teaching strategies. A discussion on the finding and a cross-case analysis will now follow.

## **CHAPTER 5: DISCUSSION OF FINDINGS AND CROSS-CASE ANALYSIS**

The purpose of this study is to explore the experiences of intermediate phase mathematics teachers' ICT integration within a BLE. This exploration was guided by an adaptation of the UTAUT framework by Venkatesh et al. (2003). A discussion on the analysis of the data from the lesson observations and semi-structured interview are presented in Chapter 4 and in this chapter, I present an analysis of each participants' experiences, followed by a cross-case analysis and summary. The discussion of the findings is then used to address the research questions in the final and concluding chapter, Chapter 6.

### **5.1.1 Analysis of each teacher**

The findings from the two data collection instruments are compared for each of the three teachers in the following sections and discussed according to the conceptual framework.

#### **5.1.2 Teacher A**

##### **5.1.2.1 Performance Expectancy (PE)**

Teacher A (TA) believes that the integration of ICT in the form of presentation software as Microsoft PowerPoint enhances the learning and teaching experiences. She argued that by integrating these PowerPoint presentations into her lessons, the learners retain information better than the learners she taught the previous year without PowerPoint presentations. This is in accordance with research done by Mansour (2019) who found that the achievement scores between two groups significantly differed in favour of an experimental group being taught with PowerPoint presentations compared to a control group being taught with a black board. TA integrated ICT into her lessons whether she taught within a BLE or a TLE. There were no visible indications that learners were more engaged in either a BLE or a TLE lesson when she integrated ICT. On the contrary, the learners appeared to be disruptive and unengaged in both cases, as she frequently had to ask learners to quieten down and do their work. The behaviour displayed by the learners during the lessons is in contrast with a vast amount of research findings. There is consensus among researchers that ICT integration, especially within a BLE, leads to learner engagement (Clark, 2015; Fisher et al., 2018; Gumban & Tan, 2020; Steen-

Utheim & Foldnes, 2018). Nagar (2014) points out that teachers need to be able to manage all the integrated ICTs for a lesson to be successful, something with which TA struggled during the observed lessons. She made use of a rotational BLE, which is heavily dependent on ICT.

The extrinsic motivation of TA could not be observed and was only noted from the data from her interview. She believes that the integration of videos leads to learner engagement. This is in contrast with the lack of engagement observed when learners rotationally viewed videos during the BL lessons. It can be argued, as found by Ghavifekr, Kunjappan, Ramasamy, and Anthony (2016), that the reason why TA integrated ICT, regardless of the teaching and learning environment, is that she perceives the integration as an enhancement of learning. Despite the disruptive behaviour, TC believes that learners must just get used to ICT integrated lessons and experience the value it brings. Seeing that TC only had one year of teaching experience at the time the lessons were observed, it may also be argued that her current belief may change.

TA claimed that the learning performance of the learners in her class enhanced when she integrated ICT rich lessons as they outperformed the learners of the previous year when she only taught with the black board. Mansour's (2019) findings support the claim made by TA. Mansour found in her study that learners who are exposed to rich PowerPoint content outperform learners that are only exposed to content via a black board. One acknowledges that there can be other factors also involved in learner performances between different year groups. However, there were no observable enhancements in both teaching and learning environments. In both cases the discipline of the learners also deteriorated due to unsuccessful attempts of ICT integration.

Research indicates that ICT integration has a relative advantage on teaching and learning experiences, as opposed to no ICT integration (Fisher et al., 2018; Pertiwi et al., 2019). This was not the case in TA's BLE lessons where Rotational BL was used. The strategy was unsuccessful as the learners were not familiar with the OLE – a situation that may change over time. Celestino and Yamamoto (2020) proposed a framework consisting of six steps to create discipline within a BLE, the fourth step is the organisation of the OLE. The organisation of the OLE according to Celestino and Yamamoto (2020) in the context of this study refers to the registration of learners on

the OLE so that they have access to the course material and video content, something that was absent during the lessons of TA.

### **5.1.2.2 Effort Expectancy (EE)**

Teacher A believes that the integration of ICT into her lessons are effortless. When she was asked whether there are any aspects about the integration of ICT into her lessons that make her uneasy, she replied with a confident “no”. She feels confident in the knowledge she gained during her high school years, because she had Computer Applications Technology (CAT) as a subject. She made no mention of her training regarding ICT integration during her teacher training years. In line with TA’s belief, she integrated ICT and the OLE into her lessons with confidence, well aware of the fact that there may always be stumbling blocks during the use of ICT. Her beliefs and attitude toward the integration of ICT, regardless of numerous ICT integration failures, remained positive.

When TA integrated ICT within a TLE she did it with ease. Kjellsdotter (2020) found in a Swedish case study, conducted in a primary school, that teachers do not generally have problems integrating ICT with direct instruction by using presentation software such as Microsoft PowerPoint. This was also true for TA. However, the complexity increased when TA integrated ICT within a BLE as she had to manage, with minimal success, the logins of more than 40 learners. The main difference between teaching within a TLE and a BLE is that the BLE incorporated the OLE. She confirmed in her interview that the most challenging part of the ICT and OLE integration is the fact that she had to support 40 learners that are unfamiliar with ICT to navigate the OLE. It appears as if the integration of ICT and the internet, as with an OLE, increases the complexity. Stols et al. (2015) found that teachers find the integration of ICT overwhelming when it comes to an online environment. Despite the increased complexity when she taught within a BLE, she did not hesitate to integrate ICT into her lesson. A possible reason for this may be explained by Gyamfi (2017), who found in a study with a similar context to this study, that younger teachers integrate ICT regardless of the ease of integrating ICT or their perceived ease of integrating ICT. Gyamfi (2017) argued that it may be because younger teachers, such as the case with TA, are part of a generation of “digital natives” who grew up with ICT.

TA continuously integrated ICT regardless of how complex it may be. Learning how to use ICT appears to be easy for TA as she stated that she is self-taught when it comes

to the use of ICT. However, she lacks formal professional development and training regarding the successful integration of ICT into lessons since. TA frequently came across stumbling blocks like internet connection issues, depleted devices and administrative problems regarding learners' profiles on the OLE. She struggled to manage the ICT integration. TA's struggle to successfully integrate ICT within a BLE is evident in the several classroom disruptions during lessons. This appears to be a common theme among novice teachers as pointed out by Gudmundsdottir and Hatlevik (2018). TA persisted in the integration of ICT, contrary to the findings of Padayachee (2017) who found that classroom disruptions (ill-discipline) as a result of ICT integration is the main reason why novice teachers refrain from integrating ICT. She was also the only teacher to integrate ICT in all her lessons regardless of the learning environment. TA displayed an ease of use regarding ICT, but struggles to integrate ICT within a BLE.

### **5.1.2.3 Social Influence (SI)**

TA perceives the BLE as more enjoyable compared to a TLE. TA is not aware of any views that her colleagues, HoD and SGB hold relating to how her integration of ICT influences their perceptions. However, she argued that learners enjoy the BLE, because it suits the different learning preferences of learners. This makes learning more accessible for all learners and aligns with the important emphasis the DBE places on "learning through the use of ICTs" (DoE, 2004). Tseng and Walsh (2016) compared the motivation of learners being taught within a BLE and a TLE respectively and found, similar to the perception of TA, that learners find BL more accessible as it promotes a flexible learning environment where learners can engage with content via different ICTs. The fact that learners should enjoy the learning experience are presumably an important outcome for TA and all the important stakeholders like the SGB and parents.

TA made no mention that she felt compelled to integrate ICT within a BLE either by authority or by the general work culture of her peers. She integrates ICT solely because she wants to and not because the current work culture dictates it.

The parents of the learners who enjoy TA's lessons, frequently give her positive feedback when they meet in social settings. She mentioned that the SGB members, who have children in her class, mentioned the positive contributions her ICT integration made in their children's schooling experiences. The fact that she integrated ICT into her lessons does not necessarily improve her social status in terms of popularity

among the other teachers as she made no mention of it. However, both the other participants mentioned how knowledgeable TA is when it comes to ICT integration and how they rely on her for support during their respective interviews.

#### **5.1.2.4 Facilitating Conditions (FC)**

It was evident during the observations of the lessons taught by Teacher A within a BLE that the technology-enhanced facilitating conditions were not supporting the teaching and learning experiences. TA frequently experienced internet connectivity issues and she pointed out that the bandwidth of the school cannot support more than 20 devices. She acted resourcefully when the lesson did not go according to plan and started to differentiate the tasks, rotating the devices connected to the OLE between six groups. This allowed the groups to each have a turn to engage with the content presented in the OLE. Learners working on worksheets from the OLE continuously complained that the content was not visible on their devices. After a thorough investigation, TA realised that the file-formats of the worksheets are not compatible with the reading devices. She spent ample time on troubleshooting which allows for classroom disruption by the learners who were doing traditional group work. In another lesson, taught within a BLE, TA decided to integrate the OLE and follow an “in-flipping” approach to teaching. In-flipping is where a teacher integrates the content video material into the lesson by letting the whole class watch the content applicable to the lesson and thereafter discussions and exercises follow. In this case, the presentation of the material was visible for all the learners, but the sound was not working continuously.

Although TA integrated the OLE and different ICTs in her lesson, she did not include that in her lesson plan. Tayag (2020, p. 2539) found that designing lessons for a BLE “requires a significant amount of preparation” and training to integrate ICTs as BL is a relatively new pedagogical approach to teaching. Preparation time in conjunction with technical support is essential to empower teachers to improve their “technical skills in manipulating relevant equipment and applications” (Tayag, 2020, p. 2540).

TA mentioned that she required technical support when implementing an OLE. She received support from a volunteer parent to connect to the internet and to get the devices set up. This is cumbersome as she had to do the troubleshooting herself, with limited knowledge, in cases where the internet connection was interrupted and when

the learners struggled to log in to the devices. The problem is that the support is off-site and not available on demand. Raphael and Mtebe (2016) found that a critical factor that prevents teachers to facilitate a lesson within a BLE effectively is the absence of technical support. As in the case with TA, it is impractical to focus on the pedagogy of the lesson if there is no technical support.

According to TA, she only attended one professional development course regarding BL and its implementation. Teachers, like any other professional, need to be subjected to continuous professional development if they want to remain proficient. Professional development is one of five forms of support that teachers need to “overcome their challenges or become a more effective” teacher as showed by Shernoff, Sinha, Bressler, and Ginsburg (2017, p. 7). TA also made mention of receiving an introductory session regarding the OLE and how to integrate it creatively. She values the importance of integrating ICT into her classroom as she stated that “teachers need to bring technology into the classroom” and she values the supportive role that ICT plays in her lessons. Therefore, the integration of ICT must comply with her needs as a teacher to develop professionally and her teaching values. Thus, it is imperative that she receives continuous professional development so that she knows how to integrate ICT since this aligns with her teaching values and needs.

### **5.1.3 Teacher B**

#### **5.1.3.1 Performance Expectancy (PE)**

There was a distinct difference between the lessons taught within a TLE and a BLE as TB only integrated ICT when he taught within a BLE. He believes that the integration of ICT into his lessons is beneficial, because learners are enthusiastic about the integration of ICT in the classroom. His belief is reinforced when he refers to his community as under-resourced, rural and isolated making the classroom the only place for the majority of learners to experience the use of technology. He believes that the integration of ICT has the potential to make the mathematical content accessible to learners with different learning styles. The conclusions of Yeop, Wong, and Goh (2016) are in accordance with the belief of Teacher B as they concluded that blended learning is a pedagogical approach that meets individual learning styles.

Chilean teachers from five different schools participated in a pilot study conducted by Light and Pierson (2014). They integrated material from Khan Academy, which is a

series of educational videos, into their lessons. Learners were expected to practice and reinforce recently learned skills. Light and Pierson (2014) found that the role of a teacher, using video content in class as a means of instruction, changes from instructor to facilitator. Similarly, TB integrated the micro-lessons of the OLE into his lessons and achieved a similar outcome. The video content served as a form of extrinsic motivation keeping the learners engaged.

The distinct difference between the lessons taught by TB within a TLE and a BLE made it possible to compare the influence of ICT integration on the teaching and learning experiences. Learners appeared to be more engaged and actively participated by completing several worksheets within the given period in the lessons taught within a BLE, as opposed to lessons taught within a TLE. He frequently asked the learners to be quiet when he taught within a TLE. One of the reasons may be that the learners were visually stimulated by the rich colours and sounds of the video material and that they found it refreshing seeing that it was the first year TB integrated the OLE into his lessons. This is supported by research done by Hasan (2017) who showed that learners express greater interest if they watch video material and it may also lead to better achievement.

TB mentioned that platforms like the OLE support him as a teacher in a rural community that is generally excluded from professional development opportunities. He mentioned that the integration of ICT within a BLE exposed him to new teaching methodologies and compelled him to become more creative. O'Byrne and Pytash (2015) concluded their study that teaching within a BLE has the potential to transform the teaching experience of any teacher and provides opportunities to develop the best possible learning environment by challenging one's own views. It appears as if TB attempted a new teaching approach when he taught within a BLE and this contributed to learner engagement.

### **5.1.3.2 Effort Expectancy (EE)**

Teacher B believes that one of the biggest challenges regarding the integration of ICT is the logistical difficulties. ICT integration, according to him, is difficult in his school as teachers rotate between classes and not, as it is traditionally known, the learners. This means that he has to travel with ICTs like speakers, a computer and sometimes a projector. Sometimes he forgets a cable or a charger cable and it immediately disrupts the continuity of lessons resulting in undesirable behaviour of learners who are left



unattended. Laronde, MacLeod, Frost, and Waller (2017) found that teachers are generally burdened with the cumbersome responsibility of administrating the logistics of ICT. TB is also concerned with the volatility of the internet connection in his community as the bandwidth is sometimes sufficient and other times not – a frustration that is recorded among many researchers (Alkahtani, 2017; Singhavi & Basargekar, 2019). He believes that the tedious experiences with ICT integration is normal or as he stated “the unpaved road of technology”.

TB has seldom integrated ICT within a BLE and generally did not integrate any ICT when he taught within a TLE. He started to naturally phase the different ICTs in a BLE into his lessons so that he and the learners can get familiar with the presence of ICT in his lessons. His practice thus reflects his belief that the integration of ICT is generally complex and OLEs are often difficult to navigate. Maphalala and Adigun (2020) found that the complexity linked to the navigation of an OLE is one of the main factors that discourages the integration of ICT. However, TB claimed that the user interface of the OLE is straightforward and logically designed making it simple to navigate. The successful integration of ICT within a BLE by TB might be ascribed to the simplicity of the OLE.

TB integrated ICT easily and seamlessly into his lessons taught within a BLE in spite of only integrating ICT twice within a BLE. He navigated the OLE seamlessly. He also made note of the fact that the OLE is available in his mother tongue (Afrikaans). The fact that the OLE is available in his mother tongue made it accessible for him and eased the learning process. For a teacher new to ICT integration, he easily learned to master the user interface of the OLE in a short span of time.

### **5.1.3.3 Social Influence**

Teacher B believes that he is a better teacher now that he integrates ICT in his lessons. He perceives the integration of ICT as something that has the approval of the SGB. The excitement he experienced from the parents and the SGB regarding the integration of ICT within a BLE makes him believe that ICT is here to stay. The excitement, he argued, is because the SGB wants to keep up with the current demands of the technological era we live in, as well as parents' desire to expose their children to technology. ICT integration is also important for the parents from the rural communities as it exposes the learners to technologies which they are generally not exposed to and it improves the quality of the learning experience. He also perceives

the learners in his class as more engaged with the content when he integrates ICT. The perceptions of TB is in line with findings from a study conducted in a similar rural setting where researchers found that a BLE stimulates learner motivation and engagement (Dey & Bandyopadhyay, 2019).

TB, similar to Teacher A, experiences no pressure to integrate ICT in terms of the work culture norms. He emphasised that ICT integration at his school is voluntary, easing the burden of the feeling of obligation to integrate ICT as many teachers experience according to Magen-Nagar and Maskit (2016).

TB makes no mention of any increase in popularity among his peers since he started integrating ICT into his lessons. However, he does believe that ICT integration makes him a better teacher as it enables him to address the fears learners generally experience with a subject like mathematics.

#### **5.1.3.4 Facilitating Conditions (FC)**

The lessons taught within a BLE by Teacher B were done using in-flipping as the mode of instruction. In-flipping minimised the resource facilitation and technological facilitations as he only required access to the OLE via an internet connection, an overhead projector, and speakers. In this way, TB could work around the registration process and the device constraints as experienced by Teacher A. Learners were engaged in the lessons and actively participated with minimal disruptions. This observation is confirmed by the findings from Ramirez and Diaz Munevar (2018) who found that learners' engagement increase when the mode selected within a BLE is in-flipping. This is relevant as the technology and resource facilitation of the school does not necessarily facilitate BL in its more traditional form. Irregular internet connection made it difficult for TB to play the video material continuously from the OLE as it caused a constant buffering of the videos, consequently disrupting the flow of the lessons. TB's experience enabled him to use the buffering time to reflect on the content knowledge of the learners. He mentioned the "user-friendliness" of the OLE which enabled him to quickly grasp the basic functionalities of the OLE. He described it as "straightforward and logically designed".

There were no on-site technical support to aid TB if he experienced any technical difficulty. The OLE, at the stage of this study, did not have an active help-line. This

resulted in TB having to solve any technical issues himself. This is problematic as researchers DeCoito and Richardson (2018, p. 373) found that teacher support “needs to be readily available” so that they can continuously integrate ICTs into their lessons. TB mentioned that the school is very isolated and that there are no information technology (IT) companies in the town so any support that he received up to this point happened at random and voluntarily by parents who have ICT experience.

TB has no formal training in pedagogical approaches that includes any form of BL and he has not received any training that will aid him in the integration of the OLE within his lessons. TB has an eagerness to explore new pedagogical approaches and has done some research on learning environments similar to the OLE. He values mother tongue education and regarded the fact that the OLE is available in Afrikaans, his mother tongue, as impressive seeing that he teaches in a school that offers only Afrikaans as a medium of instruction. Professional development is considered a necessity that TB has not been exposed to in terms of BL. However, he took responsibility of his professional development by reading up on BL, a learning experience he very much enjoyed.

#### **5.1.4 Teacher C**

##### ***5.1.4.1 Performance Expectancy***

Teacher C believes that the integration of ICT into his lessons bridges the gap between the real world and the mathematics classroom. His beliefs are in accordance with the findings of a case study done by Salim and Tiawa (2015) who found that visual representation made possible by ICT integration aids learners to connect mathematics to the real world. TC further believes that the integration of ICT into his lessons allows him to expose the learners to rich visual representations aiding the learners to bridge the gap between abstract mathematical ideas to concrete visual representations. Umbara (2020) found that the visualisation of abstract mathematical concepts is able to motivate learners and enhances the learning experiences of learners. TC’s beliefs are supported by the findings from Umbara (2020) indicating that the visual representations, made accessible by the integration of ICT, lead to the enhancement of both the teaching and learning experiences.

The lessons of the two different learning environments were comparable as the TLE had minimal ICT integration as opposed to the BLE. TC perceived the learners to be

more engaged when he integrated ICT. Findings from a case study by Wong and Yang (2017) where learners were exposed to an OLE support TC's perception since Wong and Yang (2017) found that learners experience the integration of ICT in various forms as interesting, engaging, and motivating. TC argued that the learners were more engaged, because they have a positive perception about ICT integration which is also supported by other researchers (Osakwe, Dlodlo, & Jere, 2017; Tossavainen & Faarinen, 2019).

The integration of game-based videos, in the lessons of TC when he taught within a BLE, enhanced the learning experiences of the learners as it positively contributed to the attitudinal variable like motivation and engagement. The learners seemed motivated during the lessons taught by TC because they engaged with the content and participated by raising their hands and asking questions and giving answers. Game-based learning tools that produces instant feedback was an emerging theme in the study of Wong and Yang (2017) confirming that immediate feedback that are provided by OLEs facilitates deep learner engagement. López Belmonte, Fuentes Cabrera, López Núñez, and Pozo Sánchez (2019) support this observation in a study they conducted involving 60 mathematics students. They found that the integration of ICT in a BLE in the mathematics classroom is effective in enhancing the learners' learning experiences (López Belmonte, Fuentes Cabrera, López Núñez, and Pozo Sánchez, 2019).

Lack of infrastructure is considered to be a barrier in the context of this study and is also found to be a barrier by studies conducted in similar contexts (Dube, Nhamo, & Magonde, 2018; Mwelese, Martin, & Chililia, 2016). TC had to revert to teaching within a TLE during one of his lessons originally planned to be a lesson taught within a BLE. The reason was that the network connectivity got lost and access to the OLE was impossible. TC could rely on his experience to smoothly revert back to a TLE, but the same may not be true for novice teachers. TC believes that his learners were more engaged when he integrated ICT within a BLE, a belief that is resonated with evidence by Clark (2015); Fisher et al. (2018); and Steen-Utheim and Foldnes (2018). Steen-Utheim and Foldnes (2018) showed that learners actually perceive a BLE as a more positive learning experience making the integration of ICT within a BLE superior to its omittance. Thus, regardless of the lack of infrastructure in the context of TC it still is better to integrate ICT within a BLE than to not integrate ICT at all.

One of the positive teaching-related effects of integrating ICT within a BLE for TC has been the fact that learners who do not have access to ICT at home learn how to use ICT at school. He argued that it prepares learners to become computer literate citizens. Furthermore, this decreases the digital divide between learners who do have access to ICT and those who do not have access. TC's views are similar to the findings of Mashile (2017) who found that educational institutions that integrate ICT play a pivotal role in bridging the digital gap in South Africa which ultimately leads to a skills gap.

#### **5.1.4.2 Effort Expectancy (EE)**

It is Teacher C's belief that the preparation time for lessons taught in a BLE is time consuming as it takes significantly more time to prepare than in a TLE. He experiences the preparation time as the most demanding aspect of teaching within a BLE since he needs to watch all the video material before he integrates it into a lesson. He wants to ensure that the video material supports his lessons and that the lessons do not revolve around the integrated ICT. TC's beliefs about the preparation time is in line with research findings indicating that lessons taught within a BLE takes double the preparation time compared to TLEs (Gedik, Kiraz, & Ozden, 2013; Ma'arop & Embi, 2016).

TC struggled to navigate to a specific lesson on the OLE during the first lesson he taught within a BLE. The lesson themes are static and structured as prescribed by the CAPS. Thus, teachers need to be cognisant of the location of the topics and their location within the CAPS document if they want to successfully navigate the content. TC struggled to navigate through the content of the OLE and the fact that the OLE does not contain a search function significantly increased the complexity of the navigation for TC. TC's belief regarding the preparation time of teaching within a BLE is highlighted by his struggle to navigate the content as it appeared that he did not prepare enough for the lesson in terms of the OLE integration even though it was evident that he was familiar with the content.

During the second lesson, TC navigated the OLEs interface with a lot more ease. He quickly adapted to the structure of the OLE and acquainted himself with the interface; learning how to navigate through the content of the OLE in a short time span. It appears that TC easily learned how to integrate the OLE and various ICTs into his lessons.

### **5.1.4.3 Social Influence (SI)**

Teacher C stated that the school focuses on supporting learners who struggle to master the mathematics subject content by constantly designing interventions to ensure that no learner is left behind. He feels that sometimes the learners who do not struggle with the content are not supported in the same manner. To include all learners in the learning experience, he believes, can be accomplished by integrating ICT within a BLE. The OLE can support ‘weaker’ learners with remedial content and enrich the learning experience of the ‘stronger learners’ by giving them access to more demanding tasks. This is important as it creates an inclusive environment. TC claimed that the parents from the community think it is important for their children to be exposed to technology. One reason could be because the community in general is rural and not all the learners have access to technology at home. In the contrary, the school can serve as a catalyst to narrow the digital divide. Findings from Drossel, Eickelmann, and Vennemann (2020) show that schools with challenging student compositions and average socio-economic contexts can support learners to become ICT literate.

TC is not aware of a workplace culture that is created by his peers that makes him feel compelled to integrate ICT. However, he is acutely aware of the importance the DBE attached to ICT integration. He also mentioned the fact that the available ICT in the school were sponsored and that he thinks it is important for those sponsors to know that the ICT is integrated into lessons. He feels pressurised to integrate ICT as he feels that he has an obligation towards the DBE and the ICT sponsors. The DBE and sponsors’ expectations may be one of the reasons why TC integrates ICT in his lessons.

The integration of ICT, according to TC, did not improve his image by making him a better teacher, nor did it increase his popularity among his peers. He views technology only as a useful ‘tool’ that supports his pedagogical approaches to enhance mathematics education. TC, similar to the mathematics teachers in Perienen’s (2020, p. 11) study, generally integrates ICT in accordance with his own pedagogies to “explain, discuss and exemplify mathematical concepts”.

### **5.1.4.4 Facilitating Conditions (FC)**

Teacher C made use of in-flipping as the mode of instruction minimising the dependency on technology facilitating conditions. The lesson was spent watching

video content material and thereafter learners had to apply the new knowledge by completing a worksheet. Worksheets from the OLE were printed and given to the students. Learners could work at their own pace through the content of the worksheets. The school has a printing budget for worksheets consequently not adding strain on the resource facilitating conditions. In-flipping allowed TC to spend time assisting learners who struggled with the content.

TC mentioned that he sent e-mails to the OLE helpline for support, but the response time is very slow. He had queries regarding errors on the worksheet memorandums of the OLE. Since the memorandums are in PDF-format, and therefore not editable, TC could not provide the learners with these incorrect memorandums. TC mentioned that he requires technical support on a daily basis. The DBE has technicians available on request free of charge, but unfortunately there is no technical support on-site. The problem in rural South Africa, as identified by Mwapwele, Marais, Dlamini, and Van Biljon (2019, p. 9), is that “government support in creating infrastructure and providing digital skills training is lacking” which is also the case with TC.

TC has not attended any professional development courses relating to blended learning. However, he expressed the need to undergo training. Findings from Haji, Moluayonge, and Park (2017) suggest that teachers need to receive continuous professional development to carry on integrating ICT in their lessons in addition to technical support. The school and the governing body need to address the professional needs of the teachers and support them from a technical point of view if they are serious about the upliftment of the community by learner exposure to ICT.

## **5.2 Cross-case analysis**

In this section a cross-case analysis is done between three teachers based on the four constructs. The teachers were observed in two different learning environments (TLE and BLE) followed by an interview and the integration of the findings were compared and contrasted to produce new knowledge. Table 5.1 provides a summary of the cross-case analysis.

**Table 5.1: A cross-case analysis**

Root constructs	Sub-constructs	Teacher A	Teacher B	Teacher C
Performance Expectancy	Perceived usefulness	Yes	Yes	Yes
	Extrinsic motivation	Yes	Yes	Yes
	Job-fit	No	Yes	Yes
	Relative advantages	No	Yes	Yes
	Outcome expectation	Yes	Yes	Yes
Effort Expectancy	Perceived ease of use	Yes	No	No
	Complexity	Yes	No	No
	Ease of use	Yes	Yes	Yes
Social Influence	Subjective norm	Yes	Yes	Yes
	Social factors	No	Yes	Yes
	Image	Yes	Yes	Yes
Facilitating Conditions	Perceived behavioural control	No	No	No
	Facilitating conditions	No	No	No
	Compatibility	Yes	Yes	Yes

The interpretation of the data and the comparison of the three cases are done by keeping the underpinning philosophy of this study in mind. This study followed an interpretive approach with an interest in the complexity of individual participant's views and experiences. An interpretive researcher's central endeavour, according to Cohen et al. (2007, p. 21), is "to understand the subjective world of human experience". The main purpose of interpretivist research, according to Saunders et al. (2016), is to create new understandings and interpretations of specific contexts. Thus, the interpretivist paradigm will enable me to meaningfully address the research questions. As mentioned in Chapter 3, the ontological assumption of this research is relativism that allows multiple realities to exist as experienced by each teacher. This implies that what is true for one teacher is not necessarily true for another.



### 5.2.1 A cross-case analysis: Performance Expectancy

Table 5.2 contains a summary of the sub-constructs of the performance expectancy of all three participants. Following is an interpretation of the data and a comparison of the participants. The perceived usefulness of ICT integration relates to a teacher's belief that ICT integration will enhance the teaching and learning experiences whereas the job-fit of ICT integration refers to how the teaching and learning experiences are enhanced. These two sub-constructs relate to one another, however the data of the participants' perceived usefulness was mainly collected from interviews and data from the participants' job-fit were observed in the lesson. I jointly report on these two sub-constructs. The extrinsic motivation refers to the perceptions of participants in terms of the increase of engagement resulting from ICT integration and the relative advantage is the degree to which it is better to integrate ICT than to not integrate it. Data from the participants' extrinsic motivation were collected from interviews and most of the data collected for the relative advantage were observed in lessons. I also jointly report on these two sub-constructs. Lastly, I report on the outcome expectations where the positive teaching-related consequences of integration ICT of all three participants are compared. This is done with caution as the observed data and the data extracted from the interviews are not always corroborating. For example, a participant may hold a certain belief but the behaviour accompanying the belief may be absent.

**Table 5.2: Summary of the performance expectancy of all three cases**

Root construct	Sub constructs	Teacher A	Teacher B	Teacher C
Performance Expectancy	Perceived usefulness	Strong belief	Strong belief	Strong belief
	Extrinsic motivation	ICT integration increase engagement	ICT integration increase engagement	ICT integration increase engagement
	Job-fit	Diminish teaching and learning experience	Enhance teaching and learning experiences	Enhance teaching and learning experiences

	Relative advantage	To integrate ICT is not necessarily better than not to	To integrate ICT is necessarily better than not to	To integrate ICT is better than not to
	Outcome expectations	Learner exposure to ICT	Professional development	Decrease the digital divide

All three participants express the belief, to a large degree, that the integration of ICT enhances the learning experience of the learners. However, all three believe that ICT integration enhances the learning experience differently. For example, Teacher A believes that ICT integration improves learners' ability to retain information, Teacher B believes that learners' enthusiasm increases in the presence of ICT, and Teacher C believes that ICT integration bridges the gap between the mathematical content and the real-world application. The teaching experiences of all three participants seem to be enhanced as a direct result of the enhancement of the learning experiences of the learners. For example, Teacher C believes that ICT integration allows him to expose learners to rich visual representations of mathematical content that allows him to positively experience the lesson. Learners in the lessons taught by Teacher A were disruptive and did not actively engage with the content through the integration of ICT despite her beliefs and contrary to the engagement observed in the lessons taught by Teachers B and C. This may be due to several factors such as Teacher A being a novice teacher with only two years of teaching experience or that she is the most comfortable with the integration of ICT. Another reason may be the fact that on average Teacher A had the largest number of learners present, namely 46 learners every period. Teacher A claimed that the integration of ICT, especially the visually rich PowerPoint presentations, improved the performance of her learners. Observations from lessons taught in both learning environments could not support her claims. On the contrary, it appeared as if the integration of ICT led to ill-discipline forcing Teacher A to continuously attend to learners' discipline to avoid disrupting the continuity of the lesson. The enhancement of both the teaching and learning experiences from Teacher B and Teacher C's lessons were noticeable as both refrained from ICT integration

when they taught within a TLE. The learner engagement improved within the BLE and the positive attitudes of the learners were visible in the lessons taught by Teacher's B and C. From the observations, it was perceived that Teacher A did not experience an enhancement in her teaching experiences nor was the learners' learning experience enhanced. One possible explanation for this could be the fact that Teacher A is not an experienced teacher like Teachers B and C.

The extrinsic motivation to integrate ICT which was present in the data from the interviews of the perceptions of all three participants was increased learner engagement. Both Teacher A and B perceive the video content as the reason for the engagement of the learners. Teacher C perceives the integration of various ICTs as the reason for engagement. Even though engagement does not imply that learning took place it is still an extrinsic motivator present in all three participants. All three participants mentioned the positive impact that ICT integration had on the learning experiences of the learners. Note that these learners are from a rural community where most of the learners do not even have access to electricity let alone ICT. Exposing learners to the internet and various forms of ICT may lead to narrowing the digital divide. Teacher C explicitly mentioned that the integration of ICT prepares learners to become computer literate citizens.

Teacher A, with good intentions, made use of a rotational blended mode where she divided her class into 6 groups of 6-8 learners each. Only 3 of the groups had access to the OLE via tablets but they could not get access to the content as they struggled with registration and login details. This resulted in the learners not having access to the content for the majority of the lessons which is not a positive teaching-related consequence. Teacher B mentioned that he also experienced the process of ICT integration as a professional development opportunity where he could reflect on his traditional practices and experiment with new pedagogical approaches. Teacher C experienced trouble with connectivity and locating content on the OLE, but his experience allowed him to swiftly adapt and revert to a TLE. Regardless of a BLE's dependence on a stable internet connection and the possibility of a lesson taught within a BLE lessons do not always go according to the lesson plan. The integration of ICT within a BLE was not enhancing the teaching and learning experiences in the case of Teacher A. This does not necessarily imply that Teacher A should stop integrating ICT, it only suggests that with teaching experience and professional development courses

relating to ICT integration she will be able to improve strategies used within the classroom. For Teacher B and C, it is evident that they can integrate ICT more frequently as it enhanced their teaching experiences and increased learner engagement resulting in positive teaching-related consequences.

In summary, it is evident from the cross-case analysis that ICT integration has the potential to enhance the teaching and learning experiences of intermediate phase mathematics teachers to a large extent. Some key notes to keep in mind is that enhancement is not a given when ICT is integrated into lessons. Experience in conjunction with continuous professional development is integral in the process.

### 5.2.2 A cross-case analysis: Effort Expectancy

Table 5.3 provides a summary of the findings of the sub-constructs concerning the effort expectancy of all three participants. Below, I discuss the perceived ease of use, complexity, and ease of use simultaneously as they are all linked to each other.

**Table 5.3: Summary of the effort expectancy of all three cases**

Root construct	Sub construct	Teacher A	Teacher B	Teacher C
Effort Expectancy	Perceived ease of use	Effortless	Effort	Effort
	Complexity	Complex	Complex	Complex
	Ease of use	Easy to learn but not to use	Easy to learn and use	Easy to learn and use

Teacher A believes that the integration of ICT into her lessons will be free from effort. She has a very high self-esteem regarding her abilities with ICT. Although she expressed great ease of use of ICT, the successful integration, especially within a BLE, was not without effort. Teacher A, unlike Teacher C, navigated the user interface of the OLE without trouble and did not experience it as complex. Conversely, Teacher C experienced the user interface as complex, but integrated it with great success. It was observed that the complexity of the ICT integration increased for all the teachers when they taught within a BLE that is dependent on the internet and making use of the OLE.

Teacher B believed from the beginning that the integration of ICT would be a logistical nightmare. Teacher B accepted the tediousness of ICT integration and considers it to be an unavoidable part of the journey. Teacher C mentioned that the effort regarding ICT integration within a BLE is in the preparation of a lesson. The teaching experiences of both Teachers B and C appeared to add value to their practice when they had to integrate the ICTs in a BLE. They could successfully make use of different teaching strategies that supported learners in their learning experiences. Teacher A, even though the use of ICT came effortlessly to her, she could not integrate it within a BLE where the pedagogical approaches differ from a TLE.

In summary, teachers that believe that ICT integration is free from effort tend to integrate ICT in various learning environments, but that does not mean that the integration of ICT enhances the learning and teaching experiences. ICT use within a TLE may come effortlessly, especially for a younger teacher, but the integration appears to come naturally for teachers with more teaching experience. Both groups of teachers need to support and learn from each other if they are aiming to continue to integrate ICT successfully.

### 5.2.3 A cross-case analysis: Social Influence

Table 5.4 provides a summary of the findings of the sub-constructs concerning the social influence of all three participants. The sub-constructs relates to the intermediate phase mathematics teachers' perceptions that important stakeholders consider it important to integrate ICT, feeling that they ought to integrate ICT because their peers do, and that ICT integration leads to an improvement in social status. These sub-constructs aim to explain why teachers integrate ICT within a BLE. Each sub-construct is discussed individually.

**Table 5.4: Summary of the social influence of all three cases**

Root construct	Sub construct	Teacher A	Teacher B	Teacher C
Social Influence	Subjective norm	Perceives stakeholders consider it important	Perceives stakeholders consider it important	Perceives stakeholders consider it important

	Social factors	Not compelled by the work culture	Not compelled by the work culture	Not compelled by the work culture
	Image	Do not regard it as improving their popularity	Do not regard it as improving their popularity	Do not regard it as improving their popularity

Teachers B and C believe that the integration of ICT is important for the SGB and parents, because, in general, the community is part of a rural area and learners receive minimal ICT exposure. These two participants did not mention the other stakeholders' expectations. All three participants are devoted to the community and their drive to integrate ICT, especially within a BLE. This can be explained by their perception that the community believes that ICT integration is important. Independent of other's opinions or expectations, all three participants perceive the value of ICT integration as something that contributes to the greater community.

Teachers will most likely integrate ICT within a BLE if they feel compelled by the work culture of their peers (Blau & Shamir-Inbal, 2017). Not one of the participants reported feeling obliged to integrate ICT even though it appears to be the work culture of the intermediate phase mathematics teachers at the school. Teacher C only mentioned about the obligation he feels toward the sponsors of the various ICTs. The perceptions that the participants hold that ICT integration is truly beneficial for the whole community that surrounds the school may be a strong enough motivator to continue the integration of ICT within a BLE.

Teachers B and C expressed admiration for the set of skills of Teacher A in terms of ICT. Their admiration may lead to an improvement of Teacher A's popularity among the two teachers, but Teacher A is unaware of the admiration. None of the participants mentioned any perceived improvement in their image in terms of their social status amongst their peers. What is noticeable from the interviews is the improvement in their status amongst the community members, especially the parents of the learners. Teacher A mentioned that she frequently receives positive feedback from parents when she is in social settings outside the context of the school. This is not a change in social status but acknowledgement and gratitude from parents for innovative teaching strategies.

To summarise, ICT integration is contributing to close the digital divide especially in rural communities, which seems to have a positive social influence for teachers. It appears as if these teachers will continue to integrate ICT if it contributes to the upliftment of the community.

#### 5.2.4 A cross-case analysis: Facilitating Conditions

Table 5.5 contains a summary of the findings of the sub-constructs concerning the facilitating conditions of all three participants. Facilitating conditions are divided into three sub-constructs reflecting on the perceptions on internal and external constraints on behaviour, the available technical support and the extent to which the ICT and OLE complies with the participants' established values. The sub-constructs speak to the intermediate phase mathematics teachers' perception that school infrastructure and the OLE's infrastructure exist and the availability of support if any technical difficulties arise. Each sub-construct is discussed individually.

**Table 5.5: Summary of the facilitating conditions of all three cases**

Sub construct	Root construct	Teacher A	Teacher B	Teacher C
Facilitating Conditions	Perceived behavioural control	Difficult to integrate	Moderately difficult to integrate	Easy to integrate
	Facilitating conditions	No support	No support	No support
	Compatibility	Needs professional development	Needs professional development	Needs professional development

Teacher C's classroom is situated closely to the Wi-Fi router which may be the reason why he did not experience any internet connection problems, and this facilitating condition contributes to the ease of using online learning. On the other hand, Teachers A and B had poor internet connection, with Teacher A experiencing the most connectivity problems being the furthest away from the Wi-Fi router. Poor internet

connection as experienced by Teachers A and B made it difficult for them to integrate ICT within a BLE since a BLE is dependent on a stable internet connection. Teacher B could however draw from his experience and productively used the buffering time of the video material to explain the viewed content. Resources, like the donated tablets, are not sufficient to give an equitable learning experience to all the learners. The reason is, that it required teachers to differentiate tasks for the learners, making it time-consuming in terms of lesson planning, and eventually difficult to integrate the ICTs within a BLE.

The school where the three participants teach are isolated and in a rural setting. It is noteworthy that there are no companies in the town that specialise in ICT related facilitations. Teachers A and B mentioned that they rely on voluntary support from the community, especially the parents of the learners. The main reason for this is that the school has no on-site technical support and it is the responsibility of all intermediate phase mathematics teachers to do their own troubleshooting when they experience difficulties. The DBE has technicians available, free of charge, but requests for services must be made in advance which is not always practical seeing that most of the experienced difficulties require immediate support.

Integrating ICT within a BLE requires a special set of skills (Graham, 2006). All three participants mentioned the need to develop professionally to adequately integrate the ICT within a BLE. Neither the school nor the administration department of the OLE has made any professional development opportunities available in terms of BL and ICT integration for these participants. Teacher B values the fact that the OLE is available in his mother tongue and the majority of his community speaks the language.

In summary, all three participants value the enhancement of the teaching and learning experience and believe that ICT integration is vital to the upliftment of the community. If these participants do not receive continuous professional development and on-site technical support, then the integration of the OLE and ICT will become less frequent until they eventually stop trying and fall back on what is available and known to them.



## CHAPTER 6: CONCLUSIONS AND IMPLICATIONS

### 6.1 Introduction

This chapter addresses the research questions, draws conclusions, presents recommendations for future research, states the limitations of this study, and provides final reflections.

### 6.2 Discussion of the research questions

The rationale of my study is rooted in my strong belief that a BLE may be a scalable and financially sustainable model to address the current mathematics education crisis in South Africa. From this rationale, the objective of the study is to explore the experiences of intermediate phase mathematics teachers' ICT integration within a BLE. The following four sub-questions, based on the four root-constructs of Venkatesh et al.'s (2003) UTAUT model were used to address the primary research question: How do intermediate phase mathematics teachers' experience ICT integration within a BLE?

#### 6.2.1 Sub-question 1: What is the performance expectancy when teaching with ICT within a blended learning environment?

There were five root-constructs used to answer this question, which were: perceived usefulness, extrinsic motivation, job-fit, relative advantage, and outcome expectations (see Table 4.1). To address this question an observation schedule (see Appendix E: Observation Schedule) and an interview schedule (see Appendix D: Interview schedule **Error! Reference source not found.**) were used.

##### 6.2.1.1 *Perceived usefulness*

All three teachers indicated a strong belief that the integration of ICT will improve teaching and learning experiences within a BLE (see Table 5.1). Improved teaching and learning experiences for Teacher A, B and C respectively include, improvement of learners' ability to retain information, increasing enthusiasm amongst learners, and linking classroom mathematics with real-life applications. According to Schoenfeld (1998) the beliefs that teachers hold are linked to their decision-making. This statement also holds true for this study. Teachers believe that ICT integration within a BLE improves the teaching and learning experiences.

### **6.2.1.2 Extrinsic motivation**

The perception that the integration of ICT will lead to learner engagement was a common belief among all three participants (see Table 5.1). Teachers A and B perceive the integration of video material as the main reason for learner engagement whereas Teacher C perceives the presence of ICT as the reason for learner engagement. The presence of ICT and the visually rich video content appealed to the learners since it was different from what they experience in the TLE.

### **6.2.1.3 Job-fit**

The teaching and learning experiences of Teachers B and C were enhanced as the learners were continuously engaged during lessons and were actively participating (see Table 5.1). Unfortunately, Teacher A had a different experience as her learners were disruptive and were not actively participating in the lesson due to not having access to the content of the OLE seeing that there were not enough tablets for all the learners. Teacher A also experienced technical difficulties and spent the majority of the time troubleshooting. Teacher A had a negative teaching experience in terms of disciplinary problems. This does not imply that Teacher A should quit integrating ICT, but that she may need exposure to professional development and technical support. It is worth mentioning that, at the time of the study, Teacher A was only in her second year of teaching. Teacher A has no problem using technology, but to successfully integrate ICT within a BLE she would need to develop a strong base of Technological Pedagogical Knowledge (TPK). Knowing how to integrate ICT might influence her teaching (Mishra & Koehler, 2006). Aslan and Zhu (2017) found that beginner teachers are competent ICT users, but they lack the ability to integrate ICT successfully. Seeing that the integration of ICT does improve education (Ratheeswari, 2018), it is always deemed better to integrate ICT where applicable, but not without continuous professional development.

### **6.2.1.4 Relative advantage**

Although Teacher A realise there may be other factors too, she found that her learners outperformed learners from previous years when she started to integrate ICT into her lessons within a BLE. Teacher C specifically mentioned that his geometrical drawings on the black board are inferior compared to the colourful drawings that are made possible with computer software. Kamran (2019) found that integrating ICTs with rich

colourful images make learning effective as it engages learners and makes them active participants in the teaching and learning experiences. Integrating ICT within a BLE makes content accessible to learners with different learning styles (Guzmán, Castro, Acuña, & Malo, 2019). Learning styles have been under scrutiny for the last decade and opposite opinions are expressed. Husmann and O'Loughlin (2019, p. 17) indicate that teaching according to learners' learning styles "may not actually be beneficial to [them]". This may be a subjective belief and experience since findings from the analysis above contribute to the findings from Tadayonifar and Entezari (2020, p. 336) who claim that teaching within a BLE has a "significant effect on the students' performance" as it supports different learning styles.

#### **6.2.1.5 Outcome expectations**

All three participants expected the integration of ICT within a BLE to influence the teaching and learning experiences positively and in the case of each participant there were noticeable positive effects due to their ICT integration within a BLE. Even though Teacher A did not experience positive teaching experiences, the fact that she exposed the learners to ICT is a positive outcome to her. The positive teacher-related consequences in this study are among others, 1) learners from rural settings who would not generally be exposed to ICT, received exposure thus promoting digital literacy (Guzmán et al., 2019), and 2) teachers reflect on their practices and plan lessons as they need to make a transition from a TLE to a BLE, thus improving their skills and knowledge (Yeop, Yaakob, Wong, Don, & Zain, 2019). This resulted in a form of professional development and narrowing the digital divide between rural and urban learners.

#### **6.2.1.6 Implications with regard to performance expectancy**

The integration of ICT within a BLE enhances the teaching and learning experiences except in the case where a teacher does not have access to continuous professional development in the form of courses on how to successfully integrate ICT within a BLE. Integrating ICT is not enough to enhance the teaching and learning experiences as noted in the case of Teacher A. As Koehler, Mishra, and Cain (2013, p. 14) state, "At the heart of good teaching with technology are three core components: content, pedagogy, and technology, plus the relationships among and between them".

## **6.2.2 Sub-question 2: What is the effort expectancy when teaching with ICT within a blended learning environment?**

According to the framework of this study, there are three constructs involved in the concept of effort expectancy. These constructs are: perceived ease of use, complexity, and ease of use (see Table 4.1). To address this question, an observation schedule (see Appendix E: Observation Schedule) and an interview schedule (see Appendix D: Interview schedule) were used.

### **6.2.2.1 Perceived ease of use**

Interviews with the teachers indicated that Teachers B and C believe that the integration of ICT within a BLE will require effort. Teacher B's belief stems from the logistical difficulties that arise when teachers need to move from one classroom to another between lesson periods with the required ICT. For example, he had to travel with charger cables, speakers and a laptop. He experienced disruptions due to the time it took him to set-up a lesson being taught within a BLE which is in line with his belief. Teacher C on the other hand believes that the time he needed to prepare for lessons taught within a BLE are demanding as he needed to watch all the video content material available on the OLE, and select the appropriate material when preparing his lessons. Teacher A was the only teacher who believed that the integration of ICT will be effortless. She stated, with confidence, that the exposure she had to ICT as a high school learner and during her teacher training equipped her to integrate ICT within a BLE. Her belief and experience as described under job-fit are however in disagreement.

### **6.2.2.2 Complexity**

Teacher B conversely, to Teacher C, found the user interface of the OLE logical and simple to integrate but the ICT itself as a logistical complexity. Teacher B only integrated the OLE in an in-flipping mode reducing the complexity whereas Teacher A did station rotation (see Section 2.4.2) and many of the learners had to use ICT devices. The user interface of the OLE, according to Teacher B, is easy to navigate if you know the structure of the CAPS document. Teacher C found the navigation rather complex as he struggled to find the content he was looking for. The OLE does not have a search function.

### **6.2.2.3 Ease of use**

Teacher A did not experience the integration of ICT as a complex endeavour when she integrated it within a TLE. The complexity, however, increased when she integrated ICT within a BLE. Managing a classroom of 40 learners in a BLE is rather complex as there are multiple ICTs involved that need to function properly. She struggled to manage the ICT that was integrated into the lessons. Research findings from Maleesut, Piyawattanaviroj, and Yasri (2019) indicate that teachers find the integration of ICT within a BLE difficult for several reasons, which includes workload, redesign of lessons, and technical difficulties as in the case of Teacher A. Productively integrating the ICT into lessons taught within a BLE was difficult for her as the OLE heavily relies on several ICTs to function properly. Teacher B easily mastered navigating the OLE, despite his general lack of technological knowledge for teaching, due to the fact that the OLE was accessible in his mother tongue. Teacher C who struggled to navigate the OLE during his first lesson taught within a BLE, quickly adapted to the structure of the OLE. By his second lesson he navigated the OLE's interface with a lot more ease, showing that he easily learned the basics of the OLE and could easily use it.

### **6.2.2.4 Implications with regard to effort expectancy**

Integrating ICT when teaching within a TLE is less demanding than integrating ICT in a BLE (Maleesut et al., 2019). When teaching within a BLE, teachers need to have access to the internet and devices, depending on the BL mode they selected. It appears as if the complexity to integrate ICT within a BLE increased for all participants. Possible reasons are that the participants needed to spend more time to prepare lessons, learner devices needed to be charged, necessary software needed to be installed and the set-up of the ICTs were a tedious and time-consuming process. It is evident from all three participants that the OLE is easy to learn and use. The fact that the OLE is available in their mother tongue made it easy to adapt to the OLE to play an integral part in their lessons.

### **6.2.3 Sub-question 3: What is the social influence when teaching with ICT within a blended learning environment?**

There are three constructs from existing models captured in the concept of SI (Venkatesh et al., 2003). These constructs are: subjective norm, social factors, and

image (see Table 4.1). To answer this question an interview schedule (see Appendix D: Interview schedule) was used.

### **6.2.3.1 Subjective norm**

All three participants perceived the learners to be more engaged during the lessons taught within in a BLE than in a TLE. Teachers A and C argued that the reason is that a BLE is more inclusive and accommodating towards different learning styles. The SGB and parents, according to Teachers B and C, regard it as important to integrate ICT as it exposes their learners to ICTs and ultimately narrows the digital divide. Teacher C also mentioned a sense of obligation as he feels compelled to integrate the ICT since it was sponsored and expected to be used. He therefore, feels responsible toward the sponsors. All three participants are devoted toward the upliftment of the community consisting of learners, parents and SGB members and respect their expectations. It is clear that all stakeholders involved regard the integration of ICT within a BLE as important seeing it as a powerful tool to uplift the community. This statement resonates with the findings from Kumar and Kumara (2018) indicating the role that ICT integration at school level has on narrowing the digital divide.

### **6.2.3.2 Social factors**

None of the participants felt compelled by the work culture of the intermediate phase teachers to integrate ICT within a BLE. Teacher B stated that ICT integration within a BLE is voluntary at the school and no teacher expects it from another. Teacher A mentioned that she integrates ICT because she wants to and not because the current work culture dictates it. The finding here is positive. Initially, it was predicted that the work culture of all intermediate phase mathematics teachers at the school will have a significantly higher influence on the three teachers' ICT integration within a BLE. However, none of the participants indicated that they integrate ICT because their peers integrate ICT, which contradicts the original postulations made by Venkatesh et al. (2003). On the contrary, it is consistent with findings from Attuquayefio and Addo (2014) who found that social influence, which includes social factors, has an insignificant influence on teachers' reason to integrate ICT within a BLE.

### **6.2.3.3 Image**

According to the participants the integration of ICT did not improve their popularity amongst their peers. Both Teachers B and C emphasised the supporting role that ICT

plays in lessons and that the mere presence of ICT does not imply that you are a good teacher. The ICT should be integrated with sound pedagogical approaches to improve mathematics education. Teacher A, however, noticed that the SGB and the parents of the learners from her class frequently gave her positive feedback that may lead to an increase in popularity amongst the learners and their parents.

#### **6.2.3.4 Implications with regard to social influence**

All three teachers believe that the integration of ICT within a BLE is important for all the stakeholders within the context of the school. The main reason being, that the exposure to ICT is essential for the learners who are from a rural background since it narrows the digital divide and better prepares them to become digitally literate citizens. Teachers from the school integrate ICT mainly out of free will and not because they feel obliged by the work culture of the intermediate phase mathematics teachers to do so. The participants included in this study are dedicated towards the improvement of their community and see the integration of ICT as a catalyst. None of the teachers experienced any improvement of popularity amongst their peers, but a feeling of being valued by the community was noticeable. Thus, it can be concluded that social influence was not an indicator for ICT integration within a BLE for the participants of this study.

#### **6.2.4 Sub-question 4: What are the facilitating conditions when teaching with ICT within a blended learning environment?**

There are three constructs from existing models captured in the concept of facilitating conditions (Venkatesh et al., 2003). These constructs are: perceived behavioural control, facilitating conditions, and compatibility (see Table 4.1). To address this question an observation schedule (see Appendix E: Observation Schedule) and an interview schedule (see Appendix D: Interview schedule) were used.

##### **6.2.4.1 Perceived behavioural control**

The three participants exhibited different difficulty levels relating to the integration of ICT within a BLE. Teacher A, who was the most comfortable with ICT and who integrated ICT in her lesson taught within a TLE, found it the most difficult to integrate ICT within a BLE. Integrating ICT within a BLE appears to be dependent on more than technological knowledge. Dewi, Ciptayani, and Surjono (2018) found that teachers need to develop their pedagogical content knowledge in terms of ICT integration since

it is deemed useful when improving their teaching practice. Teacher A made use of station rotation as a BL mode, but the complex and device dependent setup led to frequent disruptions during her lessons. Both Teachers B and C integrated ICT within a BLE with relative ease. Both these participants made use of in-flipping as a BL mode, reducing the dependency on technology facilitating conditions. Teacher B managed to uphold a positive teaching and learning experience even though he experienced irregular internet connections. He improvised and used the time the video content loaded to interact with the learners regarding lesson content.

#### **6.2.4.2 Facilitating conditions**

The school is situated in a rural setting with no IT companies within a 100 km radius. All three participants mentioned that they frequently required technical assistance either with ICT or with the OLE. Most of the school's technical support comes from local volunteers, which is not a sustainable form of technical support. The DBE, whose office is more than 100 km from the school, provides technical support to the school, but only on request. The problem with this is that the request needs to be submitted at least two days before the date that the school requires the support. This implies that the support is not immediate and does not support on-demand needs which in turn leads to teachers frequently troubleshooting their own technical issues. Furthermore, troubleshooting occurs while learners are present (in the class) leading to lesson disruptions. The OLE, at the time of the study, did not have an active support-line and the e-mail support was not responsive.

#### **6.2.4.3 Compatibility**

All three participants value their profession, and they expressed the need to develop professionally seeing that teaching within a BLE is a foreign teaching strategy to them. Teachers B and C have not received any training in terms of teaching within a BLE during their teacher training years. Teacher A only attended one informal course regarding BL and its implementation. The integration of ICT must comply with their needs as teachers in order to provide them with opportunities to develop their professional careers and teaching values. Dewi et al. (2018) found that continuous professional development as a critical success factor in the successful implementation of teaching within a BLE. Thus, it is imperative that teachers receive continuous professional development so that they are enabled to integrate ICT in order to be compatible with their teaching values and needs.



#### **6.2.4.4 Implications with regard to facilitating conditions**

There are ample reasons for the teachers to refrain from integrating ICT within a BLE, because there is no on-site technical support or an active helpline from the OLE. Instead, they value their profession and they recognise their role in empowering the community. Thus, they continue to integrate ICT within a BLE even in the absence of facilitating conditions. The professional development of these teachers needs to become a focus point if the school plans to continue integrating ICT within a BLE seeing that these teachers will have to rely on their own technical knowledge when challenges arise.

#### **6.2.5 Primary question: How do intermediate phase teachers experience ICT integration within a BLE?**

BLE is a combination of two modes: face-to-face and online learning (Horn & Staker, 2014). The online learning, as part of ICT integration, can either be in class or at home, but in this study it was only in class. All three participants, in the case of this study, indicated that they believe that the integration of ICT within a BLE enhances the teaching and learning experiences. Teachers A and C stated that the integration of ICT keeps the attention of learners better than when it is omitted. Teacher A specifically mentioned that her learners demonstrated more interest in lesson content when she integrated videos, like those from the OLE, into her lesson compared to when she did not. Regarding the use of ICT within a BLE and a TLE, two of the three teachers were very similar. Teachers B and C used in-flipping as a blended learning mode for instruction, where video content from the OLE, relating to specific topics, were projected on a white board. Both these teachers used the pause/play functionality of the video material to allow for questions and discussions and thereby engaging the learners with the video content. These two teachers did not integrate any ICT into their lessons when they taught within a TLE. The behaviour of the learners was noticeably different in the two different learning environments. The learners were less engaged with the content when they were taught within a TLE, not actively asking questions or answering them when prompted to. It appears as if the integration of ICT within a BLE enabled Teachers B and C to change from a more teacher-centred approach to a more learner-centred approach. This change in their teaching approach led to positive learner behaviour differences between lessons taught within a TLE and a BLE. Research findings from Rajkoomar and Raju (2016) found that one of the pedagogical

benefits of teaching within a BLE is the transformative effect it has, namely that it directs teachers away from teacher-centred teaching to learner-centred teaching. With Teacher A it was different as she integrated several forms of ICT in both learning environments, but struggled to keep the learners engaged which led to the deterioration of learners' discipline. Teacher A integrated the following forms of ICT: PowerPoint presentations, her smartphone, the OLE, tablets and her laptop. Teacher A differentiated tasks when she taught within a BLE making use of the station rotation as a blended learning mode of instruction. With each station learners worked on the same problems, but they used different ICTs. Some of the stations had tablets connected to the Wi-Fi and they had to work through content on the OLE, while other learners only worked in their books. Teacher A struggled to maintain discipline in the class as learners frequently interrupted her and disrupted the flow of the lesson. Learners struggled to connect to the OLE and in some cases struggled to download the learning material. In such instances, the learners had to wait for their turn to be helped by Teacher A resulting in moments where some learners were disengaged from the lesson. Teacher A kept integrating ICT into her lessons in both learning environments despite the disruptions.

The performance expectancy of all three participants influenced their behaviour intention in the sense that they believe that the integration of ICT enhances the teaching and learning experiences of the teachers and learners respectively. The behaviour intention, in turn, positively influenced the behaviour use as they actually integrated ICT within a BLE. Teachers B and C only integrated ICT when they taught within a BLE which is contradictory to their beliefs, but it can be assumed that if they continuously integrate ICT within a BLE, they will adopt it in the lessons they teach within a TLE.

The difference between Teacher A's ICT integration within a BLE and that of Teachers B and C, is that Teacher A integrated ICT in such a manner that the learners had to interact with the different ICT tools for the lesson to be successful. Unfortunately, the heavily ICT dependency, in the case of Teacher A, led to multiple technical difficulties. Whereas Teachers B and C integrated ICT in a simplistic manner yet delivering the content in such a fashion that learners still found it interesting. Teachers B and C kept the integrated ICT to a manageable minimum while Teacher A integrated as many forms of ICT as possible which, from the observations, deemed to be unpractical

especially for a Grade 4 group and Teacher A had no technical support. Integrating ICT within a BLE requires more than mere technological knowledge, as is illustrated by Teacher A, who is a ‘tech savvy’ teacher, but struggled to successfully integrate the many ICTs. As Koehler et al. (2013, p. 14) states, “At the heart of good teaching with technology are three core components: content, pedagogy, and technology, plus the relationships among and between them”. From the observations it was clear that Teachers B and C integrated ICT within a BLE successfully in terms of enhancing the teaching and learning experiences. However, they lacked knowledge regarding technology. Compare the statement made by Teacher C, “I am personally not that computer literate, but the more I work with it the more I learn”. Despite this lack of knowledge regarding technology, they could rely on their experience, content knowledge, and pedagogical knowledge especially in the moments when the ICT failed.

Integrating ICT within a BLE exposes learners to different technologies and content that is on the World Wide Web (www) ultimately narrowing the digital divide. Each one of the participants had a different reason for integrating ICT into their lessons, none of which were content delivering. Their reasons for ICT integration within a BLE, included saving time by recycling lessons, serving as a supplementary source and preparing learners for the labour market, narrowing the digital divide, and to expose learners to the world outside of their own isolated and rural context. Kaspar (2018, p. 54) states that “access to technology will create equity both in and outside of school”. These participants exhibit immense passion for their careers and their learners, rising above their rural context, competing academically with the schools from the city by adopting several different ICTs and integrating it within a BLE. Each of these participants hold their community dear to their hearts. The integration of ICT by these mathematics teachers served a purpose that expands outside of their classroom walls into their community.

To conclude, the role of ICT integration within a BLE for a subject like intermediate phase mathematics in a developing country like South Africa is twofold: Firstly, it closes the digital divide and helps “realise the Department of Education's vision of developing citizens who are critical and active lifelong learners” further this will “advance educational quality and reduce inequalities” (DBE, 2019, p. 59; DoE, 2004, p. 15). Secondly, it answers the call to the reform required in mathematics promoting modern

methods of teaching that are deemed necessary for the 21<sup>st</sup> Century classroom (Adu & Galloway, 2015).

### 6.3 Conclusions

It should be mentioned that this study was not conducted during the COVID-19 pandemic, but I wish to mention some influences COVID-19 has on our education system. The global COVID-19 pandemic may serve as the accelerator that pushes South Africa's mathematics education crisis over the edge or bring about a lasting reform of the predominantly teacher-centred mathematics classrooms. This study showed that teaching within a BLE leads to intermediate phase mathematics teachers' adoption of ICTs as it enhances the teaching and learning experiences by improving engagement. The current global COVID-19 pandemic left numerous intermediate phase mathematics teachers obliged to teach within a BLE and the findings of this study served as a precursor for what could ultimately reform mathematics education. This study proved that the education system should always lead the way, anticipating the future needs of our teachers and learners. The BL project that is running at this school, reported within this study, ensured that these teachers were prepared to face the challenges the pandemic presented. If the DBE wants to utilize this opportunity to reform mathematics education, the following points, taken from the findings of the study, may be considered:

- **ICT integration has additional value and purpose.** The participants from this study not only integrated ICT to hopefully enhance their lessons, but also to uplift their community. The ICTs that the learners from a rural community were exposed to, not only enhanced their learning, but exposed them to a new world. These learners were exposed to 21<sup>st</sup> Century skills, closing the digital divide by making them technologically literate preparing them for work in the 4IR (Fitri & Zahari, 2019). Although these are valuable reasons to integrate ICT within a BLE, more emphasis can be placed by the teachers who integrate ICT to develop mathematical soft skills, such as critical thinking and problem solving.
- **Teachers require continuous professional development.** It should be kept in mind that these three participants received training on the OLE by an educational specialist. This study indicates that continuous professional development is required to enhance the teachers' skills in integrating ICT in their lessons. To merely add ICT into a lesson does not enhance teaching and

learning, teachers need to have a nuanced understanding of the “complex relationships between technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations” (Mishra & Koehler, 2006, p. 1029). The participants in this study voiced their concerns that their lack of access to continuous professional development. Research indicates that this will cause teachers, similar to these participants, to terminate their integration of ICT within a BLE if it is not addressed (Dewi et al., 2018; Haji et al., 2017; Jeffrey et al., 2014). It is advised that in addition to workshops, trainers can be sent to schools spending a few days at these schools to assist the teachers in their own classes on their own devices. This may contribute to teachers receiving adequate training and becoming ICT literate.

- **Facilitating conditions (Support).** The participants of this study mentioned that the complexity of ICT integration, especially in a rural school, is daunting. The reality is that if these participants do not have technical support readily available, they may eventually stop integrating ICT (DeCoito & Richardson, 2018; Raphael & Mtebe, 2016). Graham, Stols and Kapp (2020) also found that the majority of mathematics teachers do not integrate ICT only due to the lack of professional development opportunities, but also the lack of support. The findings from this study indicates that support on demand is required and it is suggested that a support person should be appointed at a school with the responsibility of assisting teachers in their everyday activities.

To conclude, integrating ICT within a BLE may assist the DBE in the “Action Plan to 2019: Towards the Realisation of Schooling 2030”. The school in this study is an isolated school situated in a rural area of the country where the majority of the community is of a low socio-economic background. The DBE’s white paper on e-education has not been realised partly due to the fact that teachers were not instrumental in the role out of the policy (Vandeyar, 2013). The DBE’s latest action plan in terms of ICT adoption acknowledges their previous shortcoming and states that “[g]overnment needs to work more vigorously on partnerships that take certain aspects of e-education forward, or target particular disadvantaged areas” (DBE, 2019, p. 14). The school in this study showed that it is possible to integrate ICT successfully if one

is willing to partner-up with the private sector. We all share a common goal: teaching mathematics better, but also teaching better mathematics (Joshi, 2017).

#### **6.4 Recommendations for further research**

Listed here are research suggestions evolving from the findings of this investigation:

- The same study with a more diverse sample in terms of different types of schools and more teachers.
- A longitudinal study to investigate if changes in pedagogy is sustainable when ICT integration is used within a BLE.
- A quantitative study with pre- and post-test to determine whether learners' mathematics performance improves.
- Design-based research using the Lesson Study concepts where lessons are planned collaboratively, executed, and reflected on afterwards to improve the design of lessons.

#### **6.5 Limitations of this study**

Several limitations to this study need to be highlighted. One possible constraint is that the findings and the generalisability of the results were subject to limitations related to the participants. Only three teachers teaching intermediate phase mathematics, from the same school, formed part of this case study. Even though this may be a constraint, an interpretivist paradigm makes it possible to gather rich data from a rather small sample. A second possible constraint may be that this study followed a purposive sampling technique where only one school, situated in the rural parts of the Northern Cape, was selected as this school was the only school willing to participate in the project at the time of the study. A third possible constraint may be the fact that all three participants are from the same racial group and speaks the same mother tongue with one female teacher and two male teachers. A more diverse sample could potentially yield different results.

#### **6.6 Final reflections**

I have experienced an indescribable learning curve as I completed the journey on which this study took me. At the beginning of this study, I had little hope for the mathematics education in South Africa, but as I progressed through this study I realised that there is hope at the end of the tunnel. I have seen how teachers from a rural

community use their school not only as a place of education, but also a place of inspiration. I have witnessed how ICT, especially when integrated within a BLE, changed teaching practices and how it connected an isolated school in a rural community to the rest of the world. I have seen how learners change from passive bystanders in a classroom to active participants. I have seen the role that ICT can play in the improvement of mathematics education.

I will forever be grateful for the school and the teachers who welcomed me with open hearts and open minds. I echo the sentiment of Reddy et al. (2016) that improvement in our education system does not rest on the shoulders of classroom teachers and institutions only, but must become a national narrative.

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## APPENDIXES

### 7.1 Appendix A: Letters of permission and consent

Mr. J Koekemoer

Science, Mathematics and Technology

Education

Groenkloof campus

University of Pretoria

[koekemoerjohan11@gmail.com](mailto:koekemoerjohan11@gmail.com)

Cell: 082 878 0111

25 July 2019

Dear Sir/Madam

#### **Letter of consent to the Northern Cape Department of Education (NCDE)**

I am currently an M.Ed student at the University of Pretoria doing a research study entitled: South-African Intermediate Phase Mathematics teachers' ICT integration experiences within a blended learning environment. I hereby request permission to use a public school in the ZF Mgcawu District Municipality for my research. I would like to invite three Intermediate Phase Mathematics teachers to participate in this research aimed at investigating their teaching experiences integrating ICT in their lessons within a blended learning environment. This research will be reported upon in my Master's dissertation at the University of Pretoria.

If consent can be obtained from the NCDE, the data will be collected by means of interviews and observations. Six classroom observations per teacher will be video-

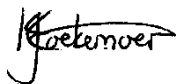
recorded over a period of two weeks while I will also be completing an observation schedule during class time to allow for a clear and accurate record of the teachers' classroom practices. The observations will be done during the normal school program and will not disrupt the classroom timetable. One audio recorded interview per teacher will be conducted after the observations and after school hours at a preferred location and a suitable time for the teachers. Although learners will be present in class, they do not form part of my research in any way. Participants may feel vulnerable to express their incompetence during semi-structured interviews, but will again be reminded that their identity will remain anonymous and that their honest beliefs and experiences will contribute to the development of the programme.

All participation is voluntary and participating teachers may withdraw from this study at any time. Pseudonyms will be used for all the parties (schools and teachers) involved to guarantee confidentiality and anonymity. Only my supervisors and I will have access to the video- and audio recordings which will be password protected. Participants will be have the opportunity to comment on the observation and semi-structured interview transcripts as a form of member checking. Time at the end of the data collection period will be allocated for this exercise. The study will be conducted in English and there will be no incentives for the participating schools or teachers. The consent letters for the learners will be translated in Afrikaans to accommodate the Afrikaans speaking learners. The teachers are bilingual, thus do I not foresee a language barrier with regard to the consent letter to the teachers.

After the successful completion of my Master's degree, I will give feedback to the NCDE in the form of a written report and if the NCDE is willing, I would like to do a PowerPoint presentation of my findings to the mathematics subject facilitators. Raw data will not be made available to the anyone other than through the dissertation itself with the exception of my supervisors.

This research will contribute to the Department of Basic Education's long term goal to ensure that all teachers are ICT literate and can use it proficiently.

Yours sincerely



2019/07/25

Date

\_\_\_\_\_  
Researcher: Mr. J Koekemoer



2019/07/25

Date

\_\_\_\_\_  
Supervisor: Dr JJ Botha

Natural Science Building 4-1, Groenkloof Campus, UP

E-mail: [hanlie.botha@up.ac.za](mailto:hanlie.botha@up.ac.za)



-----  
I hereby grant consent to Mr. J Koekemoer to conduct his research in this school for his Master's degree research. I also grant consent to Mr. J Koekemoer to video record the lessons and audio record the interviews.

District official for ZF Mgcawu District Municipality's name: \_\_\_\_\_

District official of ZF Mgcawu District Municipality's signature: \_\_\_\_\_

Date: \_\_\_\_\_

E-mail address: \_\_\_\_\_

Contact number: \_\_\_\_\_

Mr. J Koekemoer  
Science, Mathematics and Technology  
Education  
Groenkloof campus  
University of Pretoria  
[koekemoerjohan11@gmail.com](mailto:koekemoerjohan11@gmail.com)  
Cell: 082 878 0111

14 October 2019

Dear Sir/Madam

### **Letter of consent to the parents/guardians**

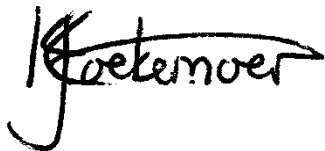
I am currently enrolled for a Master's degree at the University of Pretoria. My research is aimed at investigating the teaching experiences of teachers integrating ICT in their mathematics lessons within a blended learning environment. The research findings will be reported upon in my Master's dissertation. In order to do the research, I will observe your child's mathematics teacher. I would like to video-record six Mathematics lessons where your child will be present as it will help me to have an accurate record of the teacher's classroom practice. I need permission to conduct the study in the classroom that your child attends.

During the course of this study, I will be focusing on how the teacher integrates ICT into his/her lessons within a blended learning environment. The interaction will be video-recorded to ensure that I capture accurate information of the lessons. The video-recordings will be taken from the back of the class where I will sit, and I will, as far as possible, only record the teacher. All recordings will be password protected and will

only be used for my Master's degree. All children's confidentiality and anonymity will be protected at all times and only my supervisors and I will have access to the recordings. The data of this study will be made available through a written dissertation which is open for the public domain to read.

By signing this letter you will be granting me permission to be present in the class where your child is being taught.

Yours sincerely



14 October 2019

\_\_\_\_\_  
Researcher: Mr. J Koekemoer

\_\_\_\_\_  
Date



14 October 2019

\_\_\_\_\_  
Supervisor: Dr JJ Botha

\_\_\_\_\_  
Date

Natural Science Building 4-1, Groenkloof Campus, UP

E-mail: [hanlie.botha@up.ac.za](mailto:hanlie.botha@up.ac.za)



Parent's/guardian's name: \_\_\_\_\_

Parent's/guardian's signature: \_\_\_\_\_

Date: \_\_\_\_\_

Child's name: \_\_\_\_\_

Grade (e.g. 5 C): \_\_\_\_\_

Mr. J Koekemoer  
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Cell: 082 878 0111

14 October 2019

Dear Sir/Madam

### **Letter of consent to the Principal**

I am currently an M.Ed student at the University of Pretoria doing a research study entitled: South-African Intermediate Phase Mathematics teachers' ICT integration experiences within a blended learning environment. I hereby request permission to use your school for my research. I would like to invite three Intermediate Phase Mathematics teachers to participate in this research, aimed at investigating teachers' teaching experiences integrating ICT into their lessons within a blended learning environment. This research will be reported upon in my Master's dissertation at the University of Pretoria.

The data collection process will be as follows: I will observe six lessons taught by each of the three Intermediate Phase Mathematics teachers. The observations will be conducted during a two week period. The observations will be done during the normal school program and will not disrupt the teacher's timetable. The observations will be digitally video-recorded and I will complete an observation schedule during class time. This will allow for a clear and accurate record of the teachers' classroom practices. After the classroom observations, I will do one individual interview with each teacher.

The interviews will be conducted for 30-60 minutes after school hours and will be audio recorded. The teachers can arrange the place and time for these interviews.

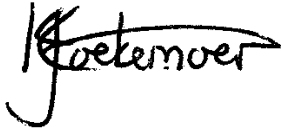
All participation is voluntary and once committed to the research, teachers may still withdraw at any time. Confidentiality and anonymity are guaranteed at all times by using pseudonyms for the school and the teachers. The school and the teachers will therefore not be identifiable during the research study or in the findings of my research. However, only my supervisors and I will have access to the video and audio recordings which will be password protected. You will have the opportunity to comment on the observation and semi-structured interview transcripts as a form of member checking. Time at the end of the data collection period will be allocated for this exercise. The study will be conducted in English/Afrikaans and there will be no incentives for the participating schools or teachers.

I believe that the teachers of your school will gain valuable insights into their own teaching practices as they reflect on it during the semi-structured interview. This will contribute positively to their teaching strategies and ultimately to the quality of the learners' learning experiences.

After the successful completion of my Master's degree, I will give feedback to the school in the form of a written report and if the school is willing, I would like to do a presentation of my findings to all Mathematics teachers at that school. Raw data will not be made available to anyone other than through the dissertation itself with the exception of my supervisors.

For any questions before or during the research, please feel free to contact me. If you allow me to conduct this study in your school, please sign this letter as a declaration of your consent.

Yours sincerely



14 October 2019

\_\_\_\_\_  
Researcher: Mr. J Koekemoer

\_\_\_\_\_  
Date



14 October 2019

\_\_\_\_\_  
Supervisor: Dr JJ Botha

\_\_\_\_\_  
Date

Natural Science Building 4-1, Groenkloof Campus, UP

E-mail: [hanlie.botha@up.ac.za](mailto:hanlie.botha@up.ac.za)



I hereby grant consent to Mr. J Koekemoer to conduct his research in this school for his Master's degree research. I also grant consent to Mr. J Koekemoer to audio and video record the lessons and interviews.

School principal's name: \_\_\_\_\_

School principal's signature: \_\_\_\_\_

Date: \_\_\_\_\_

E-mail address: \_\_\_\_\_

Contact number: \_\_\_\_\_



Mr. J Koekemoer  
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Cell: 082 878 0111

14 October 2019

Dear Sir/Madam

### **Letter of consent to the mathematics teacher**

I am currently an M.Ed student at the University of Pretoria doing a research study entitled: South-African Intermediate phase Mathematics teachers' ICT integration experiences within a blended learning environment. You are invited to participate in the research project aimed at investigating your teaching experiences of integrating ICT into your lessons within a blended learning environment. The research will be reported upon in my Master's dissertation at the University of Pretoria. It is proposed that you form part of this study's data collection phase by being observed and interviewed. I will observe two lessons during a one week period. During my observations, I would like to video-record you and complete an observation schedule to ensure that I capture accurate information of your classroom practice. After the observations, at a time and place convenient to you, I will conduct one 30-60 minute

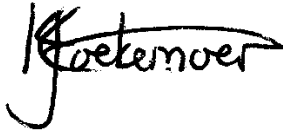
audio recorded interview with you after observing your teaching. I do foresee that you may experience being observed as something stressful. Remember participation is voluntary and you may withdraw at any time if you feel to do so.

Should you declare yourself willing to participate in this research, you will be one of three teachers that form part of my research project. Your participation is voluntary and confidentiality and anonymity will be guaranteed at all times. This will be done by allocating pseudonyms to you and the school during all phases of the research process. Only my supervisors and I will have access to the audio and video recordings which will be password protected. You will have the opportunity to comment on the observation and semi-structured interview transcripts as a form of member checking. Time at the end of the data collection period will be allocated for this exercise. The study will be conducted in English/Afrikaans and there will be no incentives for you or the school.

After the successful completion of my Master's degree, I will give feedback of my findings to the school in the form of a written report and if the school is willing, I would like to do a presentation of my findings to all mathematics teachers at your school. Raw data will not be made available to anyone other than through the dissertation itself with the exception of my supervisors. I believe that you will gain valuable insight into your own teaching practices as you reflect on it during the semi-structured interviews. This will contribute positively to your teaching strategies.

If you are willing to participate in this research study, please sign this letter as a declaration of your consent, i.e. that you participate willingly and that you understand that you may withdraw at any time.

Yours sincerely



14 October 2019

\_\_\_\_\_  
Researcher: Mr. J Koekemoer

\_\_\_\_\_  
Date



14 October 2019

\_\_\_\_\_  
Supervisor: Dr JJ Botha

\_\_\_\_\_  
Date

Natural Science Building 4-1, Groenkloof Campus, UP

E-mail: [hanlie.botha@up.ac.za](mailto:hanlie.botha@up.ac.za)



-----

I hereby grant consent to Mr. J Koekemoer to observe six lessons over a two week span and conducting one interview afterward the observations for his Master's degree research. I also grant consent to Mr. J Koekemoer to audio and video record the lessons and interview.

Teacher's name: \_\_\_\_\_

Teacher's signature: \_\_\_\_\_

Date: \_\_\_\_\_

E-mail address: \_\_\_\_\_

Contact number: \_\_\_\_\_

## 7.2 Appendix B: Letters of assent to learners and parents

Mr. J Koekemoer  
Science, Mathematics and Technology  
Education  
Groenkloof campus  
University of Pretoria  
[koekemoerjohan11@gmail.com](mailto:koekemoerjohan11@gmail.com)  
Cell: 082 878 0111

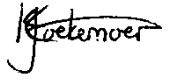
25 July 2019

Dear learner

### **Letter of assent to the learners**

I am enrolled for a Master's degree at the University of Pretoria and my research project aims at investigating teaching experiences of teachers integrating ICT into their lessons within a blended learning environment. I will be sitting in the back of the class observing your mathematics teacher, making notes and video-recording the lessons. I will not be recording you, but the teacher. That will be the only way you will be involved in the research and you do not have to do anything except what your teacher expects from you. I expect no possible risks or discomfort that you will be exposed to during the course of this study. The research aims to deepen your teachers' knowledge regarding the use of ICT and I believe this will positively contribute to your learning experience. The collected data will not be made available through any other medium other than my dissertation to any one, except to my study leaders. If you have any questions you may contact me at any time.

Yours sincerely



2019/07/25

Date

Researcher: Mr. J Koekemoer



2019/07/25

Date

Supervisor: Dr JJ Botha

Natural Science Building 4-1, Groenkloof Campus, UP



E-mail: [hanlie.botha@up.ac.za](mailto:hanlie.botha@up.ac.za)

I hereby grant permission to Mr. Koekemoer to be present in the Mathematics class where he will make notes and video-record the lessons.

Learner's name: \_\_\_\_\_

Learner's signature: \_\_\_\_\_

Date: \_\_\_\_\_

Grade (e.g. 5C): \_\_\_\_\_

Mnr. J Koekemoer  
Wetenskap, Wiskunde en  
Tegnologie opvoedkunde  
Groenkloof kampus  
Universiteit van Pretoria  
[koekemoerjohan11@gmail.com](mailto:koekemoerjohan11@gmail.com)  
Sel: 082 878 0111

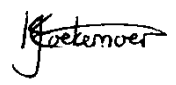
Oktober 2019

Geagte leerder

### **Brief van toestemming aan die leerder**

Ek is tans ingeskryf vir my Meestersgraad by die Universiteit van Pretoria. My navorsingsprojek beoog om die onderrig ervaringe van onderwysers wat IKT tydens hul lesse met 'n Vervlegteleer omgewing integreer, te ondersoek. Ek gaan agter in die klas sit, besig om jou wiskunde onderwyser te observeer terwyl ek video-opnames en notas maak. Ek sal jou nie afneem nie maar slegs jou onderwyser. Hierdie is die enigste wyse waarop jy sal deelneem aan die navorsing en daar sal niks van jou verlang word anders as wat jou onderwyser van jou verwag nie. Ek verwag geen moontlike ongemak of gevare waaraan jy blootgestel gaan word tydens die studie nie. Die navorsing beoog om jou onderwyser 'n dieper insig te gee rakende die gebruik van IKT en ek glo dit sal jou onderrig ervaring hopelik positief beïnvloed. Geen inligting sal op 'n ander wyse as deur my verhandeling aan enige iemand bekend gemaak word nie, behalwe aan my studieleiers. As jy enige vrae het, is jy welkom om my te kontak.

Die uwe



---

Navorsers: Mnr. J Koekemoer

14 Oktober 2019

Datum



14 October 2019

Studieleier: Dr JJ Botha

Datum

Natuurwetenskap gebou 4-1, Groenkloof Kampus, UP



E-pos: [hanlie.botha@up.ac.za](mailto:hanlie.botha@up.ac.za)

Hiermee gee ek toestemming aan Mnr. Koekemoer om teenwoordig te wees tydens die Wiskundeles.

Leerder se naam: \_\_\_\_\_

Leerder se handtekening: \_\_\_\_\_

Datum: \_\_\_\_\_

Graad (bv. 5C): \_\_\_\_\_

Mnr. J Koekemoer

Wetenskap, Wiskunde en

Tegnologie opvoedkunde

Groenkloof kampus

Universiteit van Pretoria

[koekemoerjohan11@gmail.com](mailto:koekemoerjohan11@gmail.com)

Sel: 082 878 0111

Oktober 2019

Geagte meneer/mevrouw

### **Brief van toestemming aan die ouer/voog**

Ek is tans ingeskryf vir my Meestersgraad by die Universiteit van Pretoria. My navorsingsprojek beoog om die onderrig ervaringe van onderwysers wat IKT tydens hul lesse met 'n Vervlegteleer omgewing integreer, te ondersoek. Die navorsingresultate sal opgeteken word in my Meestersverhandeling. Vir my om in staat te wees om my navorsing te voltooi het ek nodig om u kind se wiskunde-onderwyser te observeer. Ek wil graad 6 video-opnames maak van wiskunde-lesse waarby u kind teenwoordig gaan wees want dit gaan my help om die inligting akkuraat te vervaar, u kind se gesig sal egter nie verfilm word nie. Ek nodig u toestemming om die navorsing te doen in die klas waar u kind in is.

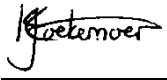
Gedurende die studie gaan ek fokus hoe die onderwysers IKT integreer in sy/haar lesse binne 'n vervlegte-omgewing. Die interaksies sal opgeneem word om die lesse akkuraat te weerspieël. Die video-opnames sal van agter die klas geneem word waar ek gaan sit en ek sal sover moontlik slegs die onderwyser afneem. Al my opnames sal met 'n wagwoord beskerm word en sal slegs gebruik word vir my Meesters studie. Die leerders se konfidensialiteit sal beskerm word en slegs ek myself en my studieleiers



sal toegang hê tot die opnames. Die data van my studie sal in 'n verhandeling vervat word wat dan op die publieke domein sal lê vir u kennisname.

Deur die brief te teken geen u my toestemming om teenwoordig te wees in die klas waar u kind ge-onderrig word.

Die uwe



---

14 Oktober 2019

Datum

Navorser: Mnr. J Koekemoer



---

14 Oktober 2019

Datum

Studieleier: Dr JJ Botha

Natuurwetenskap gebou 4-1, Groenkloof Kampus, UP



E-pos: [hanlie.botha@up.ac.za](mailto:hanlie.botha@up.ac.za)

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Hiermee gee ek toestemming aan Mnr. Koekemoer om teenwoordig te wees tydens die Wiskundeles.

Leerder se naam: \_\_\_\_\_

Leerder se handtekening: \_\_\_\_\_

Datum: \_\_\_\_\_

Graad (bv. 5C): \_\_\_\_\_

## 7.3 Appendix C: Ethical clearance from the Northern Cape Department of Education



Mr J Koekemoer  
University of Pretoria  
Cnr Lynnwood Road and Roper Street  
Hatfield, Pretoria  
South Africa

Dear Mr J Koekemoer

### ETHICAL CLEARANCE GRANTED

**Research: How does intermediate phase mathematics teachers experience ICT integration in their teaching within a blended learning environment?**

The above proposed research request, has been approved by the Northern Cape Department of Education. Arrangements with the selected schools must be concluded well in advance.

The Northern Cape Department of Education however requests that the findings and recommendations be shared with the department.

Yours sincerely

DR M ISHMAIL  
DEPUTY DIRECTOR-GENERAL: CURRICULUM, EXAMINATIONS AND ASSESSMENT



## 7.4 Appendix D: Interview schedule

### Educator interview schedule

Time of the interview:\_\_\_\_\_ Duration of the interview:\_\_\_\_\_

Date of the interview:\_\_\_\_\_ Place of the interview:\_\_\_\_\_

Interviewer:\_\_\_\_\_ Participant:\_\_\_\_\_

Pseudonym of interviewee:\_\_\_\_\_

### Semi-structured interviews

#### Performance expectancy

- a) Do you think ICT is beneficial to you? If so, in what way?
- b) Do you think teaching with ICT will help you engage better with your learners?
- c) What would you say is the main reason why you as an educator use ICT?
- d) Do you believe that teaching with ICT will contribute to learners' learning? If so why?
- e) Do you think that ICT can be used in all areas of learning?
- f) To what extend do you think does teaching with ICT help you in your career as an educator?

#### Effort expectancy

- a) Describe your confidence in teaching with ICT?
- b) Are there any aspects that make you uneasy when teaching with ICT?
- c) Were you able to blend the ICT successfully?

- d) How did you experience the implementation process?
- e) What do you think is the most challenging aspect of using ICT and teaching?
- f) Have you received any training regarding ICT integration?
- g) How does a blended lesson compare to a face to face lesson in terms of preparation and presentation?

### **Social influence**

- a) What do you say is the SGB's view on including ICT in lessons?
- b) Do you feel compelled as an educator to integrate ICT in your lessons? If so, by whom and why?
- c) Do you think parents would view you teaching with ICT in a positive light?
- d) Are you aware of the DBE's white paper on technology and do you think blending ICT into your lessons contributes to the objectives of the white paper?
- e) Do you think your career is dependent on your ability to teach with ICT?
- f) Do you think blending ICT into your teaching domain will prepare learners with 21<sup>st</sup> Century skills?
- g) Do you feel compelled to incorporate ICT into your lessons?

### **Facilitating conditions**

- a) Have you ever required technical support to implement the OLE? If so, how?
- b) Have you received professional development on blended learning and how to blend the OLE into your day to day lessons? If so, how did you experience this professional development?
- c) Do you have any on site technical ICT support? Do you think it is sufficient?

## 7.5 Appendix E: Observation Schedule

Time of the observation: \_\_\_\_\_ Duration of the observation: \_\_\_\_\_ Type of ICT integrated: \_\_\_\_\_

Date of the observation: \_\_\_\_\_ Place of the observation: \_\_\_\_\_ Number of Learners: \_\_\_\_\_

Observer: \_\_\_\_\_ Participant: \_\_\_\_\_ Lesson code: \_\_\_\_\_

Pseudonym of participant: \_\_\_\_\_ Type of lesson: Blended/traditional Type of Learning environment: \_\_\_\_\_

Class (Example 5C): \_\_\_\_\_ Lesson topic: \_\_\_\_\_

		Aspects to be observed	Yes	No	NA	Comments
SRQ 1: Performance Expectancy	1.1	Integrating ICT appears to support the teaching and learning of the lesson.				
	1.2	Integrating ICT is consuming valuable teaching time				
	1.3	Learners are actively engaged in the lesson due to the integration of ICT				
	1.4	The teacher uses ICT to perform routine tasks that usually would consume time, thus teaching more efficiently				

SRQ 2: Effort Expectancy	2.1	The teacher integrates the ICT into the lesson seamlessly.				
	2.2	Teacher wastes time on ICT integration.				
	2.3	The teacher interacts with the ICT with ease.				
SRQ 3: Social Influence	3.1	The learners are more actively engaged in the lesson where ICT is integrated into a blended-learning environment than in the traditional environment.				
	3.2	The level of enthusiasm observed in both the face-to-face and the blended learning environments are the same.				
	3.3	The teachers appears to be more confident teaching in the face-to-face environment.				
SRQ 4: Facilitating Conditions	4.1	All learners have access to the ICT required for the lesson?				
	4.2	The teacher has difficulty starting the lesson due to ICT failures.				
	4.3	The ICT failed during the lesson.				
	4.4	All the learners are registered for the OLE and have access.				
	4.5	The internet connection is sufficient for the blended learning environment.				
	4.6	The teacher has access to online support for the OLE.				
	4.7	The school has an ICT technician on site to help with ICT failures.				

## 7.6 Appendix F: Collected data of all participants

Observation schedule: Table 1 - Performance Expectancy

		TA			TB				TC						
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments		
Lesson 1	1.1	x			Teacher uses PowerPoint to convey the content of the lesson. Teacher printed the worksheets from the OLE.  Learners do not ask to participate when they are asked to and they seldomly raise their hands to ask questions.	x			Teacher uses the OLE in the class to demonstrate the content. Teacher uses pause-play perfectly to ensure the videos do not buffer and to keep continuity. The ICT together with the OLE creates an environment where the learners remain engaged. During the lesson it was not applicable as there were no observable routine tasks.			x	The lesson is a traditional lesson with no ICT integration. Teacher used physical props to illustrate the nets of 3D shapes like the cube but the teacher did not use ICT.		
	1.2		x				x							x	
	1.3	x					x								x

		TA				TB				TC			
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments
Lesson 1	1.4		x		Teacher has a teacher assistant present in the class who captures the raw marks of the learners' test. The teacher assistant records the marks on a paper grid instead of using software like excel. The teachers waists 10-15 minutes to draw shapes, like the			x				x	



		TA							TB			TC			
		Yes	No	N/A	Comments				Yes	No	N/A	Comments			
Lesson 2	1.1	x			The PowerPoint is not supporting the learning it is only used to demonstrate.	x			Teacher frequently refers back to video content previously viewed by the learners, reaffirming the, content. The work sheets available in PDF format from the OLE was printed out and given to the learners. The worksheets correlated with the video-lessons from the OLE. The learners did not need to wait for feedback from the teacher as the OLE gave the necessary	X			The in flipping mode supports the teacher.  The teachers wasted time as he could not find the lesson on the OLE. This disrupted the continuity but he recovered well.  All the learners are actively participating in the lesson.  There were no observable routine tasks in the lesson.		
	1.2			x			x				x				
	1.3			x	No routine tasks for this lessons.	x					X				

	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments
Lesson 2	1.4			x				x	<p>This kept the learner engaged.</p> <p>During the lesson it was not applicable as there were no observable routine tasks.</p>			x	

		TA							TB			TC									
		Yes	No	N/A					Yes	No	N/A				Yes	No	N/A				
		Item Nr				Comments				Yes	No	N/A				Yes	No	N/A	Comments		
Lesson 3	1.1	x			Teacher uses the OLE to illustrate how equivalent fractions look like instead of drawing it on the board.			x	No ICT used during the lesson.  The teacher wastes time by drawing cubes on the black board and the learners do not get to see visually rich illustrations of 3D shapes and their volume. The teacher could have illustrated some of the shapes by using the ICT.	x			All the learners participate actively and express enjoyment.  The videos from the OLE kept the learners engaged through games.  Teacher used PDF-view in the OLE to present the memorandum instead of writing it down and wasting time.								
	1.2	x						x			x										
	1.3	x						x			x										
	1.4	x					x					x									

		TA							TB			TC			
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments		
		Lesson 4	1.1			x		<p>The teacher struggles to get the OLE working and has to juggle between the several differentiated tasks. This causes behavioural problems and loss of retention.</p> <p>Only the groups that are working with the teacher are actively engaged.</p>				x		<p>No ICT used. Learners worked on problems while the teacher passed through the class assisting them.</p> <p>The discipline of the learners deteriorated as the lessons progressed.</p>	
1.2			x				x								
1.3			x						x						
1.4			x						x						

**Interview schedule: Table 2 - Performance Expectancy**

Question	TA	TB	TC
Do you think ICT is beneficial to you as a teacher? If so, in what way?	We use technology to widen their world views.	Definitely because kids today are technologically driven. They are exceptionally competent with technology.	Yes, definitely. The fact that it is another resource at your disposal. The advantage to it is that the kid see more. Especially in Mathematics because Mathematics is an abstract subject, he experiences it as abstract but the technology makes it a little bit more concrete together with the other resources of use. So there is definitely advantages. If I can use it daily I will.
Do you think teaching with ICT will help you engage better with your learners?	Yes, if I use video's or sound then the learners have more interest in the lesson. Learners get bored with the textbook and worksheets. Learners participate if we have discussions about a video.	Yes, it does have its place. You cannot drive a class solemnly with it. Like everything else you will lose attention span of learners eventually. Blended learner though, or the idea thereof is actually the close to perfect.	Definitely. You saw that yesterday in my class. The moment that I switch on my computer then immediately I have all the kids' attention. I do not know it it is due to the fact that they are not used to it. The kids are more active in the class. I think that to a certain distinct it is due to technology.

			I get more out of the lesson as what I would've in a normal lesson.
What would you say is the main reason why you as an educator use ICT?	It is faster and it saves time. Sometimes I type on my computer instead of writing on the black board and then I can save it if for instance I want to do the same activity next year then I can just show it. It helps me a lot and it saves time.	For me it is supplementary. I think someone who thinks he knows everything lives in a dream world. Technology is a useful tool, especially if you are far from support structures, to learn new methodologies, competencies, reasonings and approaches. To bring a little creativity to the table. Technology is that tool.	To prepare the kids. The real word is technology. We have to take it slowly though. Technology cannot take over education but has to serve as a medium to a goal. We have to slowly make the kids use to technology, especially in the rural communities. Three quarters of our kids do not have these stuff at home so they come and see it at school. The more the school can use it the more used to it the kids will become and going forward the more computer literate the kids will become. The kids will then be able to take care of themselves. Above this, it contributes to the success of the subject.
Do you believe that teaching with ICT will contribute to	Yes, because say I show them a PowerPoint and I show them videos of the planets then they understand	Yes, definitely. Look, a person consists of different senses and the development thereof of differs between	Let me say this: I've experienced that when I teach geometry and I have to draw figures on the black board and I

<p>learners' learning? If so, why?</p>	<p>it a lot quicker. If I would compare it to last years' learners, for whom I did not show videos, they did not comprehend the work as fast. So now I show them and they get a broader view of how it looks.</p>	<p>individuals. Some learns sensorial, some learn kinetical and some learn visual and the more resources you have the greater is the variance of your presentations the higher is the probability to attain common ground.</p>	<p>have to use protractors etc. then all the lines come out skew. If I do on the computer then it is in full colour, it is visual and al the learners can see.</p>
<p>Do you think that ICT can be used in all areas of teaching like record keeping and registering attendance?</p>	<p>We do absentees where we write it up and then it is captured in the computer and all our marks are on the computer. That saves a lot of time.</p>	<p>Yes, definitely.</p>	<p>Definitely. We are pass the paper ages. I am definitely in favour of using technology when it comes to administrative tasks.</p>
<p>To what extent do you think teaching with ICT helps you</p>	<p>Yes, you as a teacher needs to bring technology into the classroom as the kids are growing up with it. You have to keep up otherwise you are not</p>	<p>You know what? I cannot image my word as an educator without the presence of technology, Because, information and knowledge in its nature is of passing value. Sometimes we get</p>	<p>My career is ending soon but yes definitely. I am personally not that computer literate but the more I work with it the more I learn. I enjoy getting home and playing with it.</p>

<p>in your career as an educator?</p>	<p>going to be of interest to them. We use technology for everything. Everything in teaching is technology based. PowerPoint, work sheets etc. are made using technology. So, yes we use it a lot.</p>	<p>stuck at what we've been taught when we studied where that knowledge is most likely outdated. Knowledge is dynamic. I cannot only stay with the degree I obtained 3 years or 20 years ago. It is obsolete.</p>	
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**Observation schedule: Table 3 - Effort Expectancy**

	Item Nr	TA			Comments	TB			Comments	TC			Comments	
		Yes	No	N/A		Yes	No	N/A		Yes	No	N/A		
Lesson 1	2.1	x			Teacher uses PowerPoint to move between prepared slides.	x			In flipping allows the teacher to just use the laptop to navigate through the lesson content.			x	No ICT used.	
	2.2		x				x							x
	2.3	x					x							

	Ite	TA			Comments	TB			Comments	TC			Comments
		Ye	No	N/		Ye	No	N/		Ye	No	N/	
Lesson 2	2.1	x			There is no interaction with the ICT.	x			The internet connection got lost but the teacher continued with the lesson by using the work sheets printed from the OLE.		x		The teacher struggled to integrate the OLE and ICT seamlessly as he could not find the lesson he prepared for on the OLE.  The teacher wasted time on looking for the lesson on the OLE.  The teacher struggled to navigate the OLE. After a while he reverted back to the traditional method of teaching.
	2.2		x				x			x			
	2.3			x			x					x	

		TA			TB				TC						
	Ite	Ye	No	N/	Comments	Ye	No	N/	Comments	Ye	No	N/	Comments		
Lesson 3	2.1	x			Setting up the tablets and connecting them to the Wi-Fi wasted time but the teacher used the differentiating of different tasks to her advantage to ensure continuity.  The teacher interacts well and do not get stressed up when there is ICT failures like tablets' batteries depleting.			x	Teacher used props to illustrate the concept of volume.	x			Teacher knows where to find the lesson.		
	2.2	x						x				x			
	2.3	x								x		x			

	TA				TB				TC						
	Ite	Ye	No	N/	Comments	Ye	No	N/	Comments	Ye	No	N/	Comments		
Lesson 4	2.1		x		There were ICT and OLE interruptions.  The OLE causes a lot of problems.			x	No ICT used.	x			No ICT used.		
	2.2	x						x						x	
	2.3			x						x				x	

**Interview schedule: Table 4 – Effort Expectancy**

Question	TA	TB	TC
<p>Describe your confidence in teaching with ICT.</p>	<p>I do have confidence because I had CAT as a school subject. So, I am fairly good in Word, Excel and PowerPoint. I can do quite a few stuff and I must always help the other teachers.</p>	<p>You know what? I am old enough to not be bothered by confidence. I either know something or I don't. If I do not know then I will go and find out or ask the younger teachers. I lost the sense of confidence somewhere along the road.</p>	<p>If I had to rate my confidence on a 10-point scale I would rate myself an 8 out of 10. It does happen that when you are in class then the computer glitches but then it is comforting to know I can just call on the kids to help me. I am not afraid to stand in the classroom and not knowing how something works.</p>
<p>Are there any aspects that make you uneasy when teaching with ICT?</p>	<p>No not really.</p>	<p>What makes it uneasy is that technology comes with a few hassles. Then the internet works then it doesn't like you experience yesterday in the classroom. We would be three quarters into a lesson and then suddenly for no apparent reason the signal gets lost. What I also find problematic is the fact that the grade teachers change classrooms. The setting up</p>	<p>Nothing. I can add this: There are certain aspects of my subject that I feel can be taught better without the use of technology.</p>

		<p>of your technological resources takes ample time and you cannot start setting up during another teachers' lesson because then you disrupt the classroom. The whole logistical part thereof is cumbersome sometimes it is the cables other times it is the plugs. That is the unpaved road of technology.</p>	
<p>Were you able to integrate the ICT successfully into your teaching?</p>	<p>I will not say always. I do not always know. Sometimes I show a video or so but that does not always go according to plan.</p>	<p>Yes, I really think so. Sometimes I impress myself. The thing is you have to start. If you do not start somewhere you'll never grow. Strangeness is only gets to be a week old.</p>	<p>Yes but, in the beginning we had some frustrations. We haven't been at it for very long. After 4-5 months I would say that I am okay with it.</p>
<p>How did you experience the implementation process?</p>	<p>It took time to get everyone connected and logged in. But, after that everything when smoothly.</p>	<p>It phased in in a natural manner, it did not suddenly happen nor was there any drastic changes. I</p>	<p>Daunting because it is a lot of admin that needs completion. Learners must be registered on the computers and the internet needed some fixing up and we had to increase the bandwidth. Luckily</p>

		incorporated into my normal lessons. There were no trouble.	everything is in place now. There are a few hitches but that is always true with technology. Hitches like flat batteries. Al the preparation work are done and we have done it good now everything runs smoothly.
What is the most challenging aspect of integrating ICT and teaching?	That it works. That the internet works. That everything is charged. That the appliances work and that they are switched on. The kids do not know the technology yet. It takes a lot of time to show the learners how to type and where to click. Then I have to go to all 40 learners individually and check whether they clicked on the right links. That is time consuming because the learners are not familiar with it, some of them do not even have electricity at home..	Sometimes the information, that is conveyed from technological sources, is so compacted that learners struggle to absorb it fast enough. Now, you have to get the balance right and that is what I am working on. When do I pause the lesson so that learners can assimilate what they've heard? Yet, these assimilating pauses should not be to long otherwise the kids will loose the thread of the lesson. It is an artform that one should perfect. It comes with good preparation because then you can identify the smaller concepts that	The preparation. You have to prepare well even if you are an experience teacher that knows his subject well. To integrate technology as a resource that does not take over your whole lesson is key. You must know where in the lesson the technology will be useful. If you are not prepared well then your lesson will flop.

		are layered into the wider picture. I have to direct the pace.	
Have you received any training regarding ICT integration?	No, I am self taught and I use the knowledge I gained from school.	I steel with my eyes wherever I go. I have friends that are good with it. I am eager to learn. Everything that is mastered unlocks other dexterities. I do not have any formal training everything I've learned was in an informal manner.	Yes, three years ago we as school principals received 30 tablets from Vodacom. Vodacom gave some training and said that we must go back to our schools and get the teachers invested in the process. Si, I do have a little bit of back ground.
How does a blended lesson compare to a face to face lesson in terms of preparation time?	Blended learning is time consuming. Face-to-face teaching is something you can do even when you are unprepared, you just take an activity from the textbook and do it. But, if you want to do blended learning then it takes time to plan your lesson.	Traditional lessons takes a lot less time to prepare. You have a good idea of what you want to do where you are compelled to watch the videos you are going to use with a blended learning lesson. In some cases it is good for teachers because the blended learning	Blended learning takes more prepping time. In the evenings when you prepare you have to log on to your computer and go through the lessons of the following day especially the video content that you are going to show the kids. Then you have to decide



		environment forces them in some sense to be better prepared compared to traditional lessons.	which parts fit into your lesson and which parts will be advantageous for the kids.
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**Observation schedule: Table 5 – Social Influence**

		TA				TB				TC			
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments
Lesson 1	3.1			x	The learners are actively involved in the teacher-led instruction			x	Teacher frequently silences the class. This is however the first observed lesson so I cannot compare it.			x	This is the first traditional lesson observed. The teacher engages the learners but only a few is actively involved.  Researcher cannot compare as it is the first observed lesson of the teacher.
	3.2			x	There is no lessons to compare it to.			x	Teacher frequently silences the class. This is however the first observed lesson so I cannot compare it.			x	
	3.3			x				x	Teacher frequently silences the class. This is however the first observed lesson so I cannot compare it.			x	

		TA				TB				TC			
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments
Lesson 2	3.1			x	Learners enjoy playing with the 3D-models they constructed with jellytots and toothpicks.			x	This is however the second observed lesson within a BLE so I cannot compare it as I haven't observed a traditional lesson yet.  Learners are engaged and participate in Q&A's even if their answers are incorrect.  The teacher reverted back to a traditional teaching environment due to the lost internet connection. There were	x			The learners appears to be more engaged despite the break in continuity as the teacher struggled to find the lesson.  The learners expresses more joy compared to the observed traditional lessons.  The teacher revert seamlessly to traditional teacher-led instruction with equivalent levels of confidence.
	3.2			x				x		x			
	3.3			x						x		x	

	Item Nr	TA			Comments	TB			Comments	TC			Comments		
		Yes	No	N/A		Yes	No	N/A		Yes	No	N/A			
Lesson 3	3.1	x			<p>The learners are engaged but there are brief periods where teaching does not occur due to the admin that the teachers needs to complete regarding the OLE logging. During these periods the overall classroom discipline gets disrupted.</p>	x			<p>The learners discipline is different. The teacher frequently has to quiet the class while teacher in the traditional setting.</p> <p>There is a distinct difference. One of the learners left the classroom and did not return.</p> <p>Teacher acts different in the traditional setting. The teacher appears to get frustrated with the learners who do not grasp the concepts. The teacher appeared to be calm when he taught in the BLE quite</p>	x			<p>The class is expressing enjoyment. The teacher had time to address rich mathematical problems with the support of the OLE.</p> <p>The learners appear to express higher levels of enjoyment compared to traditional lessons.</p>		
	3.2			x			x					x			
	3.3			x				x				x			

		TA			TB			TC							
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments		
Lesson 4	3.1		x		The learners' who's ICT failed are not engaged and there are 2-3 learners working on each tablet. The class size is to big.  Today the enthusiasm dropped mainly due to the failing of the rotational model within a BLE as it is dependant on the ICT that is giving problems today.  It appears as if the teachers confidence is not affected by the	x			The teacher struggles to keep the whole class engaged. Learners are engaged in discussions that are not work related. Learners walk around and are not working.  Learners are only working on the material when the teacher arrives at their desks.  The teacher are more familiar with face-to-face teaching but it appears that it is not sufficient. The confidence of the teachers is not noticeable less or more but his frustrations are more		x		The teachers' experience allows him to keep the learners engaged regardless of the learning environment.  The teacher appears to be confident and well prepared.		
	3.2		x				x			x					
	3.3		x				x							x	

**Interview schedule: Table 6– Social Image**

Question	TA	TB	TC
<p>How would you describe the SGB's view on including ICT in lessons?</p>	<p>I think they are positive about it. They do not always no about everything. We sometimes teach them. They have kids in the school and can see what happens in the school and how it contributes to their kids' upbringing.</p>	<p>Our own School governing body is people who are innovative. I think they are moving with the times.</p>	<p>Very positive. Parents want to see that they kids are exposed to technology.</p>
<p>Do you feel compelled as an educator to integrate ICT in your lessons? If so, by whom and why?</p>	<p>No we are not compelled to do anything. We can do it on our own. I decided by myself to use technology and I am one of the few who use it because I know how to use it. Nobody compels us.</p>	<p>No at our school it is not compulsory or a burden. It is more of a challenge. Our approach is positive and we enjoy it. It does not help to complain the whole day.</p>	<p>Yes, I do feel compelled. My supervisor evaluates me yearly. Every time when he comes then he tells me that we must use all the technological donations that we have received to the advantage of the learners. So there is pressure from the departments' side. There is also pressure from the donors side, those who gave the technology to the school.</p>

<p>What are parents' views on teachers teaching with ICT?</p>	<p>They like it because they think that the lessons are more interesting. The kids go home and talk about it. Then when we are in town we hear the feedback from the parents. So, they are positive about it.</p>	<p>The parent who I've spoken to is very excited. I haven't come across any parent that are negatively inclined towards technology. This, for me, is an indication that they support the fact that their kids are engage with technology in such a manner. Parents want what is the best for their kids. If there is something new on the market then they want it. A Parent lives for his child. Parents will embrace it.</p>	<p>Very positive. The biggest problem is that not all the parents can afford to keep supporting the learners at home through the means of technology. That which happens at school is supported by the parents.</p>
<p>Does integrating ICT into your teaching make you a better teacher?</p>	<p>No because there is still a lot that I need to learn because I am still a very young teacher. But, I think in the future it will go better.</p>	<p>Yes, it makes me a better teacher but not necessarily a better educator. Being an educator lies in who you are but being a teacher lies in what you can do. So yes it makes me a better teacher. Kids hone me daily.</p>	<p>I wont say so. Teaching is an art not a science. It revolves about connecting with the kids. Nothing can replace that. A computer cannot replace a teacher. There are parts that can help me as a teacher I would say.</p>

<p>Does a blended learning environment enhance learners' enjoyment of learning mathematics?</p>	<p>Yes because you include those learners with different learning preferences those who are more visual and those who are more concrete. You include everybody compare to when you stand in front of the classroom and there are 30% who do not even listen to you.</p>	<p>Definitely. We have spoken about the fear kids have for the subject. If it can be taught in another manner then maybe we can redirect the child's focus. He sees different and hear different and he feels comfortable engaging with it.</p>	<p>Yes learners have come up to me saying ""Sir this is a fun way to do Mathematics". That is what I want. We tend to focus on the weaker learn, the department wants interventions for the weak learners but we neglect the stronger ones. Strong kids remain behind because we do no enrichment with them. I think that technology can help in this regards, learners can do enrichments while they sit in class.</p>
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**Observation schedule: Table 7 – Facilitating Conditions**

		TA							TB			TC			
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments		
		Lesson 1	4.1	X				The PowerPoint slide are clearly visible.		x				In flipping via the projection of the OLE on the white board enables everyone to have access to the required ICT. The sound of the videos were sufficient.	
4.2			X		The lesson plan did not include the use of the OLE.		x				x				
4.3			X				x					x			
4.4				X	No internet connection necessary.			x				x			
4.5				X		x						x			
4.6				X		x				The teacher is responsible to solve the problems himself.			x		
4.7			x			x					x				

		TA							TB			TC				
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments			
		Lesson 2	4.1	X				The PowerPoint slide are clearly visible.		x				The internet stopped working.  In flipping do not require all the learners to have individual access to the OLE and ICT.	x	
4.2				X		x					x					
4.3				X		x						x				
4.4				X					x				x			
4.5				x		x					x					
4.6			X				x					x				
4.7			x				x					x				

		TA			TB			TC							
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments		
Lesson 3	4.1		X		The rotational model allowed the teacher to give tablets to only a certain group. Differentiating the tasks. The groups are then rotated.			x		x			All the learners can view the projection. The teacher mails the support line of the OLE but the response is not immediate.		
	4.2		X					x							
	4.3	X								x					
	4.4	X								x					x
	4.5	X								x		x			
	4.6			X		The sound of the video stopped working.				x				X	
	4.7			x		The learners working on the OLE were registered eventually. No internet connection problem partly due to the rotational model as the schools' low bandwidth				x				x	

		TA			TB			TC						
	Item Nr	Yes	No	N/A	Comments	Yes	No	N/A	Comments	Yes	No	N/A	Comments	
Lesson 4	4.1		x		Not all the learners have access to the OLE on an individual level.			x		x			No onsite technical support.  Homework memorandums are projected on the white board and all the learners can see it.	
	4.2	x						x			x			
	4.3	x			The internet connection and the logging to the OLE is cumbersome.			x		x				
	4.4		x					x				x		
	4.5	x			The work sheets of the OLE failed to load on several tablets.  The OLE did not recognize the logging credentials of two learners.  The teachers complains that she cannot connect more than 20 tablets to			x				x		
	4.6		x					x				x		
	4.7		x					x				x		

**Interview schedule: Table 8– Facilitating Conditions**

Question	TA	TB	TC
<p>Have you ever required technical support to implement the OLE? If so, how?</p>	<p>Yes we needed it because there were some of the stuff that we did not know how its implementation worked. People helped us with our internet and to set up the tablets.</p>	<p>I have required technical support with logging details and passwords. I haven't yet required support with the OLE itself. I am in full control of the basics of the OLE due to its user friendliness. The platform is straightforward and logically designed.</p>	<p>Yes, we need it daily. We are very isolated. Luckily our district office in Upington are very helpful. We only need to write a letter stating that we have technical problems and they come and fix it free of charge. We also have parents that help, this morning a parent helped us with our printers. We haven't encountered any technical problems regarding the OLE.</p>
<p>Have you taken part of professional development on blended learning? If so, how did you experience this professional development?</p>	<p>We once went to the SAOU and they talked about it. We then implemented some of the ideas discussed there in our classrooms.</p>	<p>No. The first time I encountered the word "Blended learning" was when you sent the schedule for this field visit. I spend several night reading up about it about what universities do with blended learning and how they</p>	<p>Never. I do not think that there are schools that uses blended learning. I hope that I can.</p>

		incorporate it into their subject field. It was, actually, a great experience to read up about it.	
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Have you taken part of professional development on how to blend the OLE into your day to day lessons? If so, how did you experience this professional development?	Yes, it was really good. We received background information about the OLE and how to approach it in a creative manner for the classroom.	No, currently we are winging it.	In the beginning we received a crash course one afternoon. From there we were on our own. I think it is good because people learn when they struggle.
Do you have any on-site technical ICT support? Do you think it is sufficient?	No, the principal comes in if we ask him to but that is not always sufficient.	It happens randomly through friends we know and that are willing to help voluntarily. We are kind of isolated. There are no IT companies in our town. If all of us combine	No we don't have. Here and there are some teachers that know something. I think that it won't be enough if we would have any serious issues. Then we will need to call in someone from the outside.

		what we know about technology then we manage.	
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