GRADE 6 MATHEMATICS TEACHERS' PERCEPTIONS OF PEDAGOGICAL VARIATION WITH INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS) IN NO-FEE PAYING SCHOOLS: A CULTURAL HISTORICAL ACTIVITY THEORY (CHAT) ANALYSIS

by

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Declaration

This research work has not been submitted in whole or part, for the award of any degree.
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ABSTRACT

The South African education system is under a serious strain in relation to Mathematics attainment. Only 40% of learners in SA pass the final school leaving examination and only 5% of learners manage to pass Mathematics with more than 50%, according to The Economist (2014). In a bid to solve this problem the government proposes the use of ICTs (such as computer hardware and software, tablets, and smartphones) within teaching and learning. The assumption is ICTs can be utilised to address this important challenge and "facilitate ongoing improvement of educator skills" (The National Integrated ICT Policy White Paper: The White Paper, 2016: p.8). Research shows that teachers' perceptions regarding the use of ICTs impact on their practices (Mwendwa, 2017; Munyengabe, Yiyi, He Haiyan, & Hitimana, 2017; Alharbi, 2012; Yuan & Chun-Yi Lee, 2012).

This project intends to explore six grade 6 Mathematics teachers' perceptions about whether and how pedagogy shifts with the use ICTs in the classrooms utilising Cultural Historical Activity Theory. This research utilises interviews as a method for the collection of empirical data to describe a group of research participants' (or teachers') perceptions who happen to be directly interviewed. These interviews have been conducted across two no-fee paying primary schools in the Western Cape Province (WCP), in South Africa (SA). Interviews were analysed along the CHAT dimensions: object, subject, tools, rules, community and division of labour to establish whether pedagogy altered along any of these dimensions.

Findings indicate that teachers think pedagogy shifts in the ICT based lessons with division of labour becoming more fluid. Findings also show that the object of the activity system grows to encompass more than mere mathematical compression but also motivation, creativity and cognitive development. Besides, teachers stated that ICT based learning could assist learners in their mathematical attainment.

This project is an investigation and not an intervention study. Recommendations are also suggested in this thesis for further research such as video-taping teaching and learning of mathematic contents and concepts in both traditional and computer-based classrooms. Further study in utilising classroom observations to focus on student-student interaction in relation to ICTs is also recommended.

Keywords: Pedagogical change with ICTs, cultural historical activity theory (CHAT), primary school Mathematics, South Africa.

DEDICATION

I would like to dedicate this thesis to my family for their support. Without their unconditional love and prayer, I would not be achieving this level. A special dedication goes to:

- my wife Mirabelle Mbemba Tshink and my precious son Zion Tomi Sakafuku Tshink for the sacrifices they have endured;
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ABBREVIATIONS

AS: Activity System

CAPS: Curriculum and Assessment Policy Statement

CHAT: Cultural Historical Activity Theory

DoE: Department of Education

HoD: Head of Department

ICT: Information and Communication Technology

NDP: National Development Plan

NPDE: National Professional Diploma in Education

NRF: National Research Foundation

PGCE: Postgraduate Certificate in Education

SA: South Africa

TAM: Technology Acceptance Model

WCP: Western Cape Province

WCED: Western Cape Education Department

ZFM: Zone of Free Movement

ZPA: Zone of Promoted Action

ZPD: Zone of Proximal Development

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CHAPTER 1
INTRODUCTION

The twenty-first century has seen a number of innovations within the educational sector in most countries worldwide. The introduction and use of new tools such as Information and Communication Technologies (ICTs) (computer hardware and software, tablets, smartphones) into teaching and learning constitutes one of the most remarkable innovations. The South African educational system in general and primary school level in particular is also swayed by this technological influence. According to the South African National Development Plan's (the NDP) statement "ICTs can play a key role in facilitating [the improvement of quality education]…" (The National Integrated ICT Policy White Paper, 2016, p.8). Nevertheless, Mathematics education is still an important problematic that is affecting most learners' achievement at the final school leaving examination (The Economist, 2014).

Research shows that the use of ICTs in primary school classroom has a positive impact on learners' achievement in Mathematics lessons, but this depends on the nature of the pedagogy utilised (Higgins, Xiao & Katsipataki, 2012). Moreover, the way ICTs (such as computer hardware and software, tablets, smartphones) is utilised in teaching and learning is a result of teachers' perceptions towards them (Bray & Tangney, 2017). A teacher with a positive perception towards ICTs may be interested to possibly utilise them as pedagogical tools; whereas, a teacher who negatively perceives them may not be interested to incorporate them into his/her pedagogy. .

The context of this thesis is post-apartheid South Africa, which is still in the process of improving teaching and learning practices. It is from the view of improvement that this research will investigate the perceptions of participants (or teachers) on whether there is a potential shift of pedagogy with ICT in Grade 6 Mathematics classrooms and what does this look like?

1.1. Locating the research: ICT in South African primary education

As ICT integration and utilization in teaching and learning is still in its infancy in South Africa, research on the use of ICT as teaching and learning tools within primary education, especially in a subject such as Mathematics is still the main concern of the SA government and researchers. The meagre results of learners' achievement at final school leaving examination in Mathematics (The Economist, 2014) suggest the urgency of the problem.

Accordingly, there are a number of studies that have been conducted around ICT in education up-to-date. Technology can fundamentally change pedagogy as today's learners are actively engaged in a "*participatory culture* – technology creativity, social interaction and connections with community…" (Edwards-Groves, 2012, p.100). A learner who is positively embracing ICTs in the classroom may be more involved, motivated, creative, active and more responsible.

I argue that investigating issues of possible pedagogical alteration with ICTs has been very important because ICTs have been used in schools and it was important to know how or whether pedagogy changes with their use. This can help to unfold and critically debate on the future of ICT in education. Unlike other studies, this current research emphasises on grade 6 Mathematics teachers' perceptions of pedagogical variation with ICT. While Hardman (2008a) analysed teachers' perceptions of using ICTs in classrooms, she did not do so in a no-fee paying environment. Hence, the current study addresses this gap.

ICT has been generally recognized by the government officials as one of the instruments that can help and support the improvement of the quality education in South Africa (The White paper, 2016, p.8) and therefore, knowing what teachers think about ICTs as tools to change their pedagogy is important in understanding how ICTs can be used in classrooms.

1.1.1. Current State of ICT in SA

> *…innovative use of ICTs in the education sector can assist in addressing inequalities in education in schools across South Africa and facilitate ongoing improvement of educator skills (The White paper, 2016, p.8).*

The aforementioned point of view by the South African National Development Plan's (NDP) shows that the SA government gives serious attention to the use of ICTs within teaching and learning. While the government officials in SA have recognized that ICT can be helpful within teaching and learning environment (The White paper, 2016, p.8) when it comes to its effective integration and use as an instructional technology in the classrooms the country is still in its infancy stages.

1.1.2. Context for the Study

This study is drawn from two no-fee paying primary schools located in the Western Cape Province, in South Africa. The focus of this research is on Grade 6 Mathematics teachers

across two schools. These no-fee paying primary schools have been technologically upgraded – ICTs have been incorporated and used in Mathematics lessons, especially at Grade 6 for at least two years. These schools are encouraging and supporting teachers to utilise ICTs; for instance, there is at least an up-running or a functional computer laboratory equipped with adequate ICTs (such as computer hardware and software, tablets). Technologies are allowed in the classrooms as teaching and learning tools. Teachers have easy access to ICTs; they can easily connect, collaborate, and access web-based resources such as tutorials and online library for teaching purposes. Yet, ICTs used across these two schools may not be the same in that – hardware and software are different. The assumption is that the integration and use of technology into Mathematics classroom has an influence on learners' outcomes (Jackson, 2017; Hegedus, Tapper, & Dalton, 2016) and can possibly enable the improvement of educator skills (The White Paper, 2016, p.8). This can help to prepare learners towards a successful achievement in the final school leaving examination, especially in Mathematics and "for success in the globalization expansion" (Smith, 2015, p.2).

I have chosen Mathematics as a focus because: (i) it is one of the main subjects, (ii) it lays a solid foundation to learners and equips them with relevant and necessary knowledge and skills required throughout their learning endeavour and achievement, and (iii) it is an issue that affects most learners in SA (The Economist, 2014) and needs to be addressed in order to improve the quality of school education in SA (The White Paper, 2016, p.8).

Moreover, the emphasis of this research is principally on teachers because they "are the key curriculum implementers in the schools" (Mwendwa, 2017, p.409). While investing in ICT for improving education systems are essential for schools enhancement (Tong & Trinidad, 2010), teachers are the key-players in the "successful implementation of innovations and changes in the school curriculum" (Syomwene, 2017) as cited in Mwendwa (2017, p.409).

1.2. Rationale

The rationale for this research is twofold: The first reason is South Africa faces a crisis in relation to Mathematics education. According to the South African National Development Plan's (NDP) report the poor quality of school education constitutes one of the nine key challenges that the country is facing (The White paper, 2016, p.8). Likewise, the Economist (2014) had concretely pointed out an illustrative case of Mathematics education as the serious challenge that South Africa faces and indicates the low achievement of learners at the final school leaving examination; a very low percentage of learners (five percent) manage to pass Mathematics with more than fifty percent (The Economist, 2014). In order to solve this

problem and develop technological ability in the country, the use of ICTs in education seems to attract the attention of the government as a foundational solution to the problematic (The White paper, 2016, p.8). The assumption is that the use of ICTs within teaching and learning in South Africa can improve the quality of education. Here the understanding is that better education can foster the eradication of "poverty and reduce inequality in the country by 2030 [to enable and empower] an inclusive and prosperous society where opportunity is determined not by birth but by ability, education and hard work" (The White paper, 2016, p.8). In addition, ICTs in education can help to "prepare learners for success in the globalization expansion" (Smith, 2015, p.2). The use of ICTs to help and support the educational issue is "informed by a well-established relationship between learning outcomes and learning resources" (Hardman, 2008a, p.2). It is conceded that the use of ICTs, such as computer hardware and software, tablets, and smartphones within teaching and learning in SA "will help to build collaboration, autonomy, confidence, knowledge and exchange of ideas, and easy access to information" (Smith, 2015, p.2), hence this will facilitate ongoing improvement of the education system in SA (The White paper, 2016, p.8). Moreover, the integration of ICT comes with many advantages: "such as opportunities to address different learning styles, project based learning, learner-centered classrooms, higher level thinking, and transformational learning that includes digital literacy, problem solving, analytical, and a wide variety of skills" (Smith, 2015, p.3). If technology is to address the educational gap in SA, we need to comprehend better how teachers perceive these novel tools within teaching and learning as teachers' perceptions inform their use of ICT (Munyengabe et al., 2017). Given that the use of ICTs in education is still in its infancy phase in SA I argue that our context needs "research into pedagogical practices with" (Hardman, 2008a, p.3) ICTs in general and particularly computer hardware and software, tablets, and smartphones. This is particularly so in relation to no-fee paying schools, which are the poorest schools in the country. There is ample evidence to suggest that lower fee or no-fee paying schools do not perform as well as high fee paying schools. However, as ICTs have been rolled out into no-fee paying schools, this project sought to understand how teachers perceive the benefits, if any, that they derive from ICTs.

To address the gap in the field, this research aims to examine grade 6 Mathematics teachers' perceptions on whether ICTs alter pedagogical practices, and track what this shift looks like and whether teachers think that the shift leads to better learner outcomes in Mathematics.

The second reason for conducting this study is a personal interest on the affordances of tools, such as computer hardware and software, tablets, and smartphones to alter pedagogy and

what are the opinions of teachers and learners vis-à-vis these tools. This motive is driven by my personal concern and interest, as an educational technologist, who is passionate about the use of ICT in education sector. Drawing on Smith's (2015) notes, "Teaching has taken on a new meaning. Teachers need to learn how to reach the learners in their classrooms through technology integration. Learners are living in a global society and teachers have to take steps in providing learners with technology literacy that is needed to survive and compete" (p.19) I believe that in the 21st century both teachers and learners should work together with educational tools that can enhance teaching and learning. As an educator, I also assume there are many reasons why teachers have certain attitudes, beliefs, and perceptions toward technology.

Overall, my motives for conducting this research arise from my curiosity in how tools, such as ICT (for example computer hardware and software), can be utilised to influence teaching practices. The concerns of this study found their source from my interests as an educational technologist who is keen about technological innovation, its integration and its effects in pedagogy.

1.3. The arising of a problematic

According to the South African National Development Plan's (the NDP) report the poor quality of school education is one serious issue that should be addressed among the nine key challenges that SA is currently facing (The White Paper, 2016, p.8). Mathematics education is one practical illustration of the educational problematic that affects most learners' achievement at the final school leaving examination, that is only 40% of learners pass the final school leaving examination and only 5% of learners manage to pass Mathematics with more than 50%, according to The Economist (2014). The poor results of learners' achievement at the last school leaving examination in general and especially in a subject such as Mathematics bear indication to the urgency of the problematic. One can argue that most learners are challenged by Mathematics across SA. There have been some echoes over the use of ICTs within the primary education level in SA as one key instrument that can enable and "facilitate ongoing improvement of educator skills" (The White Paper, 2016, p.8), but there is a dearth of data currently to support this in South Africa, although international data indicates that ICTs can impact positively on maths attainment provided they are used in a constructivist manner (Hardman, 2019). The argument underlying the use of ICTs suggest that if ICTs (such as computer hardware and software, tablets, and smartphones) are successfully integrated within SA primary schools, and teachers understand and use them

correctly within classrooms and if ICTs work to improve Mathematics outcomes at primary school perhaps they will do so at secondary school. “This can be noticed in [teachers’] perceptions towards these new pedagogical tools, not as a disruptive tool in teaching and learning milieu but as a pedagogical tool for teaching practices that would make a difference in learning outcomes” (AlTameemy, 2016, p.449).

1.4. Research Aims and Questions

The purpose of this research was to investigate teachers’ perceptions regarding whether pedagogy alters with ICTs and whether they think this impacts positively on learners’ outcomes in Mathematics. This study emphasized the role of ICTs in education and explores some of the research participants’ (teachers’) insights to advise whether there is a potential shift in pedagogy and track what this looks like using a Cultural Historical Activity Theory (CHAT) lens to analyse the data.

While investigating teachers’ perceptions of pedagogical change with ICTs using CHAT, two core research vehicles were exploited to facilitate this study: a thorough review of relevant literature and the collection and analysis of empirical data. Firstly, the literature review phase focussed on revising the empirical studies pertaining to (1) Teachers’ perceptions of ICTs as teaching and learning tools, and (2) Teachers’ perceptions of pedagogical alteration with ICTs. Secondly, the collection and analysis of empirical data phase comprised a twofold stage: The first stage was to identify and select primary schools across the Western Cape Province, based on a certain criteria. The focus was on no-fee paying primary schools that are utilising ICTs such as computer hardware and software, tablets, and smartphones especially in Grade 6 Mathematics classrooms. Simply put, these schools have been technologically upgraded. The second stage was to set up appointments for a series of face-to-face interviews with Grade 6 Mathematics teachers across two non-fee paying primary schools. The results from these interviews were then analysed using CHAT to determine 1) whether teachers thought pedagogy altered with ICTs, 2) in what ways it altered and 3) whether teachers thought that ICTs impacted positively on Mathematics outcomes in grade 6.

Drawing on a case study of grade 6 Mathematics teachers across two no-fee paying primary schools in the Western Cape Province, the following core question is addressed:

1) What are the perceptions of teachers on whether there is a potential shift in pedagogy with ICT (computer hardware and software) in a grade 6 Mathematics classrooms and what does this look like? and

2) A sub-question: to what extent do teachers think that this change impacts positively or negatively on learners' outcomes in Mathematics?

The thesis utilises CHAT as a conceptual framework for answering the question. According to Hardman's (2008a, p.4) statement "this approach draws on the work of Engeström (1987; 1989; 1999a) and argues that individual actions should not be studied outside of the context in which they are enacted." Consequently, the following refinement of the research question elicited the following questions:

- According to grade 6 Mathematics teachers, in what ways does pedagogy change with ICTs (such as computer hardware and software, tablets, and smartphones)? What impact do ICTs have on:

  - *The object of the lesson*. That is, does the focus/motive of the lesson shift in any way when an ICT is utilised?
  - *Tool use in the lessons*. To what extent does the ICT, as a tool, impact on the teacher's use of other more traditional pedagogical tools?
  - *Rules in the lessons*. Are there different norms for interacting with ICTs in grade 6 Mathematics lesson?
  - *Division of labour in the lesson*. Do roles alter across the two contexts and if so, in what way do they alter?
  - *The community*. Does the ability of the ICTs to corrode space and time constraints provide for a broader community in the classroom?

1.5. The conceptual framework

The incorporation of technology in teaching and learning is the most key element in transforming face-to-face context or "*traditional classrooms* into *digital age classrooms* that are often [described] as classrooms of authentic learning" (Smith, 2015, p.12). "[Technology has a power to] break down the time and space [restrictions] in a face-to-face classroom

because one can access work outside of official school times, and access to the internet allows learners to contact peers and teachers in different countries" (Hardman, 2008b, p.29).

This research is located in Cultural Historical Activity Theory (CHAT) as a theoretical framework. Unlike other theories, "CHAT has been used to address important educational issues in fresh ways…" (Roth & Lee, 2007, p.206). I argue that CHAT is a useful framework for ICTs integration that enables researchers to investigate and to comprehend teaching and learning practices in context. "Of direct relevance to educators…, CHAT has much potential for educators, because it is thoroughly about development and learning, encompassing the system as a whole and various subjects and communities that constitute it" (Roth & Lee, 2007, p.204). CHAT places emphasises on human development and learning. Moreover, Roth et al. (2007) claim that "learning occurs whenever a novel practice, artefact, tool, or division of labour at the level of the individual or group within an activity system constitutes a new possibility for others (as resource, a form of action to be emulated) leading to an increase in generalised action possibilities and therefore to collective…" (p.205). As ICTs represent novel tools in our context, we might reasonably assume, based on this quote that these tools will lead to shifts in the activity of teaching/learning in a school.

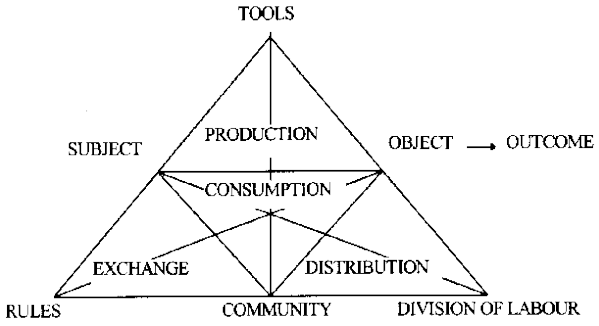
CHAT can also "bridge traditional classroom practices to modern classroom practices" (Smith, 2015, p.13), this conceptual framework is used throughout this study to investigate perceptions of participants on whether ICTs alter pedagogy.

1.5.1. Brief synopsis of CHAT

CHAT is originally found in Vygotsky's work (Vygotsky, 1978). The development of this theory has been established by Leontiev (1978; 1981) and Engeström (1987; 1989; 1990; 1991; 1996; 1999a; 2005). According to Hardman (2015:52), "CHAT holds that higher cognitive functions are necessarily mediated by signs/tools" and artefacts such as language, and, in this thesis, technology. The focal point of the first generation of activity theory CHAT advocates underlines "language [as the core] mediating tool" (Hardman, 2015, p.52). Yet, this activity theory has also seen the second as well as the third generation (Hardman, 2005a). In fact, the emphasis in the third generation of CHAT draws on Engeström's (1987) work that "has developed a model of human activity that situates mediation in a broader social context" (Hardman, 2015, p.52). It is the third generation of CHAT that informs the framework of the current thesis. In this iteration, CHAT holds that human activity needs to be studied in context.

CHAT encompasses "the system as a whole and various subjects and communities that constitute it" (Roth & Lee, 2007, p.204); and within this inclusion, it appears that "the subject(s) acts on the object in order to transform it using mediating artefacts in order to arrive at specific outcomes. In turn, the subject's position is influenced by the rules of the system, the community and division of labour..." (Hardman, 2015, p.52). While teaching and learning happen to be "a dynamic activity system" (Hardman, 2008a, p.1), this research foregrounds the discussions on CHAT dimensions of tools, rules, object, division of labour, outcome, community and subject to elaborate a logical framework for investigating pedagogical alteration with ICTs, as illustrated in Figure 1.1

Figure 1.1: An activity system



Source: Engeström, 1987: p.75.

Figure 1 exemplifies an activity system (AS) that is drawn from a model proposed by Engeström's (1987) for the analysis of this study.

In view of this current project, the core concepts illustrated in the above figure 1 consist of the research participants (teachers) '*subjects'* using ICTs (computer hardware and software, tablets, and smartphones) '*meditational artefacts or tools'* as teaching and learning tools to improve learners' understanding of Mathematics '*object'* in order to produce good results – successfully pass Mathematics with good marks *'outcome'*. The teacher and learners *'community members'* enact roles '*division of labour'* in a classroom and assure the arrangement of *'Rules and regulations'*. The analysis of pedagogic activity is needed on these dimensions because pedagogy is a complex activity.

Within and between activity systems (AS), change can occur from *'contradictions'* (Russel, 2002; Engestrom, 1987). For Karanasios, Riisla, and Simeonova (2017) "contradictions [are interchangeably perceived as] tensions, which occur within an activity and/or between

multiple interrelated activities and promote dialectical transformation [of the system over time]…" (p.2). One can argue that contradictions are identified as a traditionally accrued active tension between contrasting forces within an AS (Ilyenkov, 1974).

Further, the '*contradiction'* (or *'discomfort', or 'ambiguity', or 'conflict')* can arise from any participant involved in an AS. Thus, instead of identifying contradictions as problems or conflicts, they should be perceived as "historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p.137), which have the power to transform and a relevant effect on organisational variation (Engeström & Sannino, 2011).

A core aspect of contradictions is that their acknowledgement conveys insight into the alteration and development affordances of activities. As contradictions occur, or are recognised, they depict the underlying forces, ineffectiveness, and most significantly, "opportunities for change and action […]; precipitating the development of an activity…" Karanasios, Riisla, and Simeonova (2017, p.3). This can potentially reveal opportunities for original novelties and/or creativity for new ways of constructing and enacting the AS and learning (Karanasios et al., 2017).

In the paradigm of CHAT, learning can be described as a process of continuous interaction with the context "and others and knowledge as constructed by individual learners, building on existing historical experiences and within the learners' context" (N'gambi, 2013, p.654). Lim (2002), in addition, claims that in a CHAT paradigm "individuals learn with a wide variety of tools and with people that help them carry out their goal-oriented activities" (p. 413).

I argue that for learning to be active, it requires involvement of the learner (Hardman, 2008a), and this involvement or active participation can be orchestrated with tools such as ICTs. For example, within the traditional class pacing is highly controlled but this could alter in the ICT class (Hardman, 2008a).

In Nigeria, for example, Utulu (2012) reports that learners use ICTs for various purposes: (i) to collaborate and communicate with the teacher on a specific subject, (ii) to share knowledge, (iii) send e-mails to teachers. Throughout this process learners can move from topic to topic, in order to select the accurate information to share with teachers… Indeed, Hardman (2008a) illustrates, "In Israel, for example, Mioduser, Nachmias, Tubin and Forkosh-Baruch (2002) report that learners work on a computerised greenhouse that draws on Mathematics, biology, science and art in order to study fish, plants and water cycles. Boundaries between specialists subjects are more permeable when learners have to draw on a variety of subjects in order to solve complex real-world problems in microworlds, such as those faced in the computerised greenhouse." (p. 30). Todays' ICTs operate at the extent that

they can be used as real-world problem-solving tools. The above illustrations indicate that the use of ICTs in a teaching space happens to have an impact on division of labour, transforming teaching practices with teachers and learners playing different roles in this context.

In a CHAT paradigm, each activity system happens to be singular and unique, yet influenced with other elements from adjacent activities. Hence, the analysis of every activity is done individually, while recognising that each activity is influenced by others. In this context, CHAT is used to explicate how change in one fragment of an activity system can influence another fragment of the activity system. For instance, teacher/learner "roles (division of labour), with the [learner] taking on a teaching role in relation to the technology will effect changes in other parts of the system. For example, the [perceptions teachers have vis-à-vis their learners' ability/capacity to teach the teacher can alter]. The CHAT facility for recognising changes in one part of the system as impacting on other parts of the system [avails a range of] possibilities for understanding teaching and learning with [ICTs such as computer hardware and software, tablets, and smartphones]" (Hardman, 2008b, p.30).

1.6. Description of concepts in context:

This section describes some concepts and terms that are utilised in this research project in order to inform and foster the context of this dissertation.

1.6.1. What is pedagogy?

Hardman (2008a, p.5) defined pedagogy as "a structured process whereby a culturally more experienced peer or teacher uses cultural tools to mediate or guide a novice into established, relatively stable ways of knowing and being within a particular, institutional context, in such a way that the knowledge and skills the novice acquires lead to relatively lasting changes in the novice's behaviour; that is, learning."

I argue that the above definition of pedagogy reflects the context of this current study, which adopts a Cultural Historical Activity Theory (CHAT) framework that views learning as necessarily mediated. The examination of pedagogy in relation to the use of ICT in education involves considering the affordances of the entire learning setting, which consist of both the teacher and the learners (Webb & Cox, 2004).

In view of this research, learning is taking place within a specific context (Grade 6 Mathematics classrooms) with the involvement of a culturally more competent grade 6

Mathematics teacher(s) to guide a group of learners enrolled in Grade 6 Mathematics classrooms at two non-fee paying primary schools, utilizing tools such as ICTs (computer hardware and software, tablets, and smartphones) to impact and potentially improve mathematical knowledge and skills. This definition of pedagogy draws on the body of work from Vygotsky (1978) very specifically, his notion of mediation, or guidance by a more culturally competent 'other', as a mechanism for optimal teaching.

1.6.2. Face-to-face framework:

The concept *"face-to-face framework" or "traditional classroom"* is not new – the understanding of its rules and customs is well known.

Face-to-face framework consists of physical attendance in classes at a specific location. This is the more traditional way to teaching and learning – learners see and interact with the teacher, and often, other classmates too. Here, the emphasis is not on ICTs but they can be utilised in the same way we use other pedagogical tools such as notebook, pen, pencil, and textbook (Ictech II, 2014).

1.6.3. Digital framework:

Sharples (2013, p.3) described *"digital framework"* (also known as mobile framework), [as a framework that emphasises on] "the dual perspectives of [participants (teachers and learners)] mobility and [teaching and learning with ICTs such as] portable technology [laptops, tablets, and smartphones]". Here, the understanding is that in a digital framework, teaching and learning process is underpinned by ICT. In other words, teaching and learning process can occur "…from the use of handheld devices [such as laptops, tablets, and smartphones] in classrooms, through the use of technology [such as computer hardware and software] to support learning in context…" (Sharples, 2013, p.3).

1.6.4. What is Information and Communication Technology?

Young (2012) described *Information and Communication Technology (ICT)* as a generic term that describes types of technology that are used especially for communications. It is like Information Technology (IT), but ICT focusses more on technologies that deal with communication, such as mobile devices (for example computers, smart phones, tablets, and ipads), the internet and wireless networks, among other things.

1.6.5. What is perception?

Mwendwa (2017) has drawn on Farren et al.'s (2015, p. 413) notes to describe the concept *'perception'* as "an evaluative reaction to some referent or attitude object, inferred on the basis of the individuals' beliefs or opinions about the referent."

1.7. Outline Structure

In a bid to address the questions posed in this study the thesis is structured as follows:

Chapter 1 introduces and provides the reader with background information on the use of ICT (computer hardware and software, and tablets) in SA with a particular attention to the current state of technologies as teaching and learning tools in grade 6 Mathematics classrooms, and the need for investigating on whether there is a pedagogical alteration with ICT and how do grade 6 Mathematics teachers perceive it? The focus of this study is deliberately discussed and justified, and the overall research aim and individual research objectives as well as the research method and the conceptual framework are identified.

Chapter 2 explores and reviews the existing literature pertaining to empirical research of pedagogical shift influenced by ICT (such as computer hardware and software) in Mathematics lessons. It also unpacks studies presented in the field with a close attention to the research pertaining to CHAT.

Chapter 3 foregrounds the discussion on the conceptual framework utilised in this thesis, namely, CHAT. It explores the chronological development of CHAT from its genesis – highlighting the work of various CHAT advocates and their relevant insights: from Vygotsky's (1978; 1981) research on human activity, which theory was extended and established by Leontiev (1978; 1981) and Engeström (1987; 1989; 1990; 1991; 1996; 1999a; 2005). The chapter also draws on insightful works and contributions of Hardman (2005; 2007; 2008a; 2008b; 2010; 2014).

Chapter 4 highlights and explores the methodology used in this project. It underlines the process and criteria used by the researcher to choose the participants in context, to gather and examine research data. Drawing on an empirical case study design, the chapter explores and presents the following sections: research design, the selection of cases under study, research participants, the instructional context, data collection procedure, data analysis procedure, research ethics, validity.

Chapter 5 presents and exploits all data gathered from the instruments using CHAT, as well as the discussion of the results from the face to face interviews with research participants. It also examines teachers' perceptions on whether pedagogy potentially alters using ICT (such as computer hardware and software) and advises whether this possible variation has positive or negative impacts on learners' outcomes. Drawing on the CHAT dimensions, this chapter also illustrates twofold AS, namely, face to face and computer-based classrooms, to show their divergences.

And Chapter 6 evaluates the research questions and presents a conclusion of the thesis based on the results presented, explained, investigated and discussed in the research project. It also proposes and unpacks assumptions for practice and implementation of ICT (such as computer hardware and software) in grade 6 Mathematics classrooms in disadvantaged schools with similar background as the two schools utilised in this project. Finally, this chapter presents some recommendations for further study and some limitations of the project.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

This chapter draws on evidence and theories of various authors to foreground the discussions on the understanding of whether pedagogy can possibly be shifted with ICT, if so, how do teachers perceive this pedagogical change, and what does this look like? In chapter one the main issues of this research were introduced, the current problem was highlighted, and the background of this study was presented. This chapter reviews a series of empirical studies in the field that inform this project and address the research problem. Literature were sourced from EBSCO HOST and ERIC databases with the search terms "teachers' perceptions of pedagogical variation with computers" and "math attainment in primary schools with ICTs". Parameters of the search included a theoretical one (I looked mainly for CHAT based studies) and a time-based search, with studies being selected from 2000-2018. In the process of reviewing literature the following outlines are considered in this study:

1) Teachers' perceptions of ICTs as teaching and learning tools;
2) Teachers' perceptions of pedagogical alteration with ICT: does mobile technology have impacts in pedagogy?
3) Does the use of ICTs impact positively on primary school learners' outcomes in Mathematics? And if so, in what ways?

This chapter finally closes with a brief chapter summary.

2.2. Teachers' perceptions of ICTs as teaching and learning tools

The findings from most of the research conducted worldwide assume the effective usage of ICTs (such as computer hardware and software, tablets, and smartphones) is mostly in more developed or wealthy countries (AlTameemy, 2016). I could find no published studies on the use of ICT in no-fee paying schools or the impact that ICTs could potentially have in these contexts.

Some of the studies in the 21st century support that ICTs (such as computer hardware and software, tablets, and smartphones) constitute an influential tool that can enhance

teaching and learning, and enable learners to learn "across time, by revisiting knowledge that was gained earlier in a different context,… move from topic to topic, managing a range of personal learning projects, rather than following a single curriculum…" (Sharples, Taylor & Vavoula, 2005, p.58). Equally, teachers can interact and collaborate with other colleagues, peers; and access other resources that can enhance teaching and learning processes. In other words, the presence of technology has become inevitable and necessary in education (Halder et al., 2015).

The research conducted by Parsons (2014) reveals that, "75% of mobile [technology such as smartphones, and tablets] subscriptions are in developing countries. Generally, in 2014, more than 2.5 billion people had access to the Internet and about third of these did it through [ICTs such as] mobile devices", as per AlTameemy's (2016, p.437) claim. Similarly, The World Development Report (2016) indicates that "information about [ICTs (or mobile devices) owners in developing countries who exceed that in the developed world and that globally the number of subscribers exceeds the number of population" (AlTameemy, 2016, p.437). Simply put, ICTs (such as mobile devices) are utilised in teaching and learning as a pedagogical tool in the same way as pen, notebook and textbook; and their integration seems to be predictable and relevant as they enable or facilitate the enhancement of teaching and learning practices.

Teachers' perceptions of ICT integration within classrooms are very important because they influence practice. However, the educational benefits of ICTs depend on individual teachers (Mwendwa, 2017; Joseph, 2014 citing Krysa, 1998). "Teachers should be aware of the educational potential of ICT (such as computer hardware and software, tablets, and smartphones) – they should develop their pedagogical capacity to implement [ICT] in a variety of educationally effective ways" Mwendwa (2017, p.415).

Africa, as a continent, has considerably upgraded in terms of ICTs' (especially mobile devices) "ownership, acceptance and usage, lively and energetic [mobile devices] networks, and moderate regulatory and licensing systems", according to Matimbwa & Naano Anney's (2016, p.92) report. The assumption is that technology integration has matured after 2009s – the visibility of ICT is remarkable in all the sectors including education. "There is a growing access and reduction of the equity gap (digital divide) ranging from higher in urban and low in rural remote areas …" Matimbwa et al.'s (2016, p.92).

Drawing on Waite's (2004) research as cited in Mwendwa (2017), the findings reveal that "…teachers in schools show great interest and motivation to learn about the potential

of ICT [that is computing hardware and software], in practice, [but when it comes to the use of technology, it is comparatively low and its focus is] on a narrow range of applications, with word processing being the predominant use and video/network conferencing, e-mailing and the internet being rarely used…" (p.413-414). Teachers who are positively disposed towards ICTs should be encouraged to utilise them to their full potential as pedagogical tools.

ICT (computer hardware and software, tablets, and smartphones) as a pedagogical tool for supporting learning is not broadly well rooted in educators' practices (Cubukcuoglu, 2015; Deaney, 2003; Pedretti, Mayer-smith & Woodrow, 1999; Zhao & Cziko, 2001). Mwendwa (2017) draws on (Jules Van Belle & Suetaert, 2001) to indicate "…that information technology in the classroom is used in an ineffective way and it has proven difficult to integrate within the traditional curriculum setting…" (p.413-414).

Mwendwa (2017) also claims that "[teachers'] perceptions [vis-à-vis ICTs as pedagogical tools] can be determined by many factors such as the awareness of the innovation or change, the availability of the required resources and facilities as well as the competences required in the implementation process" (p.410). Likewise, I can additionally argue that the attitudes of teachers towards ICT within teaching and learning environment (or classrooms) will depend on their readiness – teachers' readiness is determined by a combination of three factors: (a) availability, (b) accessibility, and more importantly (c) capability. Learners mostly appear to be ready to use ICTs because they are born in digital era (Prensky, 2001) as "to them it is natural to be surrounded by technology such as smartphones" (Ictech II, 2014, p.2), unlike many teachers. The main problem is the 'capability' or 'ability' factor. Where a teacher does not feel able to use technology, they will not do so.

It is one thing to have technology available and accessible, and it is another thing to be capable of using technology. This requires certain skills which can be acquired through learning. Further, training the teachers how to use technology for pedagogical practices can enable and enhance their capacity and ability. In Williams' (2009) research conducted in Scotland, as cited in Mwendwa (2017), the findings reveal that most primary school teachers tend to utilise ICT as a supportive tool during classroom practice – a lot of primary school teachers have evidently recognized a number of benefits such as collaboration, improvement in "teacher productivity, learner outcomes, …" (p.414) that ICT offers to both teachers and learners in the classroom. But, in several occasions, teachers fail to incorporate ICT in their teaching process, and keep on teaching ICT

instead of teaching with it. Nevertheless, "…[primary school teachers who utilise ICT such as] a computer at home tend to use it more in classroom and that differences exist between subject area in the practice and perceptions towards ICT with teachers of business management using it more and Mathematics and science teachers using it the best" Mwendwa (2017, p.414).

Moreover, teachers' perceptions of ICT are a core component in its diffusion (Rogers, 2003; Syomwene, 2017). Therefore, we can say that attitudes can directly or indirectly affect people's behaviour. A person with a positive attitude towards a new ICT, his/her technological involvement within teaching and learning milieu may be positively remarkable; unlike someone with a wrong attitude vis-à-vis ICT (Zimbardo et al, cited by Asiri et al, 2012). Besides, Mwendwa (2017) argues that "learners who integrate ICT in learning may easily understand complex topics and concepts. They are more likely to recall information and use it to solve problems in the classroom" (p.414).

In research conducted by Albirini (2006) as cited in Mwendwa (2017), the findings reveal "that teachers have positive attitudes towards ICT in education" (p.414) – ICT is regarded by teachers as a powerful teaching and learning tool that can foster and increase quite significant improvements within educational environments (such as schools and classrooms). Equally, "the study also revealed a very strong relationship between teachers' attitudes towards ICT in education and their perception of computer attributes."

As per the above notes, I can argue that today's teachers seem to be positively disposed to ICT as educational tools and hence, my question is: how do they think it changes their practice, if at all? This question is informed by the body of research that indicates that it is pedagogy, rather than ICTs that leads to optimal outcomes with the use of ICTs (Hardman, 2015; 2019).

I argue that for learning to be active, it requires involvement of the learner (Hardman, 2008a), and this involvement or active participation can be orchestrated with tools such as ICTs. In other words, within a teaching space, novel possibilities are created for collaboration, and for an alteration from distorted to more proportioned power relations between teacher and learners; that is, a movement from asymmetrical power relations that pervade traditional lessons to more fluid power relations in the ICT based lessons (Hardman, 2008a). Todays' ICTs operate at the extent that they can be used as real world problem-solving tools.

The above illustrations indicate that the use of ICTs in a teaching space happens to have an impact on division of labour, transforming teaching practices with teachers and learners playing different roles in this context.

2.3. Does mobile technology impact on pedagogy?

> *"As education is regarded as the backbone of any country and in modern times, education (whether regular or ...) is inarguably interrelated with technology, [ICT such as mobile devices (laptops, smartphones, tablets) have] a pertinent role to play in education…"*
>
> *Halder, Halder, and Guha (2015, p.82)*

The above quote from Halder, Halder, and Guha (2015) states the importance and significance of ICTs (such as mobile technology) within education. They argue that education and technology are interconnected, and technology can play a relevant role in education. In addition, other studies have suggested that ICT such as mobile technology (for example smartphones) can shift pedagogy as "learners can access their own devices to achieve goals set by their teachers and become more independent learners" (Sharples et al., 2014, p.17). Here, the assumption is that today's primary school learners are born in an digital era and constitute part of a new generation that is keen to use ICTs (such as computer hardware and software, tablets, and smartphones) hence they are not intimidated by technology; in fact they use it on a daily basis (Smith, Isaak, Senette, & Abadie, 2011) – they utilise ICTs at homes and/or school environment for example to play games and communicate with others – for instance friends, family members, parents, classmates, teachers (Sharples et al., 2014, p.17).

Gwang-Jo Kim (2009, p.4) outlined and suggested a series of purposes that technology in Education (Ed.) can serve to: "(a) Restructuring education system, (b) Diversifying teaching-learning methods and practices, [and I am looking at this aspect in this thesis] (c) Engaging all stakeholders of education and adapt rapidly to changes in society and the environment, and (d) Enhancing education efficiency, effectiveness, and productivity." In addition, other studies proposed three primary goals that technology in Ed. can accomplish: "(1) Individual development, (2) Education reform, and (3) Social and Economic growth." (Song, Heo, & Lee, 2009, p.5).

Nowadays, the most popular digital device for the millennial generation happens to be 'mobile technology' (Ictech II, 2014, p.19). Moreover, drawing on Garcia's (2007) notes,

Ictech II (2014) claims that "millennials think that all learning would benefit from the utilization of technology and that the internet, which is accessible via [ICT such as mobile technology (such as smartphones, tablets)], is like oxygen" (p.19). Simply put, ICT (or mobile technology) is an indispensable or a 'must-have' tool for the millennial generation.

Mobile technology can support and foster "the learner's learner-centeredness and offering him or her learning in a meaningful real-world context will provide such a transformation in how learning is taking place in the new era of technology" (AlTameemy, 2016, p.439).

In this project, learner centredness refers to the fact that lessons can be paced to suit learners' unique needs. Thus, a teacher attempts to comprehend his/her learners' prior knowledge, including any misunderstandings that the learner undergoes in the process of constructing novel knowledge. This is relevant because it makes use of analytic tools and activities, so that the prior knowledge configurations become perceptible to both the teacher and the learner (Bransford et al. 2000). Further, in a learner-centered setting, the learner happens to be the focal point, and with the advent of mobile technology in education this can enhance teaching and learning practices.

Pollara and Broussard (2011) highlight that a continuous repetition of the use of mobile technology that reaches an extent of addiction can help to break and "eliminates the technology unfamiliarity barrier that" (AlTameemy, 2016, p.439) teachers usually encounter when utilizing new tools. I argue that technology (such as smartphones) can constitute a strong tool for pedagogical practices as it "can be a catalyst by providing tools which teachers use to improve teaching and by giving learners access to electronic media that make concepts clearer and more accessible" (Unwin, 2009, p.214).

Further, Matimbwa et al. (2016, p.93) claim that "[ICT such as mobile devices (for example smartphones, tablets] are significantly changing human computer interaction, communication, and learning activities… Generally [these mobile devices are] among the few ICTs' gadget which has defeated common physical and social barrier for technology adoption in developing countries and penetrated in rural and urban setting compared to other technologies (Olson, Kodde, deMaagd, Tarkleson, Sinclair, Yook, & Egidio, 2011)." In this thesis, I investigated the extent to which teachers think that ICTs are changing their pedagogy, using a CHAT lens. Further, assuming teacher(s) think that ICT can alter pedagogy in grade 6 Mathematics classrooms in WCP primary schools in SA, do they think that this can improve learners' understanding of Mathematics and

allow them to successfully pass Mathematics? This can be noted in teachers' perceptions in regards to these novel pedagogical tools, not as a disruptive tool within educational environment but as a pedagogical tool for teaching practices that "would make a difference in learning outcomes" (AlTameemy, 2016, p.449).

2.4. Does the use of ICTs impact positively on primary school learners' outcomes in Mathematics?

Drawing on Nichols's (2007) notes, Edwards-Groves (2012, p.99) cautioned that "digital technologies are fundamentally shifting learning. Learners are learning new literacies, new socialities and new technological competencies…" This process has become possible with improvement in ICTs and innovation in educational learning practices (Potkonjak, et al, 2016). Today's learners find themselves in a technoliterate world where they flourish on the intersected function of "technology creativity, social interaction and connections with community… as they are actively engaged in what has been described as a *participatory culture..."* (Edwards-Groves, 2012, p.100).

In light of this research, one can argue that the use of technology has a positive influence on primary school learners' outcomes in Mathematics. The study conducted by Ruthven, Deaney, and Hennessy (2009) as cited in Jackson (2017) shows that the effective integration and use of ICT into two English Mathematics teachers classrooms had a positive impact on learners' outcomes – teachers made use of technology to demonstrate "the software to [be utilised by] their learners [in Mathematics lessons] and explained the mathematical context of the results" (Jackson, 2017, p.92) to them. As a result, learners were capable of manipulating technology and more importantly resolving some mathematical problems using ICT. Further, the research revealed that "Learners preferred the software to the traditional pen and paper and became more engaged with the content" (Jackson, 2017, p.92). The incorporation of technology by these "…Mathematics teachers has been demonstrated to significantly impact learner progress" (Jackson, 2017, p.92-93). The novelty of ICTs appears to act as a motivator to encourage learners to engage with mathematical problem solving (Hardman et al., 2019). There is a well-established relationship between motivation and learning and we can, therefore, anticipate that ICTs will impact positively on learning in Mathematics if they are able to motivate learners to engage with the tasks at hand.

Likewise, Hegedus, Tapper, and Dalton's (2016) research has also revealed "that teacher integration of ICT into Mathematics classroom has an impact on learner outcomes…"

However, the availability of ICT (e.g. computing hardware and software) alone in classrooms is not enough, teachers have a vital role to play in the improvement of learners' outcomes – "It is the teacher's decisions on how to integrate ICT into the Mathematics classroom that will either improve or hinder learner outcomes" (Jackson, 2017, p.90). Hence, my study investigates teachers' perceptions of pedagogical change.

In the same vein, one can argue that the affordances of improving or hindering learners' outcomes in Mathematics classrooms are subject to teachers' decisions regarding the integration and the use of ICT within the teaching and learning space. Simply put, the teacher plays a central role in integrating ICT in the classroom (Jackson, 2017, p.90).

In research conducted by Jackson (2017, p.90), an array of hypothetical frameworks has been developed to understand the integration of technology in classrooms by Mathematics teachers. For instance, Jackson (2017, p.90) points out a few factors that can affect ICT integration in the classroom such as: "(i) *'micro models',* [which embrace features associated] to the teacher and technology; (ii) *'macro models'*, [which consist of] environmental factors; and (iii) *'integrative models'* that combine teacher beliefs and background with elements of the micro and macro models…" (See also Olive, 2011). Jackson (2017, p.91) claims that these factors "influence Mathematics teachers on ICT integration… [Likewise, each model of factors constitutes or demonstrates a specific illustration, such as] the sociocultural framework and Technology Acceptance Model (TAM) [which exemplify, for instance] *integrative models…*" Similarly, the aforementioned argument can be related to Goos' (2010) statement as asserted in Jackson's (2017) paper to also describe "the sociocultural framework [as an] interaction between the teacher's Zone of Proximal Development (ZPD), Zone of Free Movement (ZFM), and Zone of Promoted Action (ZPA). The Zone of Proximal Development (ZPD) describes the gap between current and potential capabilities of learners that can be traversed with appropriate support. The Zone of Free Movement (ZFM) refers to constraints that affect the ways an individual can interact with their environment. And the Zone of Promoted Action (ZPA) describes the efforts of an experienced learner, who is developing new skills." (p.91-92).

Drawing on Okumuş et al. (2016), Jackson (2017) additionally argues that "The TAM is built on the interaction between instructional, curricular, and organisational factors, affecting the teacher's integration of technology...; …*macro models* [are epitomized by] the Practitioner Model of Computer (PMC), [which] uses model analyses and external factors, including the working environment, resource system, activity structure, and

curriculum script…; and …Instrumental orchestration and The Technological Pedagogical Content Knowledge (TPACK) fall within the *micro model of* classification through their focus on teacher and learner use of ICT…" (p.91), according to Jackson (2017) – who also argues that "…TPACK framework focuses on the knowledge required by teacher (Mishra & Koehler, 2006) and *Instrumental orchestration* describes the processes used by teachers to gain ICT competency and develop competency in their learners (Ruthven, 2009)" (p.91).

Jackson (2017) finally concludes by arguing that "The role of the teacher in deciding when, how, and where to use ICT will determine whether its use will facilitate learner learning of Mathematics…" (p.91) hence impact learners' outcomes and progress – just like "in every profession, the ways in which people go about their work, how they build organizations, and how organizations interact with each other greatly affects the outcomes of the work" (Foot, 2014, p.2). While the above models illustrate how to integrate technology into classrooms, they do not speak to the problematic of the current study; that is, how does pedagogy alter with technology and what impact does this have on mathematical acquisition? To meet the need to explain complex actions within an unfolding activity, the thesis draws on CHAT which is discussed in the following chapter.

2.5. Conclusion

The advent of ICTs such as computer hardware and software, tablets, and smartphones in the twenty-first century within teaching and learning has changed the way educational practices occur (Juhary, 2014). Technology gives today's learners the opportunity to open up, collaborate, repeat, and practice exercises and activities related to complex subjects such as Mathematics several times in order to master some challenging concepts and skills (Gogwim, 2017) – learners become autonomous using ICT in the classrooms (Hardman, 2008a).

This literature review shows that the use of ICTs (such as computer hardware and software, tablets, smartphones) as teaching and learning tools in classrooms alters educational practices by influencing division of labour, with learners taking on teachers' role in this context and vice-versa.

Drawing from these studies, one can argue that various conceptual frameworks can be implemented. However, this research is situated within Cultural Historical Activity Theory (CHAT) framework to contextualize educational practices. Cultural Historical

Activity Theory (CHAT) as a conceptual framework enables researchers to understand complex pedagogical practices (Hardman, 2008a). Likewise, CHAT is utilised throughout this project to investigate teachers' perceptions on whether pedagogy alters with ICTs.

Teachers' perceptions are so important because they determine how ICTs (such as computer hardware and software, tablets, smartphones) are used in classrooms – positively or negatively. Simply put, the extent in which ICTs are utilised in classrooms is a result of teachers' perceptions regarding them. A teacher with a positive perception towards ICTs may be keen to use them at their full potential as teaching and learning tools; conversely, a teacher with a negative perception in relation to ICTs may not be keen to fully integrate them into his/her pedagogy.

CHAPTER 3
THEORETICAL FRAMEWORK

3.1. Introduction

This chapter aims to elaborate how a conceptual framework such as Cultural Historical Activity Theory (CHAT) can be utilised to understand teachers' perceptions of pedagogical practices within grade 6 Mathematics classrooms by observing pedagogy as an activity system.

The chapter explores the chronological progress of CHAT from its genesis – taking into account the most relevant CHAT advocates and their insightful inputs: from Vygotsky's (1978; 1981) work on human activity, which was expanded by Leontiev (1978; 1981) and Engeström (1987; 1989; 1990; 1991; 1996; 1999a; 2005). The chapter also draws on works and ideas of a scholar such as Hardman (2005a; 2005b; 2007; 2008a; 2008b; 2010; 2014).

The assumption which underpins the theoretical framework is that pedagogy is viewed as an activity system in Mathematics classrooms. This chapter therefore explores the components of the theoretical framework and provides a rationale for CHAT framework that views learning as necessarily mediated. The work of theorists such as Engeström and Hardman is predominantly used throughout this chapter to understand educational practices within the context of Mathematics classrooms.

This chapter finally closes with a discussion of the conceptual framework - Cultural Historical Activity Theory (CHAT) within a research context, before it concludes with a brief chapter summary.

3.2. Theoretical Framework Overview

The incorporation of technology in teaching and learning is the most key element in transforming face-to-face context or "*traditional classrooms* into *digital age classrooms* that are often [described] as classrooms of authentic learning" (Smith, 2015, p.12). Technology has the power to "break down the time and space [restrictions] in a face-to-face classroom because one can access work outside of official school times, and access to the internet allows [learners] to contact peers and teachers in different countries" (Hardman, 2008a, p.29). Clearly, then, technology can potentially alter pedagogical practices.

Unlike other theories, "CHAT has been used to address important educational issues in fresh ways…" (Roth & Lee, 2007, p.206). One can argue that CHAT is a useful framework for ICTs integration that enables researchers to investigate and to comprehend teaching and learning practices in context. "Of direct relevance to educators…, CHAT has much potential for educators, because it is thoroughly about development and learning, encompassing the system as a whole and various subjects and communities that constitute it" (Roth & Lee, 2007, p.204).

While CHAT can also "bridge traditional classroom practices to modern classroom practices" (Smith, 2015, p.13), this conceptual framework is used throughout this study to investigate teachers' perceptions of pedagogical shift with ICT in primary schools in order to address the main question:

What are the perceptions of teachers on whether there is a potential shift in pedagogy with ICT (e.g. computer hardware and software) in a grade 6 Mathematics classrooms and what does this look like?

and the sub-question:

To what extent do teachers think that this change impacts positively or negatively on learners' outcomes?

3.3. Cultural Historical Activity Theory (CHAT)

3.3.1. Synopsis of CHAT

Cultural Historical Activity Theory (CHAT) is originally found in Vygotsky's work (Vygotsky, 1978). The development of this theory has been established by Leontiev (1978; 1981) and Engeström (1987; 1989; 1990; 1991; 1996; 1999a; 2005). Further, this conceptual framework has also seen several researchers and scholar-practitioners who have contributed with insightful works and ideas so far, such as Hardman (2005a; 2005b; 2007; 2008a; 2008b; 2010; 2014). This current research foregrounds the discussion on a view of pedagogy as socially situated utilising the work of Vygotsky (1978; 1986), Leontiev (1978; 1981) and most deeply, Engeström (1987; 1989; 1990; 1991; 1996; 1999a; 2005) and Hardman (2005a; 2005b; 2007; 2008a; 2008b; 2010; 2014) to contextualise this project at primary school level. Drawing on the abovementioned CHAT advocates' works and ideas, it is argued "that humans learn by doing, act

collectively and communicate through their actions…" (Wilson, 2014; Taylor, 2014; Behrend, 2014) as cited in Gogwim (2017, p.31).

Cultural Historical Activity Theory (CHAT) is interchangeably referred to as Activity theory (Vygotsky, 1978; 1986). Gogwim (2017, p.30) draws on (Wilson, 2014, Bravo Olavarria, 2013) to claim that it is "because the social participation and interactions in an activity as maintained by Vygotsky can change dynamically when social and cultural conditions change". Within this context, the integration as well as the use of ICT (such as computing hardware and software) in pedagogy is the most core element in moving from "*traditional classrooms* into *digital age classrooms* that are often [described] as classrooms of authentic learning" (Smith, 2015, p.12). The actors' (teachers and learners) social participation and interactions in the digital classrooms changed from traditional to digital – technology has broken down the restrictions related to the time and space within a traditional classrooms and, hence enables accessibility to various school works during and after official school times, and fosters collaboration between learners, teachers and peers (Hardman, 2008a). In a learning process, humans create, utilise and embrace appropriate tools (Wilson, 2014; Taylor, 2014; Behrend, 2014). Foot (2014) claims that "Cultural-historical activity theory (CHAT) is one of several practice-based approaches that provides a robust framework for analyzing professional work practices, including social service provision… [and]… enables researchers to analyze complex and evolving professional practices, and practitioners to engage in reflective research…" (p.2)

One can argue that within the label cultural-historical activity theory, each word has a particular significance – this argument is perfectly illustrated and supported by Foot's (2014) explanation of each word as follows: "*Cultural* points to the premise that humans are enculturated, and everything people do is shaped by and draws upon their cultural values and resources; *Historical* is used together with cultural to indicate that since cultures are grounded in histories, and evolve over time, therefore analyses of what people do at any point in time must be viewed in light of the historical trajectories in which their actions take place; *Activity* refers to what people do together, and is modified by both cultural and historical to convey its situatedness; *Theory* is used in this label to denote a conceptual framework for understanding and explaining human activity" (p.2).

CHAT is progressively getting noticed and utilised mostly by scholar-practitioners through various fields to improve ways of thinking about and determining proficient "practices such as developing curricula and teaching at all education levels" (Foot, 2014, p.2).

Below is a simple illustration of activity theory utilising a triangle with three dimensions: the top one is the access point of mediating tools into the activity system; the left node represents subject and the right node denotes object (Bozalek et al., 2015; Engeström, 2017a) as shown in figure 3.1.This is a graphic depiction of Vygotsky's (1978) work which indicates that a subject acts on an object via mediational means or tools. Here learning happens in a unique social space Vygotsky (1978; 1986) calls the Zone of Proximal Development (ZPD). This is the gap between what a learner can achieve on his/her own and what he can achieve with the guided assistance of a more knowledgeable other.

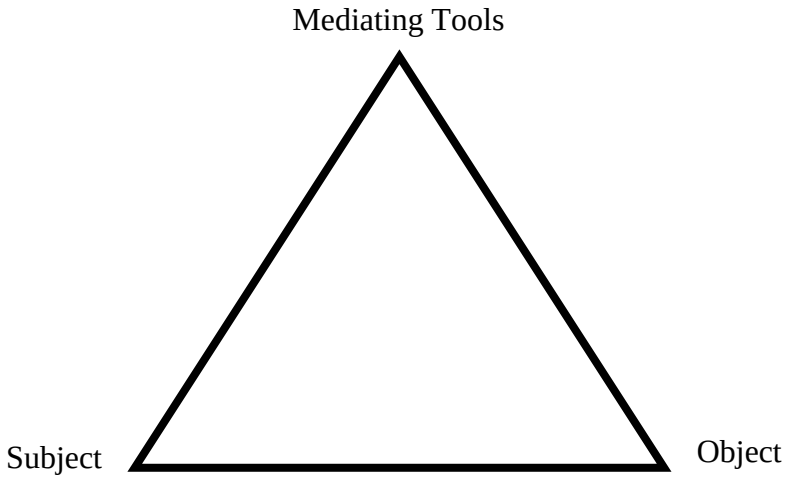


Figure 3.1: Activity theory illustration

3.3.2. The evolution of CHAT

Drawing on works and ideas of CHAT advocates, three generations ought to be considered (Engestrom, 2014); each generation (from the first to the third) of activity theory is equally explored in this project to inform and situate pedagogy in context. According to Hardman (2015), "CHAT holds that higher cognitive functions are necessarily mediated by signs/tools" (p.52) and artefacts such as language and technology; the focal point of the first generation of activity theory CHAT underlines "language [as the core] mediating tool" (Hardman, 2015, p.52). Yet, this activity theory has also seen the second as well as the third generation (Hardman, 2005a). In fact, the emphasis in the third generation of CHAT draws on Engeström's (1987) work that "has developed a model of human activity that situates mediation in a broader social context" (Hardman, 2015, p.52).

The first generation is based on Vygotsky's concept of mediation – "According to Vygotsky, all specifically human psychological processes (so-called higher mental processes) are mediated by psychological tools such as language, signs, and symbols. Adults teach these tools to children in the course of their joint activity, the children internalize them, and these tools then function as mediators of the children's more advanced psychological processes" (Karpov et al, 1998, p.27).

Looking at the current context, one can argue that in the first generation, activity is represented at an individual level where the tools (artefacts) like ICTs (for instance, computer hardware and software, tablets, and smartphones) mediate between the subjects (e.g. teachers and learners) and the object (e.g. Mathematics) (Robertson, 2008; Hardman, 2005a; Engestrom, 2014). By examining Vygotsky's works, Karpov has identified two sorts of mediation: "*metacognitive* [which] refers to children's acquisition of semiotic tools of self-regulation: self-planning, selfmonitoring, self-checking, and self-evaluating…; [and] *cognitive* [that] refers to children's acquisition of cognitive tools that are necessary for solving subject-domain problems" (Karpov et al, 1998, p.27-28).

The emphasis of this project is on cognitive mediation – according to Karpov et al.'s (1998) notes "… systematic cognitive mediation of children begins when they go to school and begin to acquire scientific concepts [for instance, mathematical concepts]" (p.28). Here the understanding is that CHAT, as a theoretic framework, can help determine the perceptions of Grade 6 Mathematics teachers on whether pedagogy varies with ICT tools in classrooms and check the extent of this variation (positive or negative) on learners' outcomes because it is able to situate individual actions within the activity (lesson) in which they play out.

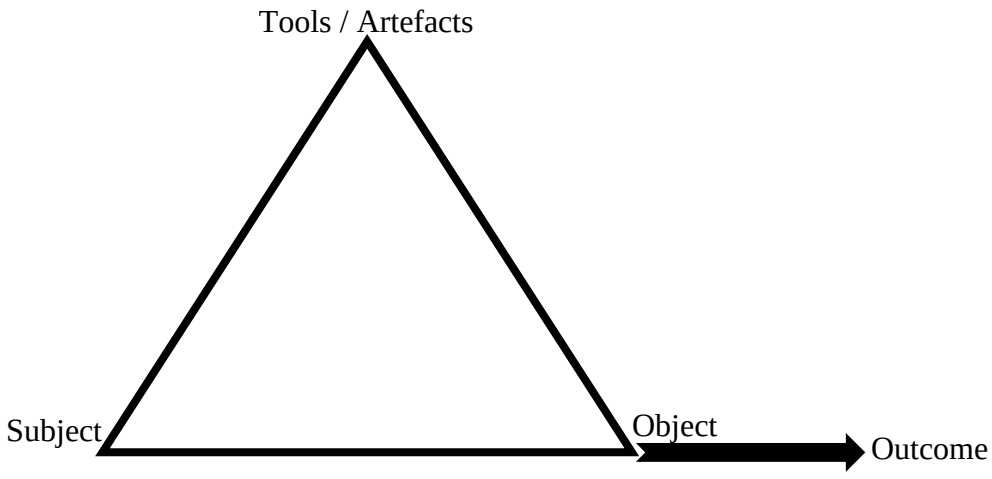


Figure 3.2: First generation Activity theory illustration

Drawing on Vygotsky's concept of mediated action, the above figure 3.2 can be interpreted as follows: the subjects are the participants (Grade 6 Mathematics teachers) in the activity system (teaching in classrooms) driven towards accomplishing a purpose or object (Mathematical concepts and procedures) of the activity (Wilson, 2014; Bozalek et al., 2015; Gogwim, 2017). The object denotes the aim of the activity and the actors' or subjects' intentions for partaking in the activity are contradictions within the activity system (Bravo & Olavarria, 2013; Engeström, 2017b; Gogwim, 2017). The tools are societal, cultural-historical artefacts that the actors (subjects) utilised to attain the object (Wilson, 2014; Gogwim, 2017). The outcome is the effect resulting from the subjects' actions motivated by the activity object, which could support or demotivate actors from participating in forthcoming activities (Bravo Olavarria, 2013; Engeström, 2017b; Gogwim, 2017).

Unlike the first generation that was developed to situate individual action in complex activity, the second generation of activity theory was established to epitomize an activity system at a collective level (Gogwim, 2017). The development of this second generation of AT was articulated by Leontiev (1978; 1981) – who added the notion of division of labour and situated individual actions within collective activities (Hardman, 2005a; Engestrom, 2014).

The work of Leontiev demonstrates how individual actions occur within the background of a social activity. In Leontiev's work the social aspect is not expounded outside of the concept of the activity as object-oriented (Hardman, 2008a). For example, Leontiev "does not theorise how social rules afford and constrain individual actions or indeed, how they dynamically impact on an activity. While accounting for hierarchical levels of human functioning, Leontiev's theory does not go far enough explain how individual actions are transformed into shared, *collective* objects through interactions with community members or social rules impact on individual actions in a collective activity" (Hardman, 2008a, p.70). Further, Leontiev's activity theory model fails to address the interaction of two or more activity systems. This is problematic in that no activity happens in isolation from other activities.

The failure of the second generation AT in addressing two or more activity systems led to the development of the third generation which is based on Engeström's Activity Theory model (Engeström, 2014). In other words, the third generation is grounded on Engeström's three-level model of activity (Hardman, 2005a; Engestrom, 2014; Gogwim,

2017). In addition to the afore-illustrated dimensions (subject, tools/artefact, object and outcome) within an activity system, three other nodes have been added: rules, community and division of labour. This work of Engeström emphasises that activities are interrelated – one does not have one system, but many systems because human activity is complex (Hardman, 2015). Further, Engeström's (2001) work also "expanded CHAT that includes networking systems with shared object, tensions, and contradictions" (Nussbaumer, 2012, p.6). Contradictions are tensions, or double-binds that force a shift in the system. The introduction of a novel tool, such as ICTs for example, potentially causes a contradiction in the activity system, leading to a change in the system.

CHAT encompasses "the system as a whole and various subjects and communities that constitute it" (Roth & Lee, 2007, p.204); and within this inclusion, "the subject(s) acts on the object in order to transform it using mediating artefacts in order to arrive at specific outcomes. In turn, the subject's position is influenced by the rules of the system, the community and division of labour..." (Hardman, 2015, p.52). While teaching and learning happen to be "a dynamic activity system" Hardman (2008a, p.1), this research foregrounds the discussions on CHAT dimensions of tools, rules, object, division of labour, outcome, community and subject to elaborate a logical framework for investigating pedagogical alteration with ICTs, as illustrated in Figures 3.3

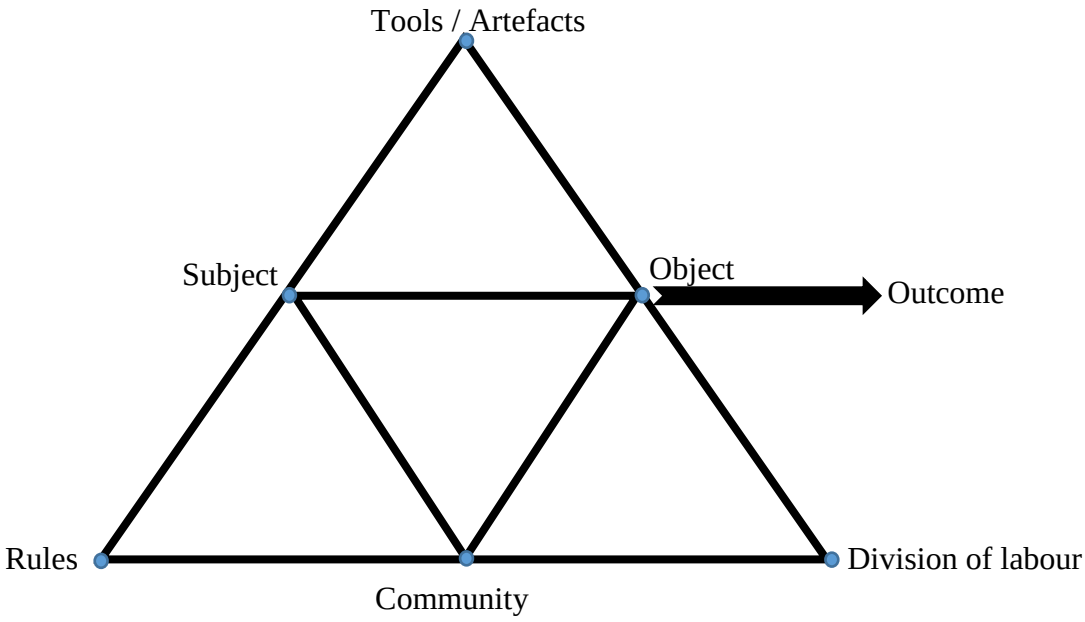


Figure 3.3: Third generation Activity theory example

Figure 3.3 exemplifies an activity system (AS) that is drawn from a model proposed by Engeström's (1987) for the analysis of this study.

In view of this current project, the core concepts illustrated in the above figure 3.3 consist of the research participants (teachers) '*subjects'* using ICTs (such as computer hardware and software, tablets, and smartphones) '*meditational artefacts or tools'* as teaching and learning tools to improve learners' understanding of Mathematics '*object'* in order to produce good results – successfully pass Mathematics with good marks *'outcome'*. The teacher and learners *'community members'* play a few roles '*division of labour'* in a classroom and assure the arrangement of *'Rules and regulations'*.

The analysis of pedagogic activity is needed on these dimensions in order to understand the activity of teaching in context. Below is a broad hypothetical illustration of the current project activity system as indicated in Figure 3.4

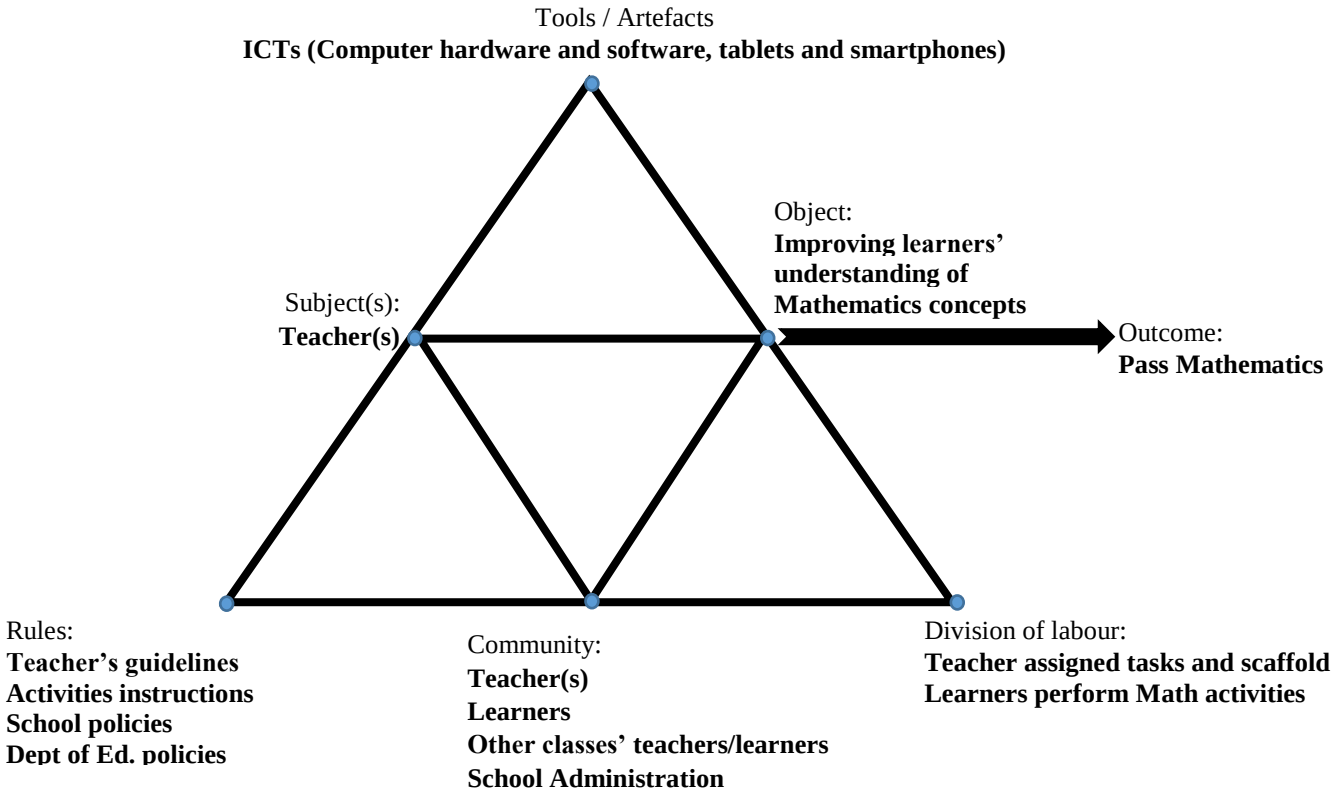


Figure 3.4: Teaching and learning Mathematics concepts Activity system

Activity systems are not always stagnant but unbalanced and unstable, and CHAT views these variations as determined by contradictions; and these "contradictions, or double binds, can arise within and between systems…" (Hardman, 2005a, p.259). Further,

contradictions or tensions or conflicts represent the subjects' motives for partaking in the activity (Gogwim, 2017) – this can arise from any participant involved in an AS.

While an activity system is not limited to one node but many, contradictions can "emerge at various nodes of the activity system" (Hardman, 2008b, p.32). As contradictions or tensions arise within an AS individuals commence to depart "from the activity's established norms, which in some cases may lead to a deliberate collective change effort" Karanasios et al. (2017, p.3). In this opinion, contradictions are viewed as a cultural-historical power, which disrupts activities, directing to continuously developing and changing activities, in which "equilibrium is an exception and tensions, disturbances and local innovations are the rule and the engine of change" (Cole & Engeström, 1993, p.8). This is discussed in chapter 4.

In the paradigm of CHAT, learning can be described as a process of continuous interaction with the milieu "and others and knowledge as constructed by individual learners, building on existing historical experiences and within the learners' context" (N'gambi, 2013, p.654). Lim (2002), in addition, claims that in a CHAT paradigm "individuals learn with a wide variety of tools and with people that help them carry out their goal oriented activities" (p.413).

Moreover, within a CHAT pattern, each AS happens to be singular and unique, yet influenced with other elements adjacent activities. Hence, the analysis of every activity is done individually and then collectively. In this context, CHAT is used to explicate how change in one fragment of an AS can influence another fragment of the activity system. For instance, teacher/learner "roles (division of labour), with the [learner] taking on a teaching role in relation to the technology will effect changes in other parts of the system. For example, the perceptions teachers have vis-à-vis their learners' ability/capacity to teach the teacher can alter. The CHAT facility for recognising changes in one part of the system as impacting on other parts of the system [avails a range of] possibilities for understanding teaching and learning with [ICTs such as computer hardware and software, tablets, smartphones]" (Hardman, 2008b, p.30).

3.4. CHAT within a research context

CHAT presents a potent conceptual lens to interpret and explicate how interaction with mediating tools such as ICT (computer hardware and software, tablet) within learning activities could improve practical skills attainment (Engeström, 2017a; Clemmensen, Kaptelinin & Nardi, 2016; Gogwim, 2017).

One can argue that CHAT proposes a framework to investigate the socio-cultural impacts of AT dimensions like rules and regulations, community and division of labour within the same AS (Behrend, 2014). The social and historical technique of teaching scientific subjects such as Mathematics at primary school level in SA classrooms progressively tend to the digitalization – some primary school teachers use technology to impart mathematical knowledge and concepts in classrooms.

The integration as well as the use of ICT by primary school teachers within classrooms raise a number of questions from educators', scholars', and researchers' point of view – one of the interrogations consists, for instance, to investigate teachers perceptions on whether pedagogy changes with the use of ICT in grade 6 Mathematics classroom, if so, to what extent this shift positively or negatively influences the learners' outcomes? This is the emphasis of this project.

Gogwim (2017) draws on Bozalek et al. (2015) and Engestrom's (2014) notes to claim that "…human interactions in an activity system is regarded as the participation, while the actions of the subject on the object are mediated by the artifacts, and guided by the community rules and division of labour of the activity being performed…" (p.31).

In light of this project, one can argue that teacher(s) and learners interact in Mathematics activity system, while ICTs (such as computer hardware and software, tablets, and smartphones) potentially mediate the actors' (subjects) actions on the object, and this is steered by the rules of community and division of labour of the activity being executed. And "…CHAT can help a researcher to understand, analyse and explain the relationship between participants' thoughts… and the activity they are doing [Mathematics] using cultural resources or artifacts…" (Gogwim, 2017, p.31). In other words, what CHAT allows investigators, and scholars to do is to explicate how alteration in a single part of an AS can influence alterations in another part of the system – this shift can occur within teacher/learner roles (division of labour), with the learner playing the teacher's role in relation to ICTs such as computer hardware and software, tablets, and smartphones, resulting to some variations in other portions of the system. For instance, teachers' thoughts and views vis-à-vis the affordances for their learners to take on their teaching role may vary (Hardman, 2008a).

The CHAT ability for identifying shifts in a single portion of the AS as influencing other portions of the activity system unlocks and avails the affordances for grasping teaching and learning with ICTs (such as computer hardware and software, tablets, and smartphones). In illustrating the power that CHAT has to study pedagogical change,

Hardman (2008a) explored pedagogical variation with computers in four South African primary schools situated in the Western Cape Province and found that pedagogical alteration occurs in one portion of a system can sway variations in another fragment of the system causing teacher and learner to interchange roles in relation to technology (division of labour). Hardman (2008a) utilised CHAT lens as a conceptual framework to explicate and comprehend interactions between human and technology in mathematical classrooms scenario. The current project draws on Hardman's conceptual framework to study teachers' perceptions of change in relation to pedagogy in two no-fee paying schools in the Western Cape Province of South Africa.

CHAT has additionally been utilised to advise research practices towards the understanding of authentic situations (Yamagata-Lynch, 2007) as well as the analysis of other projects (Roth, 2004). In a research conducted by Nussbaumer (2012) from preschool playgroup to grade 12, for instance, the findings indicate that CHAT ". . . has power to deal with the complexity in educational systems" (Jaworski & Potari, 2009, p.222). The study also shows that the importance of this theory "lies in organizing, sifting, sorting, and clarifying complex phenomena found in activity, in and beyond the classroom" (Nussbaumer, 2012, p.10). In this view, one can argue that CHAT has the ability to depict points of investigation, "intervention and indirect relationships that might not otherwise be considered" (Nussbaumer, 2012, p.10).

3.5. Conclusion

The conceptual framework for this research project is CHAT, which enables understanding how ICTs such as computer hardware and software, tablets, and smartphones are utilised as mediating tools for learning process and explicate the socio-cultural variations within the activity system. A typical example of CHAT is illustrated by a triangle; three generations of CHAT are explored – each demonstrating a distinct form of activity system.

CHAT proposes a framework to examine the socio-cultural influences of activity theory dimensions like rules and norms, community and division of labour within the system (Behrend, 2014). Likewise, in this research project, CHAT helps investigate Mathematics activity system to reveal the perceptions of teachers on pedagogical shift with ICT – both teacher and learners happen to interchange roles: with the learners playing teacher's role and vice-versa. This is clearly illustrated in-depths in the next chapter.

Further, an analytical framework based on CHAT was illustrated to demonstrate how individual and collective actions within Mathematics activity system take place – how ICT could mediate hands-on Mathematics concepts and skills acquirement.

CHAPTER 4
RESEARCH METHODOLOGY

4.1. Introduction

Chapter 3 underlined the theoretical basis of this research project, introducing the concepts of CHAT that have been established for data analysis of this thesis. This chapter highlights and describes different steps followed by the researcher to specifically conduct this research project. In the previous chapter, CHAT introduces this project with the concept of an activity system as a unit of analysis – different theoretical resources were provided such as subject, mediating tools/artefacts, object, outcome, division of labour, community and rules to facilitate data analysis of this research.

In this research project, analysis encompassed organising the data in relation to CHAT dimensions. The investigation paid attention to both resemblances and dissimilarities between cases. In this way, prominent aspects of groups were illustrated using individual cases, while still preserving the individuality of each case study.

While this chapter also outlines the process and criteria utilised by the researcher to select the research participants in context, to collect and analyze data, the following sections are included throughout this chapter: research design, the selection of cases under study, research participants, the instructional context, data collection procedure, data analysis procedure, research ethics, validity and reliability, and chapter summary.

4.2. Research design

This is a qualitative research design because this study does not seek general patterns but deeper understanding of the phenomenon on teaching with ICTs. This research investigates grade 6 Mathematics teachers' perceptions of possible pedagogical shifts using ICTs such as computer hardware and software, tablets, and smartphones. This project is small in scale, therefore an emphasis on two primary schools and six teachers (three per school) was considered to facilitate a comprehensive analysis of pedagogical practices with ICTs (such as computer hardware and software)

The study is motivated by a curiosity in the level to which new ICT influences pedagogical practices in lessons. Tacitly, this implies a comparative element within this research project that seeks to compare teaching and learning Mathematics with ICT (technology based pedagogy) versus teaching and learning Mathematics without ICT (face-to-face based pedagogy).

This project utilises a case study design that permits for an examination of various variables as they play out in context (Hardman, 2018a). The selection of cases under study was purposively done. Typical cases were chosen in the actual project in order to foreground the investigative lens on finest practice, where this consists of well-managed non-fee paying schools in which teachers regularly utilise ICTs (such as computer hardware and software) to teach Mathematics.

Figure 4.1 exemplifies a narrow graphic illustration of the research design, showing the cases (and research participants) as well as data collection methods.

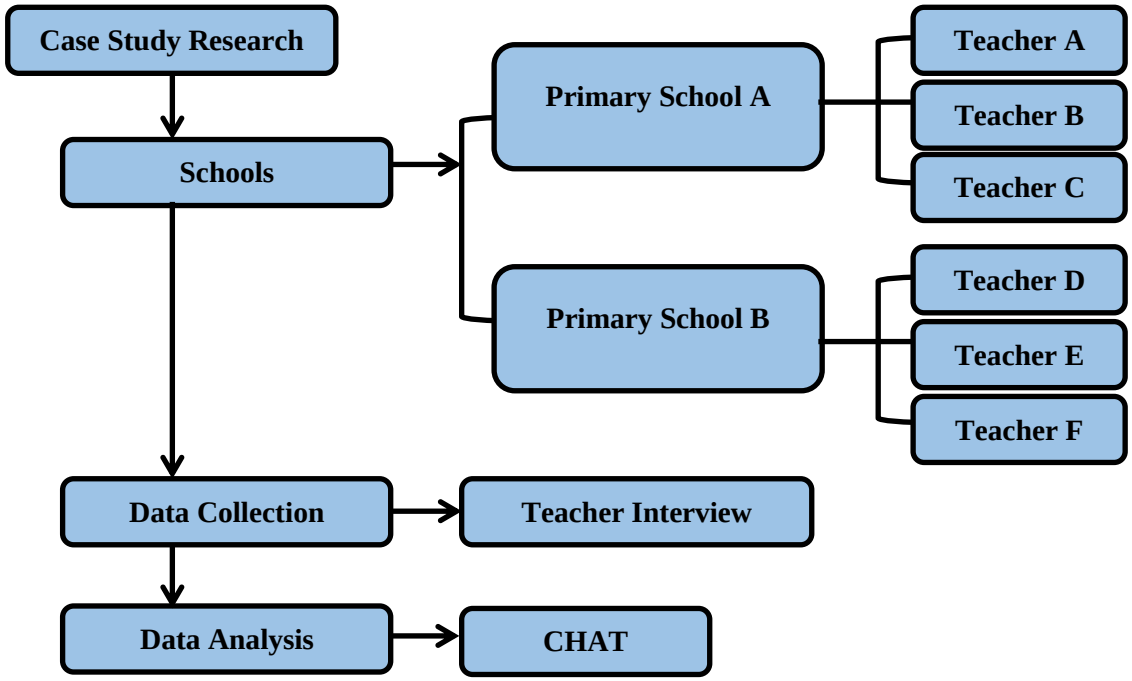


Figure 4.1: Graphic illustration of the research

4.3. The selection of cases under study

Given that this project mainly consists of addressing the key question:

1) *What are the perceptions of teachers on whether there is a potential shift in pedagogy with ICT (such as computer hardware and software) in a grade 6 Mathematics classrooms and what does this look like?*

and

2) *a sub-question: to what extent do teachers think that this change impacts positively or negatively on learners' outcomes?*

a case study approach to data collection is adopted in this project. One can argue that "the strength of a case study approach lies in its ability to provide thick descriptions of the complex phenomena under investigation" Hardman (2005a, p.260).

This research project draws on the cases under study of six grade 6 Mathematics teachers across two primary schools in the Western Cape Province. The research was situated in Mathematics classrooms: Firstly, because Mathematics constitutes the main problematic subject that affects most learners in South Africa in general and Western Cape Province in particular (The Economist, 2014). Secondly, technology is more likely to be used in Mathematics lessons than other lessons in schools in South Africa.

The selection of cases under study was subject to an array of criteria, with the twofold key selection requirement being the existence and utilization of ICTs (such as computer hardware and software, tablets, and smartphones) in the school and the geographic location of the school (township[1] area) within the following limits:

1) The profile of a learner was one of disadvantage – the concept *disadvantage* pertains to underprivileged profile – "low socio-economic status as determined by the proxy variable of school fees" Hardman (2005a, p.260);
2) The primary school operates correctly – the concept *operating* means functioning (meaning there is a presence of a management team and well-structured scheduled lessons);
3) ICTs such as computer hardware and software, tablets, and smartphones are utilised to teach Mathematics in school;
4) The primary schools are situated in townships.
5) The schools are no-fee paying schools

In total six Mathematics teachers across two primary schools in the Western Cape Province were involved as participants for the research project. Further, this selection method was purposely utilised to acquire useful and in-depth data.

4.4. Research Participants

This research project investigates grade 6 Mathematics teachers' perceptions whether pedagogy potentially alters using ICTs such as computer hardware and software, tablets, and smartphones. The subjects of this research project are six primary school

[1] This term "(in South Africa) refers to a suburb or city of predominantly black occupation, formerly officially designated for black occupation by apartheid legislation or a new area being developed for residential or industrial use by speculators", according to https://en.oxforddictionaries.com/definition/township

Mathematics teachers. The six teachers are divided in two groups – each group represents a respective primary school with three teachers per school.

Both schools are underprivileged, no fee paying schools: The first three teachers participating in the research project are black[2] Xhosa first language speakers, one female and two male, who are in the range of age between twenty seven and fifty two years old and have been teaching for between four to twenty four years. The female teacher is 52 years old, has Honours in Education, Honours in Public Administration, has completed a short course in Mathematics, and has twenty four years teaching experience whilst one of the male teachers is forty three years old and has Senior Diploma specializing in Science and Technology, and has nineteen years teaching experience. The youngest teacher in this group of teachers is 27 years old, has Postgraduate Certificate in Education (PGCE), and has four years teaching experience (see table 4.1 below).

The three other teachers partaking in the study are colored[3] Afrikaans first language speakers, also one female and two male, who are in the range of age between twenty four and fifty seven years old, and have been teaching from between seven months to thirty height years. The female teacher is 57 years old, has Professional Development (PD) and National Professional Diploma in Education (NPDE), and has thirty height years teaching experience whilst one of the male teachers is thirty two years old and has Bachelor of Education (B.Ed), and has eight years teaching experience. The youngest teacher in this group of teachers is 24 years old, has Postgraduate Certificate in Education (PGCE) and Bachelor of Science, and has seven months teaching experience.

Tabulated below are the details of the demographic data gathered from the school teachers.

[2] Categories of race are not appropriate but they continue to have a legacy in SA because of apartheid.

[3] I realize that racial categories are problematic but they still have salience in SA

Demographic details	First School			Second School		
	Teacher A	Teacher B	Teacher C	Teacher D	Teacher E	Teacher F
Gender	Female	Male	Male	Female	Male	Male
Age	52	43	27	57	32	24
First language	Xhosa	Xhosa	Xhosa	Afrikaans	Afrikaans	Afrikaans
Qualifications	Honours in Education, Honours in Public Administration, has completed a short course in Mathematics	Senior Diploma specializing in Science and Technology	PGCE	PD and NPDE	B.Ed	Bachelor of Science and PGCE
Years of teaching experience	24	19	4	38	8	7 Months
ICT Training	Yes	Yes	Yes	Yes	Not formal	Yes
ICT can use or used	Edmodo, CAMI[4] Maths, computer	CAMI Maths, computer	CAMI Maths, computer	Computer, CAMI Maths	Computer, YouTube, google classroom, CAMI Maths	Computer, YouTube, Google Ed. Level one, MS Office suite
ICT currently at school and/or using	CAMI Maths, computer	CAMI Maths, computer	CAMI Maths, computer	Smartboard, tablets, computer, internet, projector	Smartboard, tablets, computer, internet, projector	Smartboard, tablets, computer, internet, projector
Tools used before ICT	Board, textbook, some concrete things such as pictures, scales	Board, textbook	Board, textbook	Board, textbook	Board, textbook	Board, textbook

Table 4.1: Primary School Teacher demographic data

[4] "CAMI Maths is a fun and interactive educational software system that helps learners understand mathematical concepts" Source: http://www.cami-apps.com/edu/

4.5.The instructional context

This research project was located in six Grade 6 Mathematics teachers in only two township primary schools: the first school was situated in what is formerly referred to under apartheid as 'black' townships, whereas the second was located in what is formerly referred to under apartheid as 'coloured' townships.

Both primary schools in the sample could best be designated as underprivileged or disadvantaged – "low socio-economic status as determined by the proxy variable of school fees" Hardman (2005a, p.260). The two schools are categorized as public or government schools. Both schools are situated outside Cape Town CBD, with almost similar schedule – both schools stated that schools begin at 8.00 in the morning and end at 14.00 in the afternoon weekly (Monday to Friday). Periods last approximately fifty minutes. There is Tea-break and lunch-time throughout the course of the day.

The home language on the children in school A is isiXhosa and in school B is Afrikaans. However, the language of teaching and learning in both schools is English.

Both primary schools reportedly indicated that there is a presence of ICTs such as computer hardware and software, CAMI Maths, projectors, and tablets in schools (in the computer Lab) and these technologies have been and/or are used for teaching Mathematics to Grade 6 learners; however, the amount of time utilised in the computer Lab with ICTs diverges across schools – from between fifty minutes and one hundred and twenty minutes per week. Also, class (and grade) sizes diverge across schools – Some classes have more learners than others.

4.6. Data Collection Procedure

As this study consists of an investigation and not an intervention, CHAT is used as a theoretical framework enabling the data analysis. In addition to the use of CHAT as a theoretical framework the data were collected using a series of interviews techniques in this research project – a series of face-to-face interviews with six grade 6 participating Mathematics teachers across two primary schools were organised.

4.6.1. Interviews

According to Mathers, Fox, and Hunn's (2002) definition, "the *interview* is an important data gathering technique involving verbal communication between the researcher and the subject…" (p.1). The current study is underpinned by *"Face-to-face interviews"* – also known as personal interviews (Mathers et al., 2002, p.1). Unlike other types of

interviews, *"Face-to-face interviews"* "are very labour intensive, but can be the best way of collecting high quality data" (Mathers et al., 2002, p.1).

Interviews with the participating teachers were conducted on-site (meaning on their respective schools). In both schools, each teacher was interviewed once but in the presence of the Head of Department (HoD): all the teachers in the first school (school A) were interviewed separately depending on the availability of each teacher whereas in the second school the interview was conducted one by one but all three teachers were available in the same time – hence present during the interview process of fellow colleagues.

Interviews lasted from between 10 to 20 minutes, depending on the individual teacher's engagement with the questions. The questions were open but have been designed using the CHAT framework to uncover teachers' perceptions in relation to for example, tools, rules and division of labour (See Appendix A: Teacher interview schedule). "Compared to other methods of data collection, face-to-face interviewing offers a greater degree of flexibility, prompts, probe responses and follow up on new ideas in a way that is just not possible with other methods" (Mathers et al., 2002, p.1).

All the face-to-face interviews with teachers were tape-recorded by the researcher on digital voice recorder and transcribed (See Appendix A: Teacher interview schedule).

Finally, after the data had been gathered and transcribed, the conceptual framework, that is, CHAT was thoroughly utilised to view, explicate, deduce and analyze the collated research data.

4.7. Data Analysis Technique

Participants' perceptions on whether technology shifts pedagogy in grade 6 Mathematics classrooms and track what this looks like are thematically analysed in relation to CHAT dimensions of tools, rules, object, division of labour, outcome, community and subject (See Appendix A: Teacher interview schedule) – a semi-structured interview plan was utilised to guide the discussion.

4.7.1. The interviews analysis in relation to CHAT

Drawing on Engeström's (1987) activity system (AS) as graphically illustrated below (See Figure 4.2), one can see that AS can be considered as the smallest unit of analysis in investigating human activity (Hardman, 2008a). In this research project, pedagogic activity is symbolised along different nodes: The research participant (teacher) is the

subject – he acts with artefacts or mediating tools such as the computer hardware and software in order to attain an anticipated outcome through altering the object of the activity, mostly apprehended "of as curriculum content knowledge, into an outcome" Hardman (2008a, p.84).

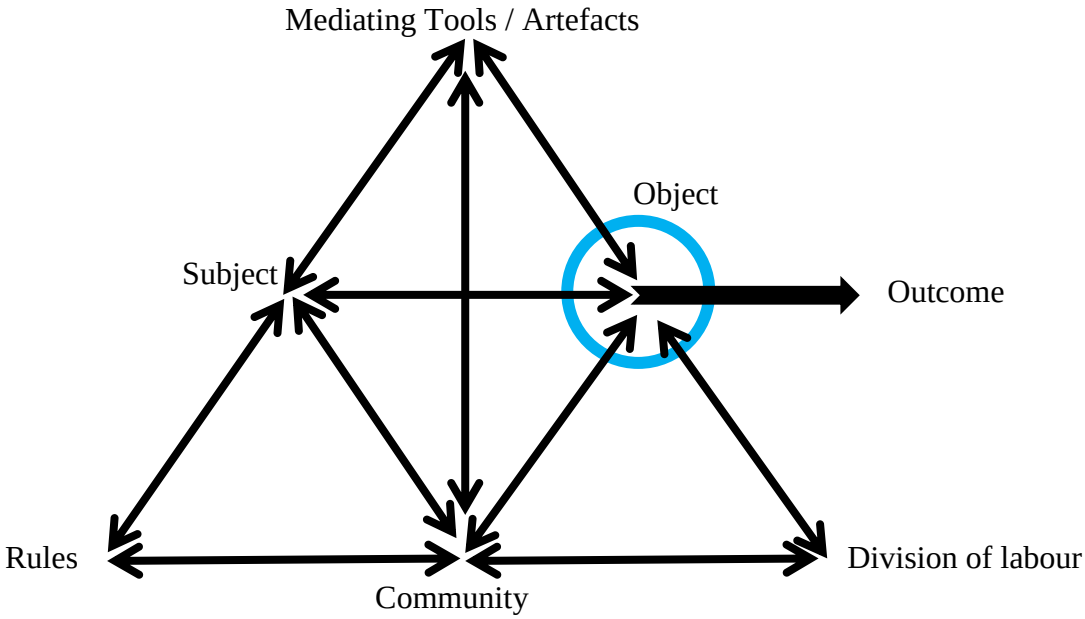


Figure 4.2: The Activity system example

The CHAT dimensions of tools, rules, object, division of labour, outcome, community and subject (See Appendix A: Teacher interview schedule) were used to structure and construct the teacher interview schedule. This interview schedule was contained an array of concise and open ended questions in order to guide and encourage the research participants to freely engage and construct a narrative around teaching Mathematics with ICTs such as computer hardware and software. Questions explored the research participants' (primary school teachers') insights and views vis-à-vis teaching and learning Mathematics as well as about the use of ICTs (such as computer hardware and software) as teaching/learning tools; the usage of ICT and non-ICT tools; rules in the face-to-face or traditional (without the use of ICT) and digital classrooms (with the use of technology); division of labour; and motives for acting on objects and the aims of ICT and non-ICT lessons – in order to comprehend the teachers' perceptions of whether pedagogy is altered by technology in grade 6 Mathematics classrooms and track what this looks like.

The analysis of the research data collected and transcribed was done in relation to the structural classifications drawn from CHAT, namely: subject, mediating tools/artefacts, object and outcome, division of labour, community, and rules – with specific attention, for this research project, on teachers position as subject hence the main research participants on this study. This facilitated the researcher to track the objects in the activity systems, and to explain the research participants' perceptions in regard to a possible change of pedagogy by ICT on the teaching and learning of Mathematics and track what this looks like (See Appendix A: Teacher interview schedule).

All the interviews sessions were recorded for comparison and verification of their trustworthiness. The analysis of all the research data with well-described classifications draws from CHAT to ensure the reliability of the investigation. Further, the data were coded independently by two other researchers and agreement was reached on codes.

4.7.2. The Object, understood as a methodological concept

Given the continuous development and growth of CHAT, one of the common, if not the broad assumptions apprehended by CHAT advocates is the understanding "of the object as that space which enables one to understand the activity system as a whole" Hardman (2005a, p.261). Accordingly, being capable of ascertaining and tracking the object (or objects) of an AS allows the researcher to elucidate the system as a whole. Nonetheless, the instantaneously material and ideal nature of any object makes it particularly challenging to disclose the object of any system (Hardman, 2005a). Nevertheless, the object is associated to the subject (in such a way that the subject acts on it to develop and alter it and it motivated to do so) pointing systematically, to the significance of comprehending the subject's position when tracing the object (Hardman, 2005a).

Consequently, in order to construct an AS that could offer a convenient unit of analysis, a series of interviews with primary school teachers was conducted with particular attention paid to unpacking their perceptive comprehensions of the object(s) of the AS they find themselves into without the use of technology (traditional classroom) and with the use of ICT (computer lab) – this could advise whether pedagogy potentially alters or not with ICT, and if so, to track what it looks like.

4.8. Research Ethics

Any academic research project that involves the participation of various parties (such as human being and animals) should follow certain norms in the conduct of the research

study – these parties, for instance, need to agree on different things in order to facilitate and carry out research project.

Research ethics are contextual means or rules for conducting research project in an adequate way, though they are now and then observed as modest common sense in conducting study encompassing human beings. Each institution, department or profession, depending on the context, perceives or implements or interprets research ethics differently, although all can point to the same aim.

For this project, the following procedures were considered: Firstly, rules and policies of the Department of Education in the Western Cape Province as well as the selected WCP primary schools were followed to officially ensure the clarity on the conduct of the interview process between the interviewer (researcher) and the interviewee (grade 6 Mathematics teacher). The letter of permission from the Western Cape Education Department (WCED) was granted to carry out research (See Appendix B: WCED Letter of permission).

Secondly, The researcher had to adhere to codes of good conduct of research to insure the confidentiality of participants data collected – the consent form was signed between the interviewer and the interviewee (See Appendix C: Research Participant Consent Form). This was communicated to the participants. The main researcher (myself) and the NRF team were the only people to have access to the data (See Appendix D: Ethics Form).

4.9. Validity and reliability

The validity and consistency issues to the conduct and conclusion of the research project are described as follows:

The interviews were customised to suite researcher's need as ascertain by Maxwell (2008, p.243) that "what the interviewee says is always a function of the interviewer and the interview situation". Validity was taken into account because the interview was designed this way and teachers could have input into it. This validity threat was control by enabling teachers to freely engage and voice out their perceptions without being tell-directed. Another form of validity issue is researcher's manipulation of research data. Interview questions were constructed very simple and straightforward, making use of familiar language. Also, steps were taken ensure that each research participant understood the questions in the same way and answers were coded utilizing the AT framework illustrated earlier. According to Maxwell (2012, p.126) as cited in Gogwim (2017, p.47), "this is the

single most important way of ruling out the possibility of misinterpreting the meaning of what [research] participants say…"

Reliability "here refers to the fact that an audience is presented with a study that, if it were repeated with the same subjects and in the same context, would yield the same results" (Hardman, 2008, p.146). One way of ensuring consistency in this research project was to involve an external transcriber and two independent researchers to code the data, and an agreement was reached on codes. All the interviews sessions were recorded for evaluation and verification of their dependability. The analysis of all the research data with well-structured categorizations draws from CHAT to ensure the consistency of the investigation.

4.10. Conclusion

This chapter emphasized and described various phases used by the researcher throughout this study. The chapter outlines the context of two no fee paying schools as research sites and elaborate participants' backgrounds before indicating an analytical framework that is used to analyse the data, which is derived from CHAT.

The analysis of the collected data was thematically done in connection with CHAT dimensions of tools, rules, object, division of labour, outcome, community and subject (See Appendix A: Teacher interview schedule).

CHAPTER 5
RESEARCH FINDINGS AND RESULTS DISCUSSIONS

5.1. Introduction

The focus of this chapter is on research participants' (teachers') explanations of how they personally teach Mathematics utilising ICT (such as computer hardware and software) and whether they perceive an alteration in their pedagogical practices when introducing this new technology, if so, what does this look like and whether this change has positive or negative impacts on learners' outcomes?

While presenting the analysis of teachers' interview data, this chapter foregrounds explicitly on developing an account of research participants' (teachers') subject positions, the community involved in the teaching process of Mathematics using ICT (such as computer hardware and software) and teachers' perceptions of how the introduction of this new technology has an influence on their pedagogical practice.

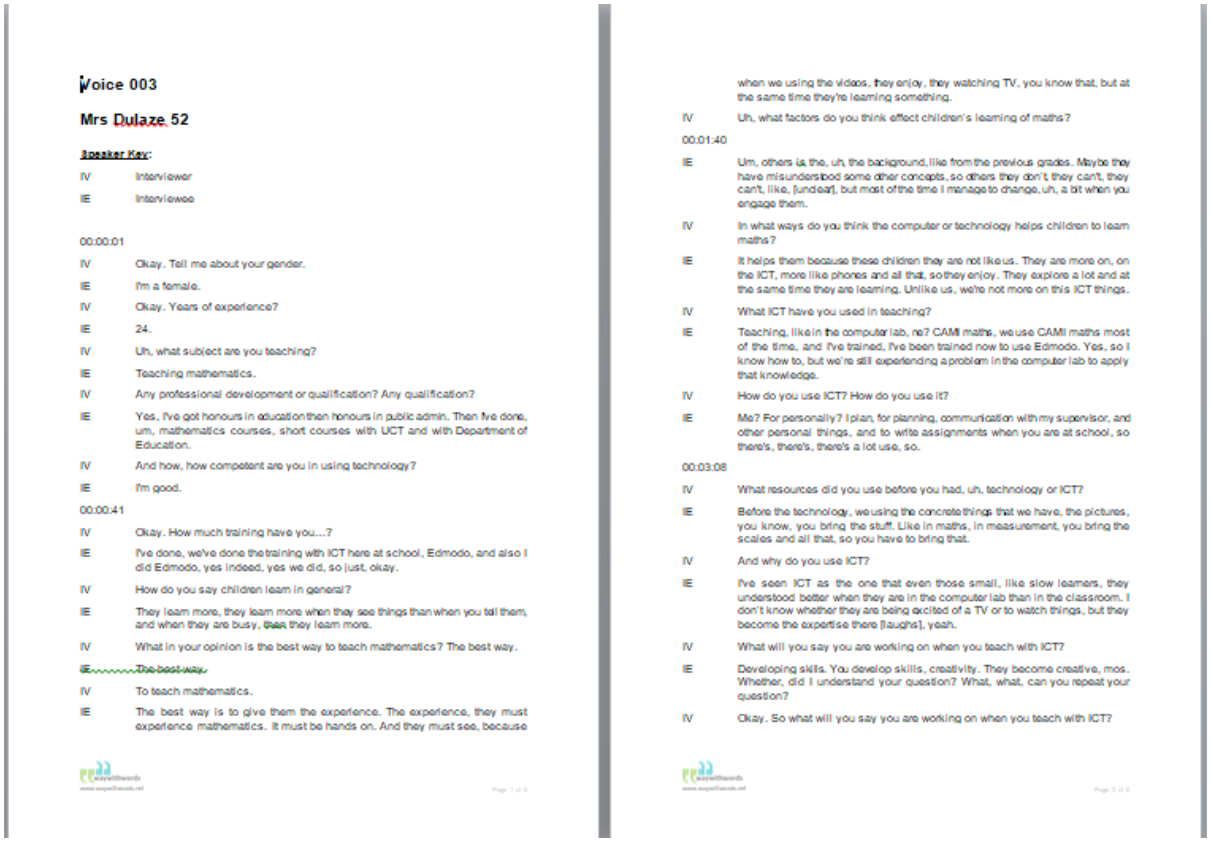
The chapter provides evidence that allows the researcher to respond to the thesis question, namely, how do grade 6 teachers perceive the activity of teaching Mathematics using ICT (such as computer hardware and software), whether there is a possible shift, if so, what does this look like, and whether this variation impacts positively or negatively on learners' outcomes?

5.2. Presentation of Data

5.2.1. Interviews

As discussed in the previous chapter 4, a series of face-to-face interviews with six teachers from two different primary schools were tape-recorded by the researcher on digital voice recorder and transcribed by the external transcribers. The theoretical framework, that is, CHAT was methodically exploited to understand, elucidate, deduce and analyze the collected research data in order to inform the perceptions of research participants on whether pedagogy varies with ICTs and track what this looks like (See Appendix A: Teacher interview schedule). The data gathered utilizing the research instruments are presented as follow.

Illustrated in appendix B are snapshots of full extracts of the interviews transcription. Shown below is part of the transcribed research data.



Voice 003

Mrs Dulaze 52

Speaker Key:

IV Interviewer

IE Interviewee

00:00:01

IV Okay. Tell me about your gender.

IE I'm a female.

IV Okay. Years of experience?

IE 24.

IV Uh, what subject are you teaching?

IE Teaching mathematics.

IV Any professional development or qualification? Any qualification?

IE Yes, I've got honours in education then honours in public admin. Then I've done, um, mathematics courses, short courses with UCT and with Department of Education.

IV And how, how competent are you in using technology?

IE I'm good.

00:00:41

IV Okay. How much training have you....?

IE I've done, we've done the training with ICT here at school, Edmodo, and also I did Edmodo, yes indeed, yes we did, so just, okay.

IV How do you say children learn in general?

IE They learn more, they learn more when they see things than when you tell them, and when they are busy, that they learn more.

IV What in your opinion is the best way to teach mathematics? The best way.

IE The best way.

IV To teach mathematics.

IE The best way is to give them the experience. The experience, they must experience mathematics. It must be hands on. And they must see, because when we using the videos, they enjoy, they watching TV, you know that, but at the same time they're learning something.

IV Uh, what factors do you think effect children's learning of maths?

00:01:40

IE Um, others is the, uh, the background, like from the previous grades. Maybe they have misunderstood some other concepts, so others they don't, they can't, they can't, like, [unclear], but most of the time I manage to change, uh, a bit when you engage them.

IV In what ways do you think the computer or technology helps children to learn maths?

IE It helps them because these children they are not like us. They are more on, on the ICT, more like phones and all that, so they enjoy. They explore a lot and at the same time they are learning. Unlike us, we're not more on this ICT things.

IV What ICT have you used in teaching?

IE Teaching, like in the computer lab, no? CAMI maths, we use CAMI maths most of the time, and I've trained, I've been trained now to use Edmodo. Yes, so I know how to, but we're still experiencing a problem in the computer lab to apply that knowledge.

IV How do you use ICT? How do you use it?

IE Me? For personally? I plan, for planning, communication with my supervisor, and other personal things, and to write assignments when you are at school, so there's, there's, there's a lot use, so.

00:03:08

IV What resources did you use before you had, uh, technology or ICT?

IE Before the technology, we using the concrete things that we have, the pictures, you know, you bring the stuff. Like in maths, in measurement, you bring the scales and all that, so you have to bring that.

IV And why do you use ICT?

IE I've seen ICT as the one that even those small, like slow learners, they understood better when they are in the computer lab than in the classroom. I don't know whether they are being excited of a TV or to watch things, but they become the expertise there [laughs], yeah.

IV What will you say you are working on when you teach with ICT?

IE Developing skills. You develop skills, creativity. They become creative, mos. Whether, did I understand your question? What, what, can you repeat your question?

IV Okay. So what will you say you are working on when you teach with ICT?

Figure 5.1: A Snapshot and Extract of Teacher Interview Transcription

5.2.2. The Object, understood as a methodological concept

In a bid to address the thesis problematic, namely, what are the perceptions of teachers on whether there is a possible alteration in pedagogy with ICTs in grade 6 Mathematics classrooms and what does this look like?, a particular attention was paid to teachers perceptive comprehensions of the objects of the activity of teaching Mathematics with ICT and without technology (traditional classroom) in which they inhabit. Speaking of the object of an activity system here, can be understood as that problem space that the subject operates on and alters (Hardman, 2005a).

Teachers' perceptions on how the mediation of the activity of teaching and learning of Mathematics in traditional (or face-to-face) classrooms (without technology) and in a computer laboratory (with ICT) were prompted during face-to-face interviews with the research participants. While there were some divergences and discrepancies between participants' individual methodologies regarding the use of ICT (computer hardware and software) and, certainly, pedagogic practices, it was possible to come up with an illustration of broad patterns that occurred from the interview data.

The researcher draws on research participants interviews to elaborate teachers' views about the activity of teaching Mathematics: firstly in the traditional classroom (without the use of ICT) and secondly in the computer laboratory (with the use of ICT).

5.2.2.1. Teaching Mathematics in the traditional classrooms: The Object(s) that Teachers believe working on

This section of the chapter highlights the object(s) that teachers believe they are working on in face to face lessons.

Extract 5.1: The object of traditional or face-to-face lessons (without the use of ICT)

Teacher A:	They learn more, they learn more when they see things than when you tell them, and when they are busy, then they learn more. The best way is to give them the experience. The experience, they must experience Mathematics. It must be hands on. And they must see,… Um, others is the, uh, the background, like from the previous grades. Maybe they have misunderstood some other concepts, so others they don't, they can't, they can't, like, [unclear], but most of the time I manage to change, uh, a bit when you engage them. we using the concrete things that we have, the pictures, you know, you bring the stuff. Like in maths, in measurement, you bring the scales and all that, so you have to bring that.

In Extract 5.1, Teacher A indicated that she is working on developing learners' comprehensions/understandings of mathematical concepts by showing them concrete things (such as pictures, measurement tools, and scales). In doing so, she stated, since learners learn through "playing" indeed, it kept them busy. The object here then, is developing learners' compression of Mathematics.

Extract 5.2: Mathematical concepts understanding as an object B

Teacher B:	They must do things on their own. The teacher is only supposed to guide them. They must also learn from each other. They came from something like [unclear]. Yeah, they also need motivation from parents, teachers.

In Extract 5.2, Teacher B pointed out that he is working on developing learners' comprehensions/understandings of mathematical concepts by making them do things, guiding them and encouraging them to learn from each other. As a result, learners were being motivated to learn. So another object here is learner motivation.

Extract 5.3: Active learning as an object

Teacher C:	Okay. You see, sometimes, uh… Okay, most of the times, learners, they are as just experiencing difficulties in Maths. Uh, some are having the barriers, some are barriers, some are having barriers in Math, so we are trying to help them also. You see, sometimes, some of them; they are having what is called, uh, dyscalculia. They are unable to work with numbers. So those learners, it's quite difficult for them to, to help them, but by all means to try and help them.

In Extract 5.3, Teacher C specified that he is working on developing active learning by using textbooks and encouraging and taking learners through the process of reading books. In doing so, it helped breaking some mathematical barriers that learners experienced.

Extract 5.4: Critical thinking as an object

Teacher D:	… I was, I just came from my maths class now and um the question was um what is the shape of the, of the cake if you see it from above. And they wrote there a circle. Now not the circle they wrote front. So now, because we're doing view, viewing at the moment. Now I'm telling her why have you got that answer, um didn't you read the question? So I closed up her answer and I told her now read the question. So she read the question and she saw shape and then she could write down the circle you know? … Starting from the concrete to the, to the... To the abstract yes.

Teacher F:	… . I think critical thinking within those because they would start asking questions. If I give them a colour red and I tell them I don't think this is red they will tell me but it is. So critical thinking starts there where I need to convince them it's not red. So it's all about the critical thinking to convince each other listen but I think this is not the colour um that you are telling me that it is. I think this is red because of these reasons. So I think visual learning um also auditory. I think only by listening would still get their brain functioning um and get that um attention span a bit, so the attention span yes. Fractions for example, um to have different, let's for example I put different stuff there in front of them um for me, to allow them to explain to me how they would um explain a bracket to someone else. Um ag not bracket… Fraction sorry [laughs]. You know breuke. So I think that for example um was a good way to see on what level are they, um what terminology are they using to, to, to see are they on the level where they're supposed to be and then fill in…

In Extract 5.4, Teacher D stated that she is working on developing learners' comprehensions/understandings of mathematical concepts from concrete to abstract. She also indicated that she is working on developing learners' critical thinking.

Like the previous teacher D, Teacher F stated that he is also working on developing learners' critical thinking but more like Teacher A by showing them things and challenge their ability to think.

Extract 5.5: Engagement and collaboration as an object

Teacher E:	I think children learn best by interaction. If you just chalk and talk like you've heard before they get bored. You know they just see you, this green board behind, behind you and that's all they see. There's nothing, there's no music, there's no sound effects and they are used to like Mrs Fortuin said watching TV they've got all these things going on. You come here reading out of a book. It's too boring for them. So I think when you interact with them, when they can be hands-on you

	know like … Um in my opinion repetition um but first of all I think what our kids lack currently is logic. They don't have logical thinking, the ability to think logically. They don't know the difference between50 kilometres and 50 metres. Um a platform is 50 kilometres high where I mean you could ask anybody that and we don't have to have any mathematic skill to be able to figure that out in kilometres and metres, we just know. Um the kids don't want to think, they don't want to read anymore. So I believe with repetition and getting them interested in the topic at hand, you know making it practical to them. Why should I be learning mathematic? Why, you're still here, all of the time you're here people say why do they throw me and bombard me with X and Pythagoras you know? We don't use it today. I've got an answer for that. It unlocks your technical thinking skill. You're not going to use X if you're going to work at a normal... But I mean going from the unknown to the known, using that mathematical skills taught me to think technically. I always tell the kids see the car coming on there, you listen to the sound of the car. Is he coming on fast, is he coming on slow? You learn that through Mathematics. You think it had nothing to do with X and Y but it had everything to do with X and Y. Figuring it out. What could X be? What could Y be? How far is that car coming on? By listening, by looking at it. It's Mathematics. So to get that kid to break the, the topic down to why do I need this, if they understand that they need to know that I get better engagement from them. They're not interested in the topic then I don't care. So...

In Extract 5.5, Teacher E indicated that he is working on developing the learners' ability to think thoroughly and logically by initiating an interaction with and between learners. He also stated that he is working on evolving learners' Mathematics skills by repetitions, on getting learners interested in the topic at hand – making Mathematics more practical to them, and on unlocking learners technical thinking skills.

Object: As afore-illustrated it is fascinating to record that research participants emphasized that they are working on developing learners' comprehensions and aptitudes of mathematical concepts, with many of participants – three out of six or fifty percent of teachers (A, D and F) stating that they do this by using concrete things. In doing so, indeed, teacher A indicated that it keeps learners busy; whereas teachers D and F pointed out that it fostered their ability to think critically. Further, one out of six participants (that is teacher B) indicated that he is doing this by making learners do things, guiding them to learn from each other and to get out of their laziness. Besides, one teacher (that is teacher C) stated that he is doing this by making learners reading books, hence fostering active learning. Finally, the last participant (teacher E) specified that he is doing this by initiating teacher-learners' and learners-learners' interactions.

Above all, the focus here is on providing learners with subject knowledge that can enable their understandings of mathematical concepts in their lives. The above extract 5.1 highlights twofold fundamental features of these participants' assumptions about the activity of teaching and learning Mathematics, that is, learners learn through active learning, and consequently, teachers teach utilizing concrete things.

Tools: Research participants emphasized that in the traditional lesson they utilise traditional tools such as the board, textbooks, concrete things (for example pictures, measurement tools, and scales), and "activities" as tools to operate on and improve learners' mathematical concepts. In this case, activities refer to tasks that learners are indeed given to complete during face to face classrooms. These tasks, then, become tools that teachers utilise to improve the understanding of mathematical concepts (see appendix B).

Division of labour: In a face to face classroom (traditional lesson), division of labour happens to generally illustrate a case of the teacher as controlling the pace, monitoring and sequencing the course of the lesson. The teacher has the leading power in initiating interactions, of course, utilizing the traditional Initiate-Response-Evaluate (IRE) model[5]. Simply put, the role of the teacher remains of one of teaching and the learners are

[5] IRE is described as "a teacher-led, three-part sequence that begins with the teacher asking a learner a question or introducing a topic for the purpose of finding out whether the learner knows an answer. In the IRE pattern, the learner answer evaluated by the teacher, who makes a brief reply such as 'Goo', or 'No, that's not right.' Then the interaction ends.", according to https://www.learner.org/workshops/tfl/glossary.html

expected to listen and, hopefully, learn. Likewise, in this instance, the traditional division of labor remains the same as per research participants' interviews (see appendix B).

Community: Research participants stated that, although they are all surrounded with the broad community of colleagues (such as teachers and HoD) in their respective schools, they consider this specific community (classroom community) encompasses only themselves and their learners (see appendix B).

Rules: The teachers' main emphasis on helping learners to grasp and improve mathematical concepts is swayed by existing social rules and protocols that both support and compel activity. In this case, all the teachers follow CAPS[6]. These rules influence the subject position of a teacher, eventually advising teachers' assumptions of knowledge pertaining to teaching and learning.

Illustrated below is the graphical representation of the activity system of the face to face classroom, as described by the six research participants (teachers) in figure 5.2. By ascertaining the object of the traditional Mathematics lesson (mathematical concepts), it enabled the researcher to construct an image of the AS as a whole, of course, motivated by learners' understandings of Mathematics as vigorously learnt, teachers utilise a number of traditional tools such as the board, textbooks, concrete things (for example pictures, measurement tools, and scales), and "activities" as tools to act on in order to prepare and evolve mathematically well-educated learners. The main focus on evolving comprehension means that the educators play their traditional role (teach, assigned tasks, question), with teachers having full control over teaching and learning.

[6] According to the SA DoE CAPS is "a National Curriculum and Assessment Policy Statement [it is] a single, comprehensive, and concise policy document, which has replaced the Subject and Learning Area Statements, Learning Programme Guidelines for all the subjects listed in the National Curriculum Statement Grades R - 12.", https://www.education.gov.za/Curriculum/CurriculumAssessmentPolicyStatements(CAPS).aspx

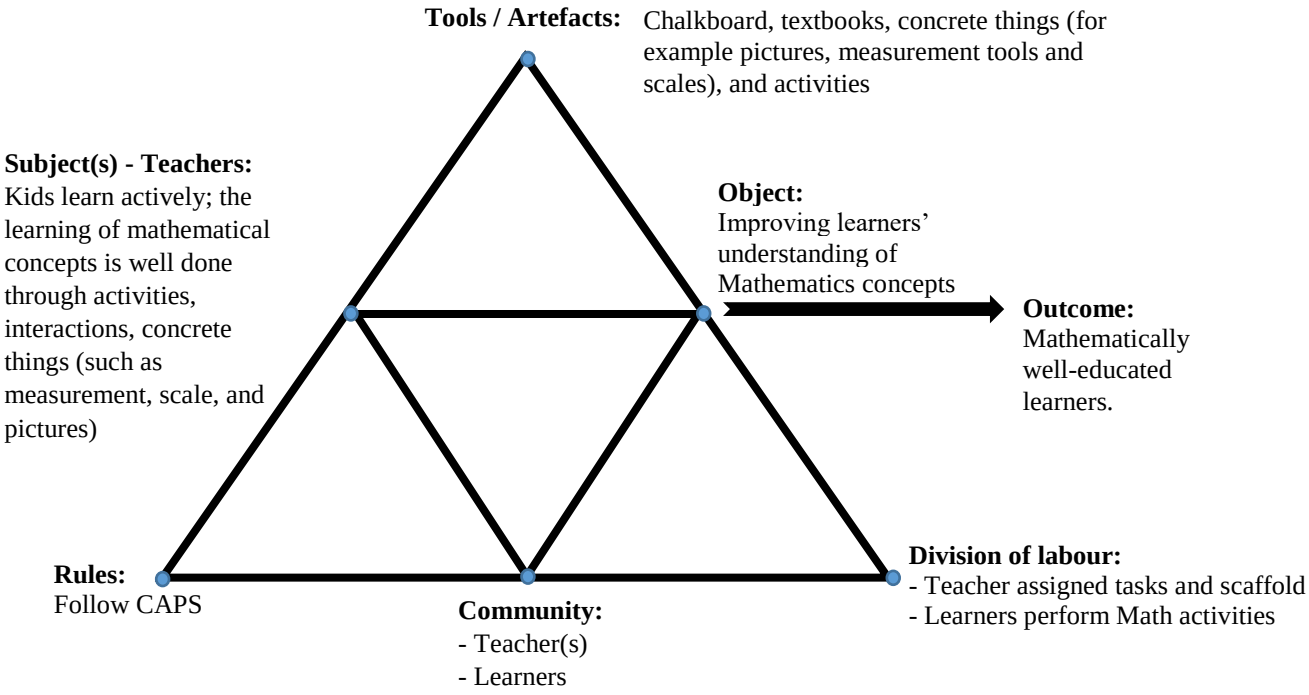


Figure 5.2: Teachers' illustration of the face to face lesson activity system

5.2.2.2. Teaching Mathematics in the computer laboratory: The Object(s) that Teachers believe working on

This section of the chapter highlights the object(s) that teachers think to working on in computer lessons.

The discussion in Extract 5.1 indicates that teachers consider that they are working on evolving learners' understandings of Mathematics concepts in their face to face lessons. With the introduction of a new tool (ICT – such as computer hardware and software) into the lessons it is fascinating to investigate the extent to which this novel tool can potentially impact on teaching and learning, if so, to indicate whether this alteration on teachers' pedagogical practice influences positively or negatively on learners' outcome.

Extract 5.6: The object of computer lessons (with the use of ICT)

Teacher A:	Developing skills. You develop skills, creativity. They become creative, mos. Whether, did I understand your question? What, what, can you repeat your question? I, I think I'm working on the semi concretes, so semi concrete because now they see the pictures and they see people doing things, explaining things, concrete, so, and they enjoy that.

In Extract 5.6, Teacher A stated that she is working on developing learners' mathematical skills and creativity by making them do things. She works on semi-concrete; she downloads different educational materials, videos, images, and tutorials to help learners' conceptual understandings of Mathematics much better.

In doing so, she specified, it emerged motivation and collaboration are an object worked on in the computer based lessons. Learners become more engaged, involved and same time they are grasping mathematic concepts. As a result, there is improvement on learners' marks and grades.

Extract 5.7: Motivation as an object

Teacher B:	I'm trying to motivate learners, improve… They learn better in, in… In the computer lab Motivate them, yeah. … collaboration… Yes, yes.

In Extract 5.7, Teacher B pointed out that he is working on emerging learners' conceptual improvement of Mathematics, their motivation to learn much better through playing. As a result, there is improvement on learners' marks, motivation and collaboration.

Extract 5.8: Active learning and engagement as an object

Teacher C:	Yeah, I would say that when I teach Mathematics, I should involve, uh, technology to engage my learners. Hmm. Okay, what will I say I work on when I teach with ICT. Yeah, I would say that… Hey. Hmm. What do I work with? Okay. I use that software Oh, improving marks? Yes Yeah, it will motivate them

In Extract 5.8, Teacher C specified that he is working on developing learners' active learning and engagement. In doing so, it helped breaking some mathematical barriers that learners experienced. It helped learners improving marks and be motivated.

Extract 5.9: Critical thinking and collaboration as an object

Teacher D:	… I think so yes.

Teacher F:	… . Um that also I think to be more engaging because we want the learners to be more engaged um and I think in that sense you'd want them to actually do then, do the stuff there where they sit. So critical thinking starts there where I need to convince them it's not red. So it's all about the critical thinking to convince each other listen but I think this is not the colour um that you are telling me that it is. I think this is red because of these reasons. So I think visual learning um also auditory. I think only by listening would still get their brain functioning um and get that um attention span a bit, so the attention span yes. So, so I want critical thinking. I want them thinking skills. I want them to harness that you need to think for yourself. You need to figure it out for yourself. I shouldn't be the one that, that have all the information and just blow it out and you be like catch what you can. So they can seem as if they're engaged but it can be at another level. They could play a game and be engaged or nod when the others nod. Um but I think, um and I actually experienced this at the school I was practice teaching, um that grades go up with technology. So I think in that way it's much more engaging um to have the technology right in front of them. Ah collaboration amongst learners? Yes I think so, yes.

In Extract 5.9, Teacher D indicated that she is working on developing learners' critical thinking from watching and seeing things (such as pictures); and learners' engagement and collaboration.

Similarly, as teacher D, teacher F highlighted that he is also working on developing learners' critical thinking and collaboration. Further, he also indicated that he is working on learners' collaboration and motivation (as teachers A, B and E). Teacher F also indicated that is working on developing learners' conceptual mathematical skills. He is doing it using tools such as projector, videos; downloading things from internet, summarising and constructing PowerPoint slides.

Extract 5.10: Motivation and confidence as an object

Teacher E:	Um I think a lot of the kids you know we, the kids are required to have your maths sets, in primary school not that much calculators and that kind of thing but you know kids are like this if they compare themselves to others, you know I'm poorer than you immediately that confidence is, is not there. So if, if a child doesn't have a lot of confidence personally I think it affects how that child learns as well. So that is one of the things I try to implement in my class is to boost their confidence first. That is a very very very big factor in my opinion. Yes I've seen it personally. Um first term I didn't have those facilities in my classroom. Second term I did and my learners have all come through the subjects that I teach into the top ten of the grade sevens and they weren't there before. The only thing I did differently was ICT. So I can only tell them or tell you it's because of that because it's the only thing I changed in my teaching. It's definitely different. They are very excited as you've heard. You know you can, anything visually if it's not the duster, if it's not the chalk, if it's anything different the kids are, you know they immediately give their attention, their focus is there because we've, I've, I've, I've stirred their curiosity a little bit now you know I'm interested because it's what they are interested in. Yes, I do see now that you know when I display something on the screen um sometimes I don't want to break their concentration with too many images because you know if you Google images there's a lot of images going on so I zoom in on one if I want them to focus.

	But if I just open it up and I have a lot of images you can see how they group up and start showing one another. And it gets them to talk. And this one says look at that one over there or, but this is how I, we start talking to each other especially when I ask them questions so they can engage with me they start talking amongst each other. It's like you know when you go to the movies everybody's watching the movie and then you ask did you see that? [Laughs] I'm watching the same movie. So it's, I think it all boils down back to that excitement that exists in the class now because of that in my opinion.

In Extract 5.10, Teacher E indicated that he is working on developing the learners' motivation, confidence and interest vis-à-vis mathematical concepts; their ability to collaborate; and on improving learners' marks (grades).

Object: Teachers A, B, C, E and F specified that the object space they are working on in the computer laboratory is indeed the improvement of learners' marks (grades), motivation, confidence, creativity, interest, engagement and collaboration as well as critical thinking (as also indicated teacher D) by using ICT (such as computer hardware and software, tablet, projector, video, internet, and PowerPoint slides)..

Drawing on the afore mentioned discussion in extract 5.6, one can argue that according to teachers' views technology happens to be serving firstly its intended purpose as a cognitive tool mediating higher order matter solving skills, the ability to think critically, hence enabling learners to improve marks; and secondly as a tool to attract learners' attention, motivation, and boost their confidence, interest, engagement, collaboration, and understandings vis-à-vis Mathematics concepts.

Extract 5.11: ICT as a higher level cognitive tool

Teachers believed that ICT is serving as an intellectual tool mediating higher order problem solving skills – a tool capable of providing learners with the possibilities to grasp knowledge, to think critically, hence to improve marks. Here, one can argue that ICT has the potential to open up learners' zone of proximal development (ZPD) by

enabling them to critically think, grasp and comprehend Mathematics concepts, and consequently, to improve marks.

Teachers A and E stated that ICT help learners' conceptual understandings of Mathematics much better. As a result, there is improvement on learners' marks and grades. Teachers B and F pointed out that ICT enable learners' conceptual improvement of Mathematics. Consequently, there is improvement on learners' marks. Teacher C specified that ICT help breaking some mathematical barriers that learners experienced. It helped learners improving marks. Teacher D indicated that ICT enable learners' critical thinking.

Tools: According to teachers' views regarding the use of ICT in the computer laboratory, it is interesting to note that teachers utilise ICT firstly as a tool capable of attracting learners' attention, motivation, and boosting their confidence, interest, engagement, collaboration, and understandings vis-à-vis Mathematics concepts; and secondly as a cognitive tool able to mediate higher order matter solving skills, the ability to think critically, hence enabling learners to improve marks.

The ability to engage and collaborate amongst learners demonstrates indeed an increased learner on learner interaction, which has an impact on alterations in division of labor, with learners playing teachers' role.

Rules: In the computer laboratory, firm rules are established and followed concerning the use of ICT.

Extract 5.12: Rules in the computer based lessons

Teacher A:	In my maths lesson. They do, uh, these rules, ne, they do facilitate because the rules, mos, are the ones that's guides them how to be behave in the, in the class, differently from the classroom, in, in the ICT, differently from the classroom, so they made their learning more effectively with the ICT.

Teacher C:	Yeah, we do have rules in the lab, whereby they must not eat, even in the class, they must not, not eat. They must not make noise in the lab, also in the classroom. Yes, it works those rules. Okay, those rules, actually, they work because, uh, [clears throat], you see, it's part of classroom management. So you

	manage your class. You cannot teach while others are there making noise and so on, others are not listening. So they work, it works. Yeah. They work.

Teacher E:	Yes there is. Ah in my class for example we've got the screen up front, no more computer screen, monitor. Projector's high up there so it's mounted. Um kids will take chances to throw things around in class but now not anymore because they know if that thing falls from there they will be liable.

Teacher A indicated that there are rules to guide learners how to behave, which make learning more effective with ICT. Teacher C stated that rules exist in the laboratory to monitor and manage the computer classroom. Teacher E specified that there are rules to set up limitations and to control learners' behaviours in the computer laboratory.

Extract 5.13: Division of labour in the computer based lessons

Teacher A	Their role is to maybe, let's say I can give a example, ne. Like with Edmodo there's a lot that I've learned there, ne. Although I've not applied it yet, ne, but with technology, like with the, with the CAMI maths, ne. So you, you enforce what you've learned in the class, then in the class, then in the lab mos they will do those exercises. They write, uh, pre-tests and, uh, mental maths, completing the task on time. Is to facilitate then you are not, it's more the, the technology is more centred. The learners are the ones that, they, they, they grasp the learning on their own than you telling them.

Teacher E	There is a, I do believe there's a shift yes. I think they become more responsible as well. If they had to have the tablet in their hands you know if somebody's too on top of them they're going to be like dude you know so they're going to be more, they're not going to throw their bags on the floor, their books are not going to lie on the floor like we see it but they are going to be more because they know it's expensive basically and... Kids have you know with this, if you put on a video you hear a lot of

	things going on the video you know, noises, sound effects, whatever you see, movement. Kids can laugh. I, we played them a video renewable, non-renewable um resources and things. There was a game show that kids hosted and they made little jokes in the video and the kids could freely laugh about it. But once the people got back to being serious the kids also quietened because they knew they had to listen again. So this computer it actually, it's actually a bit scary but it's also dictating how the, the lessons should be. They know exactly shh now you have to be quiet. When I put it on I start the video they know they have to be quiet. Nobody's going to watch a movie while somebody's talking. So you'll get this shh in the class the entire time while if I'm going on.

Teacher F	Yes, I think so because if you change it, if they, if you, if you go in an ideal world where every learner in the classroom have ICT in front of them, not just see the board, there's something on the board, I think in that way they're also more engaging and we learn from each other. So they for example ask a question and then you would say but I don't know and they'll be like oh I'll Google it.

Division of labour: Drawing from teachers views as demonstrated in Extract 5.5 it is interesting to note that teachers indicated that the use of ICT (such as computer and software, tablet, CAMI Maths, projector, video, internet, PowerPoint slides) affects the roles of teacher and learners, with the teacher playing a role of a facilitator and learners guiding their own stride and array (Hardman, 2005a). For instance, the technology such as internet fosters an alteration from teacher centred to a learner centred methodology – learners are always ready and prompt to google everything, anytime.

Extract 5.5 highlights that teachers A, E and F pointed out there is a shift in division of labour in their computer based lessons, with teacher F stating that learners becoming more responsible, for example, when a learner asks a question if the teacher does not know the answer, the learner is prompt to google it. Likewise, with teacher A indicating for example, her learners grasp learning without her telling them and share it amongst

them – learners become teachers of "slower" learners. Similarly, with teacher E pointing out that his learners are even the ones telling others to keep quiet instead of him to silence them. As per one's argument "…clearly if the [ICT] can be used to achieve this it will go some way towards meeting the needs of the new Curriculum" Hardman (2005a, p.263).

Community: According to teachers' views regarding the use of ICT in the computer laboratory, it is interesting to note that all the teachers stated that it is only a teacher and learners that form a community in their computer based lessons.

Below is the graphical illustration of the computer based classroom as per teachers' descriptions in figure 5.3. It is important to note that teachers are working on the object such as the improvement of learners' marks (grades), motivation, confidence, interest, engagement and collaboration as well as critical thinking. It is clear that ICT is not only used for drill and practice purposes but also for the development of higher reasoning purposes. A possible alteration in the division of labour is also obvious, with the roles of teacher and learners being affected – teacher becomes more like a facilitator and learners beginning to cautiously play the teacher's role. There is a potential variation from teacher centred to a learner centred approach.

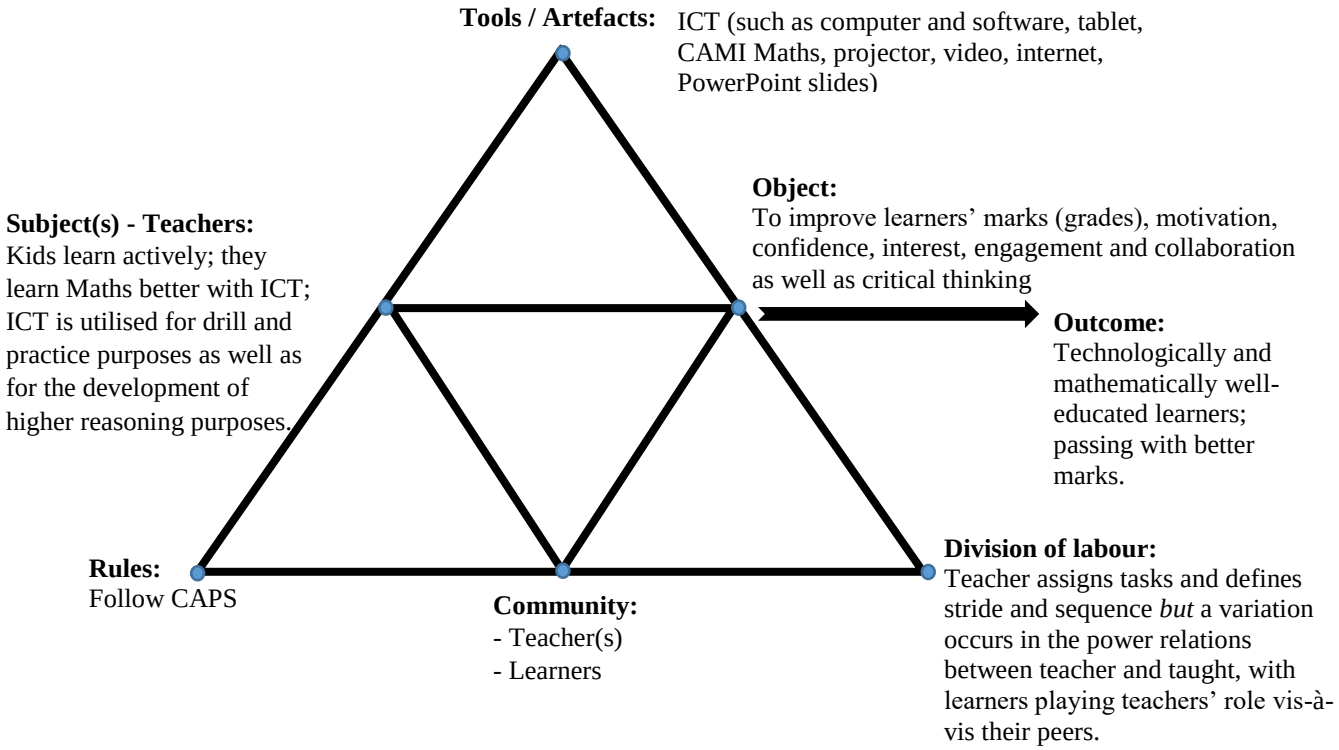


Figure 5.3: Teachers' illustration of the computer based classroom activity system

5.3. Results Discussion

In this research project, the researcher sets out to investigate grade 6 Mathematics teachers' perceptions on whether pedagogy potentially shifts using ICT, if so, to track what this looks like, whether this change impacts positively or negatively on learners' outcomes, utilizing CHAT framework to 1) conceptualize an illustration of AS across face-to-face and computer based classrooms, 2) to study the level to which these AS vary, by paying attention to a potential variation of the object lesson across the two systems, 3) to construct a methodological tool able to track pedagogical changes across the two situations, and 4) to elaborate on the impact of this shift vis-à-vis learners' outcomes.

5.3.1. Interview Results

During the face-to-face interviews with research participants, it is interesting to note that teachers admit the relevance of ICT in the activity of teaching Mathematics. ICT is a useful and valuable tool; capable of enhancing learners' motivation, confidence, interest, engagement and collaboration, critical thinking, as well as improving their marks, as

assert the research participants' statements (see Extract 5.5). Further, there is a potential variation in the division of labour from teacher centred to a learner centred approach, with the roles of teacher and learners being affected – teacher plays more like a facilitator's role and learners starting to thoughtfully play the role of a teacher (see figure 5.3). What this means is that in the computer based lessons, the power dynamic appears to shift with learners taking on a more active, teaching role than in the face to face lessons. Consequently, learners' outcomes appear to be positively impacted – there is an improvement in learners' marks (see Extract 5.4).

One very relevant aspect in any form of teaching and learning is the ability to manage learners (Gogwim, 2017). Therefore, the affordances of the mediating tool (ICT such as video projection) that allow the subject (teacher) to attract learners' attention, keeping them quiet to easily manage them is an important attribute that could support the use of ICT (video projection) for practical Mathematics AS. This was asserted by the teacher's statement: *"…They know exactly shh now you have to be quiet. When I put it on I start the video they know they have to be quiet. Nobody's going to watch a movie while somebody's talking. So you'll get this shh in the class the entire time while if I'm going on…"* in extract 5.5.

5.3.2. Activity System Contents Results

Twofold activity systems were constructed: one illustrating the face-to-face Mathematics classroom and the other illuminating the computer based classroom.

Drawing on Hardman's (2005a) paper, "activity theorists (Engestrom, 1987; Russell, 2002; Nardi, 1996) suggest that when one wants to track shifts in a system, one should focus on the extent to which the objects change, as systems change when their objects change" (p.264). Thus, during the analysis of research data, the emphasis was on the object of the lessons in order to notice that both systems, namely, traditional and computer based are in operation in this research project. Two distinct objects were noticed (see section 5.2). Paying attention to the objects as a tool for tracing pedagogical alterations enables one to construct an illustration of the whole system, and indeed, a graphical representation of the two different AS.

The assumption underlying the use of ICT (such as computer hardware and software) in Mathematics lessons is that the technology will be utilised as a cognitive tool to influence learners' outcomes. Therefore, the object of the computer based Mathematics classroom is assumed to be learners' mathematical concepts. As a result, learners' grades

should be improved. As per teachers' beliefs, technology appears to be utilised not only for drill and practice purposes but also for the development of higher cognitive purposes. We can say that the object alters to one of creativity and collaboration in a way that is not evident in the face to face lessons.

5.4. Contradictions arising from interviews

Drawing on the findings from the interviews with teachers, it is interesting to note that there are some contradictions. One acknowledges "contradictions as tensions, disturbances, and disagreements in […] an activity system…" (Eri, 2012, p.7). Moreover, I will argue that roots of particular but recurring difficulties and conflicts can also be theoretically hypothesized as contradictions of the AS. Likewise, one also claims that "contradictions are dynamic forces that provoke changes in a system…" (Hardman, 2008a, p.33). Any discomfort or ambiguity within an activity system can be related to a 'contradiction'.

However, this research project is not an intervention work but rather an investigation project. Therefore this study is not aiming to propose an intervention to a particular problem. The focus is on investigating variation in pedagogical practices with the use of ICT from the teachers' perceptions. In this view, one can see that in this study, teachers believe the introduction and use of ICTs into their lessons change their pedagogy.

This study is only on mapping differences and not necessarily looking for contradictions. This can be exemplified in different ways, for instance, teachers use more control over the rules of the AS and the community is not broader in a traditional face to face lesson than in the ICT based lesson. Further, in teachers' traditional face to face lessons, primary tensions are found in the object and outcome of teaching Mathematics, with tensions arising between covering the curriculum and evolving better understanding of mathematic concepts. This relates to time as a significant influencer of teaching. Teachers are facing a double-bind between developing learners' comprehension of mathematic concepts and covering the curriculum. In ICT based lessons, teachers are more flexible and have more time to evolve learners' mathematical understanding. No tensions in the ICT based lesson were evident. This does not mean that in practice no tensions do exist, but it does propose that research participants are not aware of any of these tensions. Besides, the object of the ICT based lesson is wider than in the traditional face to face based lessons, with motivation, creativity, and collaboration featuring as significant spaces that are worked on to nurture the outcome of mathematically well-educated learners. Also, there is a

variation between chalks and talk pedagogy vis-à-vis the use of tool, which research participants (subjects) claim to be "boring" for learners to a pedagogy that fosters more interactions with the use of ICTs. Moreover, when a new tool such as ICT entails a new division of labour in pedagogy (as elaborated in extract 5.5) – with division of labour being impacted as teachers' and learners' roles appear to be affected, with the teacher becoming a facilitator and learners directing their own pace, hence becoming teachers of "slower" learners.

The divergences or discrepancies related to participants' opinions and motives from different activity systems can also exemplify contradictions. The use of ICT into a classroom can possibly "lead to a contradiction between any elements of the system" as maintained by Hardman (2008a, p.34).

In section 5.2, it is interesting to note that the findings show that teachers act on different objects in computer based classroom than traditional classroom. Also, teachers believe that ICT appears to be used for both drill and practice purposes, and for the development of higher cognitive purposes. While this may seem contradictory, learning requires both process: repetition lays down memory tracts while mediation open ups space for the development of new forms of thinking.

It is interesting to record that ICT has an influence on pace, sequence and selection of content in teacher's lesson, as asserted by teacher A – this is evident in the participant's statements: *'It does influence because it makes learning more meaningful and insightful than rote learning, you understand? So there is a difference, it's not rote, it's more experience, like the experience...'* (Shown on Appendix B: Snapshots of Full extracts of Teachers' interviews transcription).

One can argue that "a focus on meaningful learning is consistent with the view of learning as knowledge construction in which learners seek to make sense of their experiences. In constructivist learning, learners engage in active cognitive processing, such as paying attention to relevant incoming information, mentally organizing incoming information into a coherent representation, and mentally integrating incoming information with existing knowledge… In contrast, a focus on rote learning is consistent with the view of learning as knowledge acquisition in which learners seek to add new information to their memories…" Mayer (2002, p.227).

Equally, I will debate that 'rote learning', as a learning method, emphasizes the memorisation of information based on repetition, whereas 'meaningful learning' entails comprehension – to understand the construction of an entire concept from all the pieces.

The findings also indicate that teachers believe that ICT appears to be used for both drill and practice purposes, and for the development of higher cognitive purposes (see section 5.2).

5.5. Conclusion

This chapter presents findings from the data in relation to the question of whether teachers' believe that pedagogy shifts with ICTs. The findings presented indicate that teachers do think that pedagogy shifts with ICTs in specific ways: namely, division of labour changes to be more fluid and learners can take on the role of teacher and the object of the lesson widens to accommodate for creativity, motivation, collaboration, confidence and higher order thinking.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1. Introduction

This chapter reviews the research questions and presents a conclusion of the research project based on the outcomes presented, illustrated, investigated and debated in the preceding chapter.

This chapter also suggests and unpacks assumptions for practice and application of ICT such as computer hardware and software in grade 6 Mathematics classrooms in underprivileged schools with similar background as the two schools used in this project.

While the project is a small-scale study, recommendations are suggested from the findings, although they may not pertain in full to other similar cases. Finally, this chapter presents some recommendations for further research.

6.2. Research Questions Review

The main purpose of this research project was to investigate teachers' perceptions of whether pedagogy potentially changes with ICTs (such as computer hardware and software), and whether teachers think this alteration impacts positively or negatively on students' outcomes in Mathematics. This research draws on a case study of grade 6 Mathematics teachers across two no-fee paying primary schools in the Western Cape Province to address the following key question:

1) What are the perceptions of teachers on whether there is a potential shift in pedagogy with ICT (e.g. computer hardware and software) in a grade 6 Mathematics classrooms and what does this look like?
2) And to what extent do teachers think that this change impacts positively or negatively on students' outcomes?

The use of CHAT as a conceptual framework enables me to investigate and analyse research participants' (teachers') perceptions on whether ICT (such as computer hardware and software) possibly shift pedagogical practices in Mathematics classrooms. An array of contextual features such as object, tools, the community, rules and division of labour (Engestrom, 2017; Engestrom, 2014) were thoroughly explored to elucidate and construct two broad activity systems: one representing the traditional Mathematics classroom and the other demonstrating the computer-based classroom.

The study was carried out to comprehend how these contextual features (e.g. object, tools, the community, rules and division of labour) illuminate and unpack the transcribed research data collected during face to face interviews with teachers. The aim was to understand whether pedagogy potentially alters using ICT in Mathematics lessons, and if so, whether this variation impacts positively or negatively on learners' outcomes.

Drawing on the research findings the following points can be considered:

1) Investigating the activity system utilising CHAT lens, it was found that the artefact ICT (such as computer and software, tablet, CAMI Maths, projector, video, internet, PowerPoint slides) is a socio-cultural tool that indeed, according to teachers, allows change of pedagogical practices in Mathematics lessons and has a positive impact on learners' outcomes, according to teachers. Teachers' and learners' roles appear to be affected, with the teacher becoming a facilitator and learners directing their own pace, hence becoming teachers of "slower" learners. The ability to collaborate and engage amongst students indicates an increase on learner-learner interaction, which has an impact on change in division of labour (see extract 5.5, p. 50).
2) The computer-based Mathematics activity system encourages and fosters student-centred methodology and self-pace hands-on Mathematics lessons; such commitment and engagement of mathematic subject could enable and boost learners' motivation, interest, and confidence as potential Mathematics literates and mediate their Mathematics skills, according to teachers, as examined in extract 5.2 (p.48). That is, the object of the ICT based lesson is broader than that of the traditional classroom.
3) According to teachers, practical Mathematics activities within a computer lab foster and reinforce comprehension and knowledge of mathematic contents and concepts learnt in a traditional classroom. It enables learners to improve competence in mathematic skills and therefore has a positive impact on learners' outcomes (see extract 5.2, p.48).
4) Utilising CHAT to analyse the research data, it was found that the learners' experience with ICT environment offers them a novel way of engaging with Mathematics contents and concepts (see extract 5.2).
5) The teachers' pedagogical position towards the use of technology for teaching and learning mathematic concepts changed after their experience with ICT (such as computer and software, tablet, CAMI Maths, projector, video, internet, PowerPoint slides). This implies that the pedagogical techniques for teaching and learning Mathematics concepts in a computer lab diverge from traditional classroom – this is

revealed in division of labour, where the teacher's role shifts to facilitator and the students take on a more active, teaching stance in relation to their peers (see extract 5.5, p.50).

6) The individual-driven aspect of the computer-based Mathematics classrooms constitutes an advantage for introverted or passive learners through collaboration with other fellow classmates who are more advanced and happened to play their teacher' role (see extract 5.5, p. 50).

In summary, findings indicate that teachers in no-fee paying schools perceive that their pedagogy changes for the better when they use ICTs. They also believe that students' outcomes improve in relation to Mathematics because the ICT based environment slows pacing and enables an increase in motivation, facilitating revision and reinforcement of classroom-based concepts.

6.3. Conclusion

In this research project, CHAT was used to investigate teachers' perceptions on whether there is a potential change of pedagogical practices with ICT in Mathematics lessons, and to trace whether learners' outcomes are positively or negatively impacted by this variation.

One can argue that the investigation of a potential variation of pedagogy across contexts appear to be challenging (Hardman, 2005a). However, there is "one possible way of tracking pedagogical shifts across the dynamic environments of a traditional and computer mediated Mathematics class, [which consists of tracking] shifts within the object(s) of the activity system" as suggested by Hardman (2005a, p.264).

This study adopted face to face interviews as a method of data collection. Face to face interviews, unlike other methods of data collection, "offers a greater degree of flexibility, prompts, probe responses and follow up on new ideas in a way that is just not possible with other methods" (Mathers et al., 2002, p.1).

Six Mathematics teachers across 2 primary schools were interviewed in the Western Cape Province – three in each school.

Two activity systems: one representing the traditional Mathematics classroom and the other demonstrating the computer-based classroom were constructed to explore

contextual features of the environment such as object, tools, the community, rules and division of labour (Engestrom, 2017; Engestrom, 2014).

The research findings indicate that teachers perceive that pedagogical practices alter with ICT in Mathematics lessons and this alteration has a positive impact on learners' outcomes, as per teachers' beliefs (see extract 5.2, p.48).).

The research findings also show that learners become more responsible, motivated, keen, and confident as Mathematics literate in the computer based mathematic lessons, as illustrated in extract 5.2 (p.48).

In division of labour, it appears interesting how teachers' and learners' roles are affected, with the teacher becoming a facilitator and learners leading their own step, henceforth becoming teachers of "slower" or more passive pupils, as indicated the research findings (see extract 5.5; p.50).

6.4. Recommendations

The following points should be considered:

- For further research, this study's focus was on teachers' perceptions on whether there is a possible variation of pedagogic practices with ICT in Mathematics lessons, and to trace whether teachers think that learners' outcomes are positively or negatively impacted by this variation. The research project was limited to teachers as the main subject, which is in line with the thesis question. Also, the study is an investigation and not an intervention project. I believe, for further research, some other aspects should be considered such as video-taping teaching and learning of mathematic contents and concepts in both traditional and computer-based classrooms. While teachers believe that ICTs can impact positively on Mathematics attainment, this study did not track actual Mathematics scores of students. This was beyond the scope of the study and further research in this area is suggested.
- It is recommended that learner-learner interactions, also known as horizontal interactions between learners should be encouraged and fostered but with involvement and significant guidelines of teachers acting on learners' acquisition of scientific concepts, sometimes referred to as schooled concepts, as the object of the lesson and to avoid, if not reduce the affordances of the computer usage itself to become the object of the lesson. Further research using classroom observations to focus on student-student interaction in relation to ICTs is recommended.

Limitations of the study

This study was located in two no-fee paying primary schools in the Western Cape province of South Africa. The results discussed should be viewed in relation to this context. The study is a small-scale case study and generalising to a larger population is not recommended. I do note however, that further research could help illuminate teachers' ICT beliefs and perceptions in relation to ICT in similar contexts.

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APPENDICES

APPENDIX A: Teacher interview schedule

AT concepts	Questions
Subject	1. Gender 2. Years of experience 3. Teaching subjects 4. Professional development/qualifications? 5. Comfort/Competency level in using IT? How much training? 6. How would you say children learn? (probe for theory of learning) 7. What, in your opinion, is the best way to teach mathematics? Can you give an example? 8. What factors do you think effect children's learning of maths? 9. In what ways do you think the computer helps children to learn Gr. 6 maths?
Tools	10. What ICTs have you used in teaching? 11. How do you use ICTs? 12. What resources did you use before you had the computer?
Object	13. Why do you use ICTs? 14. What would you say you are working on when you teach with ICTs? 15. Do you think ICTS have changed the way you teach? How?
Outcomes	16. Do you think children learn better in a classroom without technology or with technology? If yes, how? 17. Do you think that using ICTs will help students in • improving grades • motivation • Collaboration
Division of labour	18. Do teachers share ideas, lesson plans, self-created materials? 19. What type of support do teacher get from Principal, HOD? 20. Role of students in computer-based lessons? 21. Role of teacher in computer-based lesson? 22. Do roles differ in computer-based lessons to roles in face-to-face lessons?
Rules	23. Are there specific rules that apply in the computer laboratory that don't apply in the face-to-face lesson? 24. How do these rules facilitate/inhibit the integration of IT in your lessons? 25. Does the use of technology impact on pace, sequence and selection of content in the lesson? How?
Community	26. Are parents involved in working with the technology in the school? 27. Is the community involved in working with the technology?
Math success	28. Do you think technology improves children's outcomes in mathematics? How?

APPENDIX B: Snapshots of Full extracts of Teachers' interviews transcription

Teacher A Interview:

Voice 003

Mrs Dulaze 52

Speaker Key:

IV Interviewer

IE Interviewee

00:00:01

IV Okay. Tell me about your gender.

IE I'm a female.

IV Okay. Years of experience?

IE 24.

IV Uh, what subject are you teaching?

IE Teaching mathematics.

IV Any professional development or qualification? Any qualification?

IE Yes, I've got honours in education then honours in public admin. Then I've done, um, mathematics courses, short courses with UCT and with Department of Education.

IV And how, how competent are you in using technology?

IE I'm good.

00:00:41

IV Okay. How much training have you…?

IE I've done, we've done the training with ICT here at school, Edmodo, and also I did Edmodo, yes indeed, yes we did, so just, okay.

IV How do you say children learn in general?

IE They learn more, they learn more when they see things than when you tell them, and when they are busy, then they learn more.

IV What in your opinion is the best way to teach mathematics? The best way.

IE The best way.

IV To teach mathematics.

IE The best way is to give them the experience. The experience, they must experience mathematics. It must be hands on. And they must see, because

when we using the videos, they enjoy, they watching TV, you know that, but at the same time they're learning something.

IV Uh, what factors do you think effect children's learning of maths?

00:01:40

IE Um, others is the, uh, the background, like from the previous grades. Maybe they have misunderstood some other concepts, so others they don't, they can't, they can't, like, [unclear], but most of the time I manage to change, uh, a bit when you engage them.

IV In what ways do you think the computer or technology helps children to learn maths?

IE It helps them because these children they are not like us. They are more on, on the ICT, more like phones and all that, so they enjoy. They explore a lot and at the same time they are learning. Unlike us, we're not more on this ICT things.

IV What ICT have you used in teaching?

IE Teaching, like in the computer lab, ne? CAMI maths, we use CAMI maths most of the time, and I've trained, I've been trained now to use Edmodo. Yes, so I know how to, but we're still experiencing a problem in the computer lab to apply that knowledge.

IV How do you use ICT? How do you use it?

IE Me? For personally? I plan, for planning, communication with my supervisor, and other personal things, and to write assignments when you are at school, so there's, there's, there's a lot use, so.

00:03:08

IV What resources did you use before you had, uh, technology or ICT?

IE Before the technology, we using the concrete things that we have, the pictures, you know, you bring the stuff. Like in maths, in measurement, you bring the scales and all that, so you have to bring that.

IV And why do you use ICT?

IE I've seen ICT as the one that even those small, like slow learners, they understood better when they are in the computer lab than in the classroom. I don't know whether they are being excited of a TV or to watch things, but they become the expertise there [laughs], yeah.

IV What will you say you are working on when you teach with ICT?

IE Developing skills. You develop skills, creativity. They become creative, mos. Whether, did I understand your question? What, what, can you repeat your question?

IV Okay. So what will you say you are working on when you teach with ICT?

IE I, I think I'm working on the semi concretes, so semi concrete because now they see the pictures and they see people doing things, explaining things, concrete, so, and they enjoy that.

IV Do you think ICT have changed the way you teach?

00:04:32

IE A lot.

IV How?

IE How? Because in the, because in my teaching when I, before, I never have any experience of the ICT, but with now, with the learners, so the ICT has changed, is changing in my teaching a lot because the planning, you do the planning, and then you're planning, when you're done with your planning then the learners get involved on their own. You are not, like, you just facilitate learning that.

IV So do you think children learn better in a classroom with technology or without technology?

IE Better with technology.

IV How?

IE Better. Because, like, when you, when you, like, sometimes, ne, with the other things, other concepts, you don't have concrete of that. But with the ICT, so you, you download different, the, uh, videos on different, uh, images or tutorials, then you make them understand more better.

IV Do you think that using ICT will help students improving marks, grade?

00:05:48

IE A lot, a lot. Especially with those technology children. These children are more on technology, so if you, you teach like, if you're doing a teacher talk, you make them not so interested in you, but when you involve them using the ICT, they enjoy engaging with the computer, but at the same time they're getting the concepts.

IV Do you think it will motivate them?

IE A lot.

IV Do you think it will enable collaboration?

IE Exact, mm.

IV Do you teachers share ideas, lesson plans, self-created materials among you?

IE Yes, we do. We do a lot.

IV Okay.

IE Like we've got a subject meeting as well where we create a platform, where we share things together.

IV What type of support do you teacher get from your principal or the HOD?

IE Oh, there's a lot [laughs]. Planning, when you do the planning, and maybe you start with a certain, uh, topic. Then you're not sure how to, to, to present that topic, then you share together.

00:06:56

The principal is a good, uh, in motivating us to be competent in any, collect things like with the, with the systemic, they give us the material to practice, you know, just to motivate us. When we have classes during the weekends, and he's always with us, the principal.

IV What is the role of student in computer based lessons, when you're teaching with technology, what is their role, the role of the student?

IE Their role is to maybe, let's say I can give a example, ne. Like with Edmodo there's a lot that I've learned there, ne. Although I've not applied it yet, ne, but with technology, like with the, with the CAMI maths, ne. So you, you enforce, what you've learned in the class, then in the class, then in the lab mos they will do those exercises. They write, uh, pre-tests and, uh, mental maths, completing the task on time.

IV And what is the role of the teacher in a computer based lesson?

IE Is to facilitate then you are not, it's more the, the technology is more centred. The learners are the ones that, they, they, they grasp the learning on their own than you telling them.

00:08:25

IV So do roles differ in computer based lessons to roles in face to face lessons?

IE Yes, they do differ, cos as I've said, the other one is more learner centred than the other one is teachers and you do the talking too much, but in the ICT no talking, just communicate, and they, they collaborate within themselves.

IV Are there specific rules that apply in the computer lab that don't apply in the face to face lessons? Any specific rules that is applied there in the computer lab that is not applied in the face to face?

IE In the face to face, as I've said, you do the, the talking most of the time, but with the computer, they are the ones that, they discover things on their own, then you, you first just facilitate learning, not engaging them, like, like as you are doing there talking, yeah.

IV So how do these rules facilitate the integration of, uh, ICT in your lessons? The rules, how do they, uh, facilitate integration of ICT in the lessons?

IE They facilitate the integration because, like, I'm not sure of this question now. I'm not sure I'll be asking, I'll be answering correctly. Can you just rephrase your question?

IV Okay. So we're taking about the rules the computer lab, so we are looking at those rules. How do they facilitate the integration of ICT?

IE Okay.

IV In your lesson.

00:10:07

IE In my maths lesson. They do, uh, these rules, ne, they do facilitate because the rules, mos, are the ones that's guides them how to be behave in the, in the class, differently from the classroom, in, in the ICT, differently from the classroom, so they made their learning more effectively with the ICT.

IV Does the use of technology impact on pace, sequence and selection of content in your lesson? When you select your lesson, does the use of ICT impact or influence your selection of lesson?

IE It, yeah, it, it, I think it does. I'm not sure, I'm not sure. Can you rephrase again?

IV Okay. Does the use of technology impact or influence on…?

IE It does influence because it makes learning more meaningful and insightful than road learning, you understand? So there is a difference, it's not road, it's more experience, like the experience.

IV Are parents involved in working with technology in school?

IE Uh uh, no.

IV Is the community involved in working with the technology?

IE Here at school? Uh uh, it's only us and the children.

IV Do you think technology improves children's outcome in mathematics?

IE Exactly, it does, it does.

IV How?

00:11:34

IE It does because sometimes maybe one learner will try and explore. I remember one learner tried to, to say to me, the parent wanted CAMI maths so that he can, can the parent be able to, to open up CAMI maths at, at home, so that he can just get practice for the time because they learn… The parent find that the learner understand more with the computers than with the teacher doing the talking, and also… What I was going to say? I forgot now, again. Anyway, go on.

IV Okay, thank you.

Teacher B Interview:

Voice 002

Mr Dube 43 yrs

Speaker Key:

IV Interviewer

IE Interviewee

IV Can I ask your gender?

IE Um, I'm a male.

IV Years of experience?

IE Um, 19 years experience teaching maths.

IV Uh, any professional development qualification?

IE Uh, the senior teachers' diploma plus Ace [?] specialising in science and technology.

IV How competent are you in using technology?

IE Technology?

IV Yes.

IE I'm comfortable technology was… we are trained by the Department of Education.

IV How much training did you get?

00:00:46

IE No, it was a basic of computer and how to search for information.

IV How will you say children learn?

IE How will you say that children learn? No… in our school?

IV In general.

IE In general, no, I found that the learners of today, they are lazy. They are lazy.

IV What, in your opinion, is the best way to teach mathematics? Can you give an example? The best way to teach mathematics.

IE I think it must be learner-centred. They must do things on their own. The teacher is only supposed to guide them. They must also learn from each other. They

came from something like [unclear]. Yeah, they also need motivation from parents, teachers.

IV And what factors do you think affects children's learning of maths?

00:01:49

IE Maths?

IV Yeah.

IE I think it's a, it's a foundation… uh, if they have a foundation and motivation, I think they…

IV In what ways do you think the technological helps children to learn maths?

IE I think they can learn maths better if they are using technology because every learner nowadays had a phone. They are using a phone… if they can use technology to study maths. Okay, they can use their phones to study maths. They can, they can also study maths at home where there's no teacher if they have some websites.

IV And what technology have you used in teaching? What ICT have you used, yeah, technology?

IE No, we, we're only using [unclear] maths in our school. We're using [unclear] maths wherever proper.

IV How do you use that technology?

IE How? I don't understand.

00:02:52

IV How do you utilise that?

IE You know, we have a problem of backlog this year because we have periods of maths in the computer lab where you can use the, a computer to support that topic you have done in class.

IV And what resources do you use before you had the technology?

IE It's only a text… that's what we are using, textbook [?].

IV Okay. And why do you use technology now?

IE We want to improve maths…

IV Okay.

IE … So that the learners can be motivated because they like computer, they like technology.

IV What will you say you are working on when you teach with technology? What will you say you are working on when you are teaching with, uh, technology?

IE I'm trying to motivate learners, improve...

00:03:48

IV Do, do you think ICT have changed the way you teach, technology, have, have changed the way you teach and how? Do you think technology, uh,...

IE Yeah, I think they, they change because they thought that they are playing in, in the computer whereas they are, they are learning. Yeah.

IV Uh, do you think, uh, children learn better in a classroom with technology or without technology?

IE Eh, because we don't use technology in our class, we use only technology in computer lab.

IV Labs.

IE Yeah.

IV So do you think they learn better?

IE They learn better in, in...

IV In the computer lab?

IE In the computer lab.

IV Using technology?

IE Technology, yes, yes.

IV Okay. So do you think that using technology will help students in improving marks, grade?

00:04:37

IE Yes, it will help them.

IV And it will motivate them?

IE Motivate them, yeah.

IV And will also enable collaboration?

IE Yes, yes.

IV So do you teachers share ideas, lesson plan, self-created materials among you?

IE Yes. We have, uh, planning days for... so we share problems.

IV How do you share?

IE We share the problems we encounter during our lesson.

IV Do you use technology to share your lesson?

IE No, no. We just... we don't use technology.

00:05:09

IV Okay. What type of support do you teachers get from your principal and the head of, uh, department? What kind of support do you get from your...

IE [Unclear] will identify a problem then they'll refer you so that you can do a course to uplift their standards of teaching.

IV And what is the role of a student in a computer lab while you are teaching mathematics?

IE The role of...

IV Of them.

IE They must do their exercises.

IV Okay. And then your role as a teacher?

IE Is to see whether they understand the, the programme.

IV Do rules differ in computer lab? Do rules in face-to-face lessons?

IE Face to face?

IV So when you are in the computer lab teaching mathematics and when you are in the... in your classroom face to face?

IE Yeah.

IV Do rules differ?

00:06:10

IE Yes, I think they are different, the rules are different.

IV Ah, these specific rules that apply in the computer lab that don't apply in the face-to-face lesson?

IE Mm...

IV The rules that apply in the computer lab do not apply in the face-to-face...

IE Face to face...

IV ... Lesson.

IE No. The rules, I don't understand the question but in a computer lab, ah...

IV So you have some rules in the computer lab.

IE Yes, yes.

IV Okay?

IE Yeah.

00:06:41

IV Okay. Are they different from the rules in the face to face?

IE No, no. They are not different.

IV And how do these rules facilitate the integration of technology in your lesson plan, in your lessons?

IE Ah...

IV The rules that you have in the computer lab, how do they facilitate the integration of technology in your lesson?

IE Mm, let's see. I don't understand clearly. This question is not clear to me. Would you mind to give me an example maybe?

IV So, uh, you, you... we just spoke about the rules...

IE Okay.

IV ... That you have in the computer lab.

IE In the computer lab, yes.

IV So, are they facilitating and how do they facilitate the integration of your, uh...

IE Of my lesson?

IV ... Technology in your lessons?

00:07:43

IE In the lesson.

IV Those rules that you have there. For example, you mustn't, uh, do this in the computer lab.

IE Oh, okay.

IV How do they facilitate the integration of, uh, um, your lesson?

IE Uh, I think the rules are good because, uh, [laughs] yes, because they guide the learners how to do their, their, their studies.

IV Does the use of technology impact on paces, sequence and selection of content in the lesson? When you select lessons, does the use of, uh, technology impact or influence...

IE Yeah, influence, yes.

IV ... And how?

00:08:35

IE Uh, on my side, I have a problem with, uh, with the pace because it took my time. If I have... maybe I have, uh, maybe five periods per week, then one I use in, in integrating the content [?]. It slowed me down.

IV Are parents involved in working with the technology in the school?

IE No, no, no.

IV Is the community involved in working with the technology?

IE No, no, no.

IV Do you think technology improves children's outcome in mathematics?

IE Yes, it improves it.

IV How?

IE Uh, because they understand better when they are taught using a computer, because they thought that they are playing but at the same time, they are learning.

IV Okay, thank you.

00:09:27

Teacher C Interview:

Voice 001
Mr Cele 27

Speaker Key:

IV Interviewer

IE Interviewee

IV Good. All right. Uh your gender is, uh...

IE Male.

IV Okay, and years of experience?

IE Four years.

IV Okay. And what subjects are you...?

IE Maths and science.

IV And any qualification, professional development?

00:00:19

IE Yes, PGCE.

IV Okay. And, uh, how competent are you using in IT, and how much training have you been sort of...?

IE Actually, I did, um, IT at the university.

IV Okay.

IE And I'm applying it. I really apply it.

IV Okay. How would you say children learn? So in general, how would you say?

IE When, when I'm using technology?

IV Uh, yeah, when you're using technology?

IE Okay. They learn a lot because they like it. You know, sometimes they are lazy to write, uh, even to read books, you see? So technology is quite, uh, interesting for them.

IV And what, in your opinion, is the best way to teach mathematics? Can you give an example?

IE Yeah, I would say that when I teach mathematics, I should involve, uh, technology to engage my learners. Like, for example, there in the computer lab, we have got, uh, soft one that is called [unclear].

You see, the, uh, [clears throat], they actually come and log in. Then that program, they say that two plus two, for example, two plus two, if the learner pressed eight, that programme would correct him or her. You see?

00:02:00

Uh, so they really enjoy it and they see their mistake.

IV And what factors do you think effect children's learning of Math?

IE Um, okay.

IV So, let's...

IE Generally?

IV Hmm.

IE Okay. You see, sometimes, uh... Okay, most of the times, learners, they are as just experiencing difficulties in Maths. Uh, some are having the barriers, some are barriers, some are having barriers in Math, so we are trying to help them also.

You see, sometimes, some of them; they are having what is called, uh, dyscalculia. They are unable to work with numbers. So those learners, it's quite difficult for them to, to help them, but by all means to try and help them.

IV And in what ways do you think the computer helps children to learn Maths, or technology? Let's just put it that way.

IE Hmm.

00:03:24

IV In what ways do you think technology, uh, helps children to learn math?

IE Hmm. Yeah, I would say that, uh, to go to the computer lab and search some videos and Google, uh, they will learn a lot, and watch those lessons that, uh, have been done by other teachers or lecturers, and they will see the examples. Yeah.

IV And what, uh, technology have you used in teaching?

IE Yeah, as I've told you have tried, uh, I've tried Kimmy Mats, and it helped me a lot.

IV And how do you use it?

IE Yeah, I took them to the science lab. Oops, sorry, to the lab, and then they log in there. You see? After they have logged in, they work with that program.

IV And what resources did you use before you had that technology?

IE For that technology?

00:04:33

IV Yeah, before that. What resources?

IE Resource. Uh, I've used a board, chalkboard before.

IV And why do you use ICT? Why do you use technology?

IE Yeah, because learners, they like technology. They are very lazy to work with books, to read books, so they like technology.

IV And what would you say you are working on when you teach with, uh, technology.

IE Say again?

IV What would you say you are working on when you teach with, uh, ICT?

IE Hmm. Okay, what will I say I work on when I teach with ICT. Yeah, I would say that... Hey.

IV What do you work with when you teach with ICT?

IE Hmm. What do I work with? Okay. I use that software [unclear].

00:05:50

IV Okay. So do you think ICT have changed the way you teach, and how?

IE Yes, of course. Of course, ICT has improved a lot for me. Uh, [clears throat]. For example, some learners, they don't like maths, actually. But when they go to the computers, they say, Oh, maths is like this one, and they, when they watch those videos, they say, Okay, okay, it's nice.

IV So do you think children learn better in a classroom without technology or with technology? If yes, how? So they learn better with technology or with...?

IE They learn better. They learn better with technology because they do what they like. Or they use what they like.

IV Okay. Do you think that using technology will help student in improving grade?

IE Do I think that the use of ICT is...?

IV In improving marks?

IE Oh, improving marks? Yes.

IV Or it will motivates them?

IE Yeah, it will motivate them.

IV And will actually enabled collabs, collaboration. Do you share ideas, lesson plans, self-created materials among you as, uh, teachers?

00:07:12

IE As teachers, yes.

IV How do you do that?

IE Share that. [Clears throat].

IV Which technology do you use to share...?

IE To share the technology, to share lessons, no?

IV Yes.

IE Okay. In fact, we email each other.

IV Okay.

IE Yeah.

IV And what type of support do you get from your principal or head of department?

00:07:40

IE We get a lot of support from our [clears throat] SODs and principal. They actually support us by giving us the materials also as well as the department. And then when we have a problem, we go to them and we tell them we have a problem here. They help us. Anything that we need, they give us.

IV And what is the role of students in computer based lessons, their role.

IE The role of students in computer-based lessons? The role of students, no, in a computer? They just watch the videos.

IV And your role as a teacher?

IE I explain to them also.

IV So, do roles differ in computer-based, uh lesson to roles in face to face lessons? So we are looking at the traditional way of teaching math and compared to the...

IE The previous ones.

IV Yes, the use of technology.

IE Yeah.

IV If roles...

IE Yeah, it's differ, yes, it's differ.

IV Okay, how?

IE It's differ. Because, you know, sometimes they are more involved when they are using technology, okay?

00:09:13

IV Uh, are there specific rules that apply in the computer lab that don't apply in the first lessons?

IE The rules like...

IV If there is any rules.

IE Rules like?

IV In the lab.

IE In the lab?

IV Yes.

IE Okay.

IV If you have rules there.

IE Yeah, we do have rules in the lab, whereby they must not eat, even in the class, they must not, not eat. They must not make noise in the lab, also in the classroom.

IV And how do these rules facilitate the integration of, uh, technology in your lesson?

00:09:53

IE Yes, it works those rules. Okay, those rules, actually, they work because, uh, [clears throat], you see, it's part of classroom management. So you manage your class. You cannot teach while others are there making noise and so on, others are not listening. So they work, it works. Yeah. They work.

IV Does the use of technology impact on pace, sequence and selection of content in the lesson, and how? While you are selecting lessons, does it impact?

IE Hmm. Does the use of technology impact?

IV And how?

IE Sequence and selection...

IV Because you know that you'll be using technology, how does it impact? How does it influence...

IE Influence...

IV The selection of content?

IE Okay, [clears throat]. Yeah, um, actually, technology improved a lot. Yeah, improved a lot.

IV Are parents involved in working with the technology in the school?

00:10:57

IE Yes, they involved.

IV They're involved?

IE Yeah.

IV Is the community involved in working with the technology?

IE Yes also.

IV Do you think technology improves children outcomes in mathematics?

IE Yes, I think so.

IV How?

IE Yeah, you see, um, [clears throat], I've compared my teaching when, without technology and teaching with technology. Then without technology, I got the, the lower results than when I used technology.

IV Okay. Thank you.

00:11:36

Teacher D Interview:

180801_002

Westlfeur mrs fortuin 57 years old

Speaker Key:

IV Interviewer

IE Interviewee

UF Unidentified Female

UM Unidentified Male

IV So you, there we, no just talk into it. Don't worry. Um, so the first thing, you're obviously female, how many years of experience have you got teaching?

IE 38 this year.

IV Jola.

IE Next year, yes this year, this year, this year yes 38.

IV And what subjects do you teach?

IE I, at the moment I teach maths and science.

IV Okay. Your qualifications, professional development and qualifications?

IE I've got the PD um, the NPDE from the UWC and um, ah that is now for all subjects. Ah not all but most of the subjects. And then I've got the Sunset ah one that, that was also through Stellenbosch that we, that we did now about two years back, we did it for a year course. And yes, that is, that is about it.

00:01:03

IV And how comfortable are you using ICTs?

IE Not very. Not, not, not very.

IV How much training have you had?

IE Um...

IV Like any formal training?

IE I've, I've four...

IV For using ICTs.

IE Oh um we did the what you call that?

UF The Khanye

IV The Khanye.

IE Yes, yes we had Khanye at our school that we went in that was fine for us when the children would sit by the computer. And myself training was just the basics on the computer.

00:01:39

IV Mm. And how would you say children learn? Your theory of learning on how children learn. Your own personal, 38 years of experience you have got a wealth of knowledge.

IE [Laughs]. Shew I mean when, when I was at school at those years and when I started teaching we did a lot of, of, of repetition. Um we also um did a lot of reading whereas um now the children is not very into reading. We also did a lot of listening because we didn't have this.

So we listened to the radio and we could make a picture in our mind. At the moment like the critical thinking that he was talking about it's very difficult for the child now because they watch and they see pictures all the time but they're not, they're not really thinking what's going to happen next.

Um we, I'm also um English home language teacher and when I ask them if you look at this picture what do you think is going to happen, what do you think is happening in the book, then they can't tell me. You know they, they, they, they haven't got that, like I was talking just now about analysing something.

They can't do that in maths also. So um because they don't read. I was, I just came from my maths class now and um the question was um what is the shape of the, of the cake if you see it from above. And they wrote there a circle. Now not the circle they wrote front.

So now, because we're doing view, viewing at the moment. Now I'm telling her why have you got that answer, um didn't you read the question? So I closed up her answer and I told her now read the question. So she read the question and she saw shape and then she could write down the circle you know?

00:03:38

That is what I was telling my, the, the, our other department also that reading is a very big problem in, in, in, in writing tests like ah, um on paper. So it is really a very big problem because the children, they don't read what they must know. I've been doing, solving problems now last week, the whole of last week and every time I must remind them, read the question. What do they want to know? Read it you know? And that is our, our biggest problem that we have, they don't read.

IV Okay, in your opinion as a maths teacher, what is the best most effective way to teach mathematics?

IE Starting from the concrete to the, to the...

UF Abstract.

IE To the abstract yes.

IV Okay, thank you. And what factors do you think impact on learning in mathematics negatively?

00:04:41

IE Um the fact that…

IV I mean you mentioned the, the reading, yes.

IE Um this is a, is a, is a, is a, is a big factor. They go home, they sit on their phones, they watch TV um and, and they play games on their computers.

IV So, so ITCs impacting negatively.

IE The children doesn't even go, nowadays children doesn't even go play outside. Um I um also I just want to mention this quickly, I'm also a um, um an official on the track and field in, in athletics and the children cannot see straight lines on the, on the field which is a problem because and like he said children have to explore a lot when they, when they are smaller and, and, and sometimes parents don't, don't see that.

Um I don't want my, right enough it isn't a good thing also your child to play outside but let them play outside and watch them you know because they don't get a lot of exposure outside to go and, go and play and climb and, and, and even in the park for that matter, parks are empty here in Atlantis because of the, of the negative things that's happening around.

IV And um in what ways do you think that ITCs can help children to learn mathematics in grade six?

00:06:02

IE Um like he said children is, is um, they learn so very quick on, on, on these things. He said they don't know how to work here which I know now but um on the phone they know much better than what I know because I am ah phone me, sms me and that's it.

I don't, I haven't got Youtube. Ask him, I don't have Youtube or all, all that. I don't have it. But you can ask them anytime. I must come to him and ask him or, or to somebody that knows I will go to for now him, he was, he only started now but I go to him and I go to Dylan that is in grade five that also teaches maths in grade five then I will ask them come help me here you know? But the children in grade six for now they, they know what is, what is, what is happening over there. So it can be a good thing but like I said the problem will still come in by the, by the, by the reading.

IV And tell me um what ITCs have you used in teaching?

IE Used?

IV You personally, yes.

IE At the moment the only thing that I knew of at that time was the, was what, when we did Khanye when we had it on, when we had a computer class then we

brought our children into the computer class and we did the Khanye thing. But, otherwise not, not much.

00:07:41

IV Okay.

UF What was the programmes that we used again?

IV Canny Maths.

UF That's it, Canny Maths.

IE Canny Maths yes, Canny Maths.

IV Yes, great [unclear].

UF Yes.

IV Um how do you use ICTs or you don't really use them in the class?

IE I don't use it.

UF Can I say something?

IV Yes.

UF In our ah safe room, in the safes there we got from MTN there's 20 tablets lying there dormant not, now I'm so glad he came when these came because they're going to make use of it now. There's 20 tablets in there wasn't used at all. We were trained halfway, didn't train the whole…

IE Yes.

UF We didn't go through the training.

IE We, we, weren't trained properly.

UF But now I'm so glad…

IE So we don't know, I don't even know how to switch that thing on. I'm just saying.

00:08:30

UF There's 20 tablets lying there.

IE They did it, they did it for us or the Smartboard like you were asking him about the Smartboard. It is there in our computer room but we can't, we don't know how to use the things. So because we don't get training in the thing.

IV Okay so if, if I would ask you why do you use ICTs who would say I don't?

IE I don't yes.

IV Okay. Um okay, do you think children learn better in a classroom with technology or without technology?

IE That's a very difficult question to ask me.

IV But ask, no, give me your own opinion.

IE Yes, no I'm, no I'm, no I'm talking about myself now. But it's a difficult question to ask me because I am not um, um…

00:09:20

UM Using technology.

IE Um yes and I'm not very good in it.

IV That's the answer.

IE Yes.

IV That's the answer.

IE I'm not very good at it.

IV Do teachers share ideas, lesson plans, etc?

IE Yes, yes we do.

IV Okay. Um what kind of support do you get from your principal, HOD?

IE Ah we are, our principal usually, we get things from the ah where, from wherever, he gives it to Miss Pretorius and then Miss Pretorius will then distribute it. Like we're going now on a, on a…

UF And I just sign them up.

IE [Laughs]. Um we are going on a, on a is the word [overtalking] yes for, with Mr Roode so yes. I was taken out for now because I'm old. They're going in my place.

IV And if you, if you can think about when you had Khanye in the school and the students were using the computers was their role different, was it different for them in the computer lab to the face to face lab, the face to face classroom? So the face to face classroom it's like put your finger on your lip, put your hand up. Is it, is it different, was it different in the computer lab did you find?

00:10:36

IE Yes and, and no I would, for me. They, you are, they are put onto the computer yes but you still need their attention to tell them how to use it and what to do and, and, and all that. So I would say yes and no for me.

IV So did, did you think your role was any different or did you still feel very much like a transmission traditional teacher in the computer lab?

IE Not, not really. Ah it wasn't a traditional thing because they could then engage on their own um and do their own thing there. But um you still had to tell them listen you must go here now or you must go there and, and whatever.

IV Okay, um, are parents involved in, with working with the school and is the community involved in working with ICTs in school? In other words, do you have

a lab where the, the teachers, the, the community can come in and engage?

IE No.

00:11:35

IV No, not presently.

UF Our lab is currently used as a classroom. This school has 1 750 learners. We don't have enough space. And everybody wants to enrol their children here.

IV I can see that.

UF And, and it's a, it's a business. We've got a big fight on our hands and then they go to the department and say they want their children here and Mr [name] can't do anything anymore. We must, we try to, to, to you know we've got six classes of every grade, six classes and the six classes has 48 or 50 children in there. And they don't want to understand we can't take any more children.

IV And so the final question I'm asking you and you can or cannot answer this because you don't really use technology but do you think that technology could potentially improve children's outcomes in mathematics?

IE I think so yes.

IV How?

IE Because um…

IV How do you think so?

IE Um there's a, there's a lot of things besides the textbooks and, and that they must, that they must go through but there's a lot of visual things that they can see on the computer because questions are usually with pictures that moves and, and they like that.

00:12:54

UM Mm, yes.

IE So I think that, that, it can help them a lot when they go to Youtube and you, you find um teachers facilitating ah certain classes where they can also see oh that is how I can do it better and, and, and how to, to do something better and so on. So I think it can, yes.

IV Fantastic. Thank you so…

00:13:17

Teacher E Interview:

180801_003

Westleur 3 Mr Lewis 32 yrs

Speaker Key:

IV Interviewer

IE Interviewee

UM Unidentified Male

IV Obviously your gender is male.

IE Yes that's correct.

IV And um years of teaching experience?

IE Um I've got about eight years experience.

IV Okay. Teaching subjects currently?

IE I'm currently teaching mathematics, English, Afrikaans and technology.

IV Professional development and qualifications?

IE I've got a B Ed degree. Um yes and that's four years.

IV And how comfortable are you with using ICTs?

IE I am extremely comfortable.

IV Okay. Um how much training have you had?

IE Ah professional training zero. Um I think it's just my level of interest in ICT so…

00:00:44

IV Okay, you also teach technology?

IE Yes I teach technology but it's the first year that I teach technology, um.

IV Okay. And you look very young to me. What are you, 25?

IE Oh thank you so much [laughs]. I'm 31 years old.

IV Okay 31, okay so you're, you're in the technological age?

IE Yes, yes, yes, yes.

IV Um, how would you say children learn best? What's your theory of how, how they learn?

IE I think children learn best by interaction. If you just chalk and talk like you've heard before they get bored. You know they just see you, this green board

behind, behind you and that's all they see. There's nothing, there's no music, there's no sound effects and they are used to like Mrs Fortuin said watching TV they've got all these things going on. You come here reading out of a book. It's too boring for them.

00:01:38

So I think when you interact with them, when they can be hands-on you know like ah you said that's the best way I believe a child learns.

IV And what's the best way to teach mathematics?

IE Um in my opinion repetition um but first of all I think what our kids lack currently is logic. They don't have logical thinking, the ability to think logically. They don't know the difference between50 kilometres and 50 metres. Um a platform is 50 kilometres high where I mean you could ask anybody that and we don't have to have any mathematic skill to be able to figure that out in kilometres and metres, we just know.

Um the kids don't want to think, they don't want to read anymore. So I believe with repetition and getting them interested in the topic at hand, you know making it practical to them. Why should I be learning mathematic? Why, you're still here, all of the time you're here people say why do they throw me and bombard me with X and Pythagoras you know?

We don't use it today. I've got an answer for that. It unlocks your technical thinking skill. You're not going to use X if you're going to work at a normal… But I mean going from the unknown to the known, using that mathematical skills taught me to think technically.

I always tell the kids see the car coming on there, you listen to the sound of the car. Is he coming on fast, is he coming on slow? You learn that through mathematics. You think it had nothing to do with X and Y but it had everything to do with X and Y.

00:03:22

Figuring it out. What could X be? What could Y be? How far is that car coming on? By listening, by looking at it. It's mathematics. So to get that kid to break the, the topic down to why do I need this, if they understand that they need to know that I get better engagement from them. They're not interested in the topic then I don't care. So…

IV Okay, and in your opinion what factors impact or affect badly on children learning mathematics?

IE Um I think a lot of the kids you know we, the kids are required to have your maths sets, in primary school not that much calculators and that kind of thing but you know kids are like this if they compare themselves to others, you know I'm poorer than you immediately that confidence is, is not there.

So if, if a child doesn't have a lot of confidence personally I think it affects how that child learns as well. So that is one of the things I try to implement in my

class is to boost their confidence first. That is a very very very big factor in my opinion.

00:04:38

IV Brilliant. And um do you think that ICTs can help children to learn grade six maths?

IE Absolutely. Absolutely.

IV Why do you say that?

IE Um when you look at a normal standard textbook the textbook can only give you so much only because you wouldn't want the textbook to look like this. Um you get three examples of a shape. If I go onto Google right now Google images tetrahedron I get moving ones, I get stationary ones, I get silver ones, gold ones, shaded ones, a kid that drew one.

And kids are like oh my goodness, this textbook is just limiting them to that specific… And if, in their heads they believe it's just that to them, that's all it is but if I open up Google and we scroll for pages and pages look at that daai een, look at die een, look at that one, look at that. So I used to teach in classrooms I can't wait for the date when it's, when it's fully rolled out.

IV Okay, so what ICTs would you use in teaching or have you used or…

IE What I'm, what I'm currently using is my computer in the classroom and the projector and the internet of course um and that is basically as far as I can take it right now.

IV Okay, why do you use ICTs?

00:05:58

IE Um like Mr Lewis has said um I find that I have more time um usually writing things on the board, let, let's take for example if I take technology now. I've got a textbook for them, I've got my teacher's guide with the answers and everything. Right so once we do revision or once we do the corrections or giving them answers to their homework I don't have to go write that answers on the board. I can display the answers meanwhile I'm going checking their work where I couldn't get to all of those things. So technology in the classroom is buying me some time to be interacting with the child.

IV Right, okay. So and what would you say you are working on with the child, okay so you've said interaction, but what, what more than that do you think you're doing when you're using technology?

IE Um like I said previously I think it's, I'm expanding their thinking slightly more and um you know you can always bring back what you just had on the screen yesterday. We are not excellent artists so today I'll draw my cube, ah this looks fantastic [laugh] tomorrow I have to try again, tomorrow again might not be, but just so I can show that same thing.

So it's always going to be there and when I get that opportunity to go through the

books I can sit and I can go ask listen here what are you struggling with, where, tell me exactly technically your processing? Right, what are you doing? Okay there's your mistake. While if I have to be at the board and the textbook and I'm planning the entire period I don't have that time to actually go and do that.

00:07:35

IV And um [clears throat] do you think ICTs have changed the way you teach? If so, how?

IE Ah yes it has. Um it's also, I'm much more excited about teaching because I've got an endless, endless, endless library of information. Um I can tell you one, two, three things and it stops there but with ICT I can tell you let's look at things I've never seen. Oh wow, I've never seen this. So the ICT has basically become my assistant teacher. When I run out of ideas I can definitely rely on it.

IV Okay so do you think children learn better in the classroom with technology or without technology.

IE With technology.

IV Why do you say that?

IE Um I have more discipline in my class now when that lights go off and the screen goes on we are quiet in the class. And currently I like, I don't know what's going to happen in the future but currently I think right now it's because kids are in awe of what they see because a lot of them have more access to those kind of things and um when they speak, they speak about Youtube, they speak about this, that and the other all coming from ICT, ICT, ICT. So when I bring that to the classroom they immediately gain interest because it's what they know. So I've seen, I've seen the change.

00:09:11

IV So do you think that it helps them improving their grades?

IE Yes I've seen it personally. Um first term I didn't have those facilities in my classroom. Second term I did and my learners have all come through the subjects that I teach into the top ten of the grade sevens and they weren't there before. The only thing I did differently was ICT. So I can only tell them or tell you it's because of that because it's the only thing I changed in my teaching.

IV Do you think their motivation is different?

IE It's definitely different. They are very excited as you've heard. You know you can, anything visually if it's not the duster, if it's not the chalk, if it's anything different the kids are, you know they immediately give their attention, their focus is there because we've, I've, I've, I've stirred their curiosity a little bit now you know I'm interested because it's what they are interested in.

IV And collaboration? More collaboration, less collaboration with…

IE Yes, I do see now that you know when I display something on the screen um sometimes I don't want to break their concentration with too many images

because you know if you Google images there's a lot of images going on so I zoom in on one if I want them to focus.

00:10:34

But if I just open it up and I have a lot of images you can see how they group up and start showing one another. And it gets them to talk. And this one says look at that one over there or, but this is how I, we start talking to each other especially when I ask them questions so they can engage with me they start talking amongst each other.

It's like you know when you go to the movies everybody's watching the movie and then you ask did you see that? [Laughs] I'm watching the same movie. So it's, I think it all boils down back to that excitement that exists in the class now because of that in my opinion.

IV Okay so um do teachers share ideas, lessons, plans, self-created materials?

IE Yes, all the time.

IV Okay.

IE I'm old school with Mrs Fortuin and I'm new school with Mr Lewis. We, when we get a chance to chat which is every so often we always chat about Google classroom, mailing lists and it's, it's fantastic.

IV Do you think the role of students change with ICTs?

IE Um...

IV Given that the traditional role is put up your hand and keep quiet. Would you say there is a shift?

IE There is a, I do believe there's a shift yes. I think they become more responsible as well. If they had to have the tablet in their hands you know if somebody's too on top of them they're going to be like dude you know so they're going to be more, they're not going to throw their bags on the floor, their books are not going to lie on the floor like we see it but they are going to be more because they know it's expensive basically and...

00:12:15

Kids have you know with this, if you put on a video you hear a lot of things going on the video you know, noises, sound effects, whatever you see, movement. Kids can laugh. I, we played them a video renewable, non-renewable um resources and things.

There was a game show that kids hosted and they made little jokes in the video and the kids could freely laugh about it. But once the people got back to being serious the kids also quietened because they knew they had to listen again. So this computer it actually, it's actually a bit scary but it's also dictating how the, the lessons should be.

They know exactly shh now you have to be quiet. When I put it on I start the video they know they have to be quiet. Nobody's going to watch a movie while somebody's talking. So you'll get this shh in the class the entire time while if I'm going on.

00:13:13

IV Mm, they'll be, mm.

IE They don't listen when you shh, have to shh the whole...

IV And is your role different when you use ICTs? Will it be different when you use your tablets?

IE Um not necessarily different but I think it's going to be a bit more sophisticated, a bit more structured, a bit more organised at the end of the day.

IV Okay. Are there specific rules that apply in the computer laboratory?

IE Yes there is.

IV Okay, such as?

IE Ah in my class for example we've got the screen up front, no more computer screen, monitor. Projector's high up there so it's mounted. Um kids will take chances to throw things around in class but now not anymore because they know if that thing falls from there they will be liable.

IV And do you think that the use of technology has affected the pace, sequencing and selection. I mean you said it's definitely selecting the selection...

IE Absolutely.

IV ...because you've been able to select a whole lot of...

00:14:14

IE Yes.

IV So you would say it's absolutely?

IE Yes. Time as well is being saved. And I find that I have more time to revise now because I don't know what it is but these videos just make the kids remember things for longer time.

IV And finally the question I've asked everyone but I still have to ask you, are parents and community involved in ICTs in the school?

IE Not currently.

IV Not currently?

IE No.

IV Thanks so much. All of...

00:14:40

Teacher F Interview:

180801_001

WESTFLEUR mr davids 24 yrs

Speaker Key:

IV Interviewer

IE Interviewee

UF Unidentified Female

IV My inability to do anything. Is this recording?

IE [Laughs].

IV Um yes it is [laughs]. Okay so the first thing I need to ask you, Carol I'm not going to ah interview you, I'm going to interview these two. So your gender?

IE I'm male.

IV Years of experience?

IE Seven months.

IV Okay. Teaching subjects? [Door opens]. Come in.

IE Okay I, I taught natural science, biology, life science, maths, doing life skills, history, geography at the moment. Um, yes.

IV And your professional qualification?

IE Ah so I have my bachelor of science and my post-graduate certificate in education.

00:00:47

IV How confident are you in using technology?

IE I would say if you put it on a scale of one to, ah zero to ten I would say I'm about seven and a half confident.

UF [Laughs].

IV Okay. How much training have you had?

IE Um through my studies I've had um four years of training actually because we needed to use um technology a lot. And I did a Google education level one course ah now in the June holidays, yes.

IV Anything from the department that you've been given?

IE Um I have, we have this, at my previous school where I was um I was doing the, it's like a distance learning computer course. So you first need to do like a introductory course where you need to do some certain stuff on a certain program and then they kick you out a certain percentage to say okay what level and how much you still need to do.

00:01:44

IE And I'm currently still doing that course.

IV Okay.

IE So from the department side yes, I'm doing PowerPoint, Word, um Excel, ah Note, what's it Notebook, what's the other one? Publisher, yes, all that, yes.

IV And how do you think children learn best? What's, in your opinion, just your opinion.

IE I think they learn visually because it stimulates them. Colours stimulate stimulates learning. I think critical thinking within those because they would start asking questions. If I give them a colour red and I tell them I don't think this is red they will tell me but it is.

So critical thinking starts there where I need to convince them it's not red. So it's all about the critical thinking to convince each other listen but I think this is not the colour um that you are telling me that it is. I think this is red because of these reasons. So I think visual learning um also auditory. I think only by listening would still get their brain functioning um and get that um attention span a bit, so the attention span yes.

IV [Bell rings]. Okay, and what's the best way to teach mathematics and can you give an example? From your, from your opinion.

IE Yes. I think um learners aren't experienced is on a very very, they're a bit behind with the maths. So I think in that sense to bring in the technology in the classroom not just by having a projector and you know playing a video um is necessarily the best way for those type of, type of learners but I think also to bring in some, have your thing in front of me and let them play around, let them figure it out. That also brings in the e-learning because it's not chalk and talk. It's them actually grappling with a concept and see how they can build that concept for example. One example would be if we do um breuke, what is breuke in English?

UF Fractions.

00:03:56

IE Fractions for example, um to have different, let's for example I put different stuff there in front of them um for me, to allow them to explain to me how they would um explain a bracket to someone else. Um ag not bracket.

UF Fraction.

IE Fraction sorry [laughs]. You know breuke. So I think that for example um was a good way to see on what level are they, um what terminology are they using to, to, to see are they on the level where they're supposed to be and then fill in

those gaps. I think that was a good way, yes.

IV Okay and what, what do you, what factors do you think can affect children's learning maths?

00:04:38

IE Ah are we talking about affecting now in a negative sense, both sides?

IV Yes, in a negative sense.

IE Okay negative um I think the pre-exposure, if there's no pre-exposure to, to any sort of um learning. For example now I'm talking about before grade R. Um that exposure at home or going to a crèche, I think that is quite important because if you expose the child only to learning in grade R there you have that gap because you have more children coming from crèche now um and they already have that pre-exposure of just basically just counting and that kind of thing.

So I think um that pre-exposure is putting our kids behind. I also think um it's the CAPS curriculum so but it's very very dense and so you are rushed and you are so rushed in the sense that you're just focusing on those strong learners because they're going to give you your marks.

So then you forget the, you neglect the, the learner that actually needs that help. Because that strong learner can actually go and do it because they can give you, the answers, but what about the others? Um I also think um big classes, big classroom size, that also plays a role.

00:05:56

Um you can't, I don't think you can actually do a lot of group work um and get a strong learner in each group if it's, if it's, if the group is too big because you'll have, within that group you'll have learners just stepping out like it's fine, they'll do all the work. They have that intention of it's fine I'll just look and then I'll do my own thing.

I think also um sometimes teachers, the shortage of maths teachers, I think that also plays a role because they don't have the terminology and size necessarily. For example foundation phase teachers um or within the foundation phase you have FET phase teachers going there because there's a shortage of teachers.

So schools don't have a choice but to take them on because you don't, you want the learning to carry on. So I think there might be also economic status of, of the group. I've come from a very very poor background, the school I was at and um it was to see only you know just on the outer side of, of, of the learners there's, there's a bit of a, of a back, you know a gap.

UF A gap.

IE Yes.

IV Great. Um and what ways do you think that ICTs, so ICTs, Smartboard, Smartphone etc can help children to learn grade six mathematics?

IE So for me a Smartboard is, there needs to be training for Smartboards. You can't just pop up a Smartboard in a classroom and be like hey here's a Smartboard and then you need to go with it. And then the maintenance of it. So I think in that way Smartboard is not the most viable option for a school if the school is not able to maintain that Smartboard.

00:07:40

Um that also I think to be more engaging because we want the learners to be more engaged um and I think in that sense you'd want them to actually do then, do the stuff there where they sit. Because the classes are big. If you, having consideration for the big class sizes you can't have everyone at the Smartboard, um and you want them to actually engage with the content right at the desk.

You can perhaps share the iPad or the tablet um and I think in that sense also it's a bit more maintainable because you can just charge it. It's easy to, to get used to. It's going to take them about a week to get used to where it is. You can actually stick the, the technology in the classroom by you know just getting certain programs.

Am I missing a part? I think I…

IV No, nothing.

IE Um, So I think you can, games for example, and you can actually connect games to, to the maths. You know for example if you just take like ah Bubbles for example, they need to get the certain colours together. Visually it's also stimulating because now they're also stimulated by I need to get this colours because certain games have the rule of if I have three bubbles I'll get a fruit or something like that. So in that sense also they can count and they, you know just that basic type of ah, of maths also would help them you know.

00:09:00

IV So do, in your opinion as someone who uses ICTs, do you think it improves children's outcomes as defined as like testing because you guys do the ANAs and whatevers, do you think it improves, use of ICT improves their outcomes in mathematics?

IE I think so, yes.

IV Okay. Um and what ICTs have you used in your teaching when you were using, teaching maths?

IE So I was using um, I was using the projector because at the school there was no rollout of any tablets in the school. So I was using um the projector and I was using um videos, Youtube videos, I was using different sources that I used for my classroom so I took different textbooks, I had to take sources from there to get the best and I would summarise into a PowerPoint.

Um then I would also use some games in the classroom where we played just mental maths, that kind of thing um in a different way for example they can stand or sit, you know that kind of thing, subtract, add. Um so in that way and I was

also using sites from, also from the department um I would use videos that they put on their, on their website to use in the classroom. Oh and I was also using um Vodacom's Top Dog. They have this educational website that they use, that they've rolled out.

00:10:23

So if you're a Vodacom customer you can actually sign on and then you can use their videos to play in the classroom and that also helps. It gives you a nice explanation of that stuff.

IV And how do you use ICTs? I think what I'm trying to ask you here is, is um how, how, how do you harness ICTs for your kids? How do you use them? I mean you've spoken about the PowerPoint.

IE Mm.

IV I actually think, I actually think you've answered that to be honest.

IE Okay.

IV Thank you.

IE Yes I, I think if there's, if there, if there were tablets and that kind of things rolled out at the school based on the economic status of the school, of the area I think if there were um that because I, it was B classes, it would have been better in a sense that I could actually use that.

But there was not that, that facility. I couldn't, they didn't even have the cell phones because not all of them had cell phones. Um Wi-Fi for example wasn't available to them. So there's that thing so I think the best in that way I could harness the PowerPoints and the Youtube videos and that in the classroom.

IV And now you're completely new to teaching so this is perhaps a stupid question to ask you, but um what resources did you use before ICTs? But I, I take it that you haven't been around when there's no ICTs?

IE No [laughs], no no. I grew up with the ICTs I think.

00:11:51

IV So top question for us we don't need to [laughs]… Okay, why do you use ICTs? What's your motive?

IE Um for me it's to get more engaging learners in the classroom um and that's what you want. You want that interaction in the classroom. You don't want just the chalk and talk passive learning.

IV Okay.

IE Um so I'm…

IV Okay, so what would you say you're currently working on when you are working with ICTs with these children? What…

IE So, so I want critical thinking. I want them thinking skills. I want them to harness

that you need to think for yourself. You need to figure it out for yourself. I shouldn't be the one that, that have all the information and just blow it out and you be like catch what you can.

UF But they don't analyse, they must be able to analyse the [unclear].

00:12:42

IE Yes. So give me answers you know that kind of thing, help me if I've made a mistake for example on the PowerPoint or whatever. They'll be like oh there's a mistake you know but you can't calculate that, you know that kind of thing. And because only in that way you can see that they are, they are engaged.

IV And tell me, now again this is a, it's a difficult question for you, but if you can just, because you're so, so young in teaching, but if you can think about maybe your experience at your underprivileged school and a different experience here, um how would you say that ICTs either has changed or you think can change your teaching?

IE Um for me ah it helps, it also helps me on the bigger picture, if I look at the bigger picture, also for discipline in classrooms. Um because if I walk in I set up my stuff you know and all that, I face the learners. So there's not really that time for them to you know do their own thing and not work.

Because once you do the chalk on the board you turn your back. Um so I think in that way. And also because their attention span is so, so short. So I think in that way um I can be engaged with them for most of the time um when I'm there. So I think in that way it, it also helps me to, it helps me at the moment, the ICT, the technology in the classroom but I also think in, in the future it can help them because we will probably won't be able, we will probably be the ones only facilitating.

00:14:15

So I still think that we are now teachers but in the next few years coming we will be facilitating the classroom and not a teacher because they will, they can Google it. Because in the next few years a lot of school's going to have the tablet and they're going to be like…

Because when I did my practice teaching I was at a private school and they could easily Google something if they don't understand. And they'd be like oh but sir but Google says this you know that kind of thing. So they were much more engaged in that sense.

And in that sense I was a facilitator for them to be, you know be I want to know more, I want to know more. So I think in the next few years we're going to be facilitators in the classroom and I think that's how technology's going to change the teaching profession.

IV And do you think they learn better with technology or without technology?

IE Definitely better with, with technology.

UF Because they grow up with it.

IE Yes, they can't use a computer. I figured that that, that a learner, if you put them in front of a computer they don't know where's the switch on, power on, that kind of thing and where to enter and that kind of thing but give them a phone, they know exactly where to go.

00:15:21

UF Just going on.

IE Yes.

IV Okay, do you think that ICTs will help students improving grades?

IE The machine is really well oiled. The roll out of, it's nice to have the technology in the classroom if they have their own tablet with them but it needs to be restricted in some way because they can do whatever they want if you don't control that situation in the classroom.

So they can seem as if they're engaged but it can be at another level. They could play a game and be engaged or nod when the others nod. Um but I think, um and I actually experienced this at the school I was practice teaching, um that grades go up with technology.

IV Fantastic. Motivation? Does it help them with motivation?

IE I think it's because um for me note-taking in a book is not the most efficient way of, of learning because there already you have passion, ah passive learning because they need to copy what you say. And in that, in that sense you're actually taking away the critical thinking for them.

00:16:34

So I think you know just, just by having a tablet in front of them and make their own notes but have the textbook at home that's fine, you know you can take notes with whatever you want and you can Google it. So I think in that way it's much more engaging um to have the technology right in front of them.

IV Collaboration, does it help with collaboration, students?

IE Ah collaboration amongst students? Yes I think so, yes.

IV Okay. And tell me, um do teachers in this school, your, there are three of you who are grade six maths, do you share ideas, lesson plans, self-created materials?

UF Yes.

IE Mm.

IV Okay. And what do, I just know your head of department is here, do you get, what kind of support do you get from your head of department?

UF Lots and lots and lots and lots.

IE [Overtalking]. Lots and lots. Mentoring, you get lots, a lot of mentoring. If you don't understand you can easily ask you know how do you present this to the learners? I'm sitting with this type of learner in my classroom, um is there a way that, or a, a teaching style that I can perhaps use with them because they have more experience, she has more experience than me.

IV Okay, so what would you say the role of the student is in an ICT lesson?

00:18:00

IE The learner?

IV Mm.

IE Oh.

IV Like in a traditional lesson the role is to sit down, shut up, put up your hand, that kind of thing. I guess I'm asking is there a difference in the role of the student in an ICT embedded…

IE Yes, I think so because if you change it, if they, if you, if you go in an ideal world where every learner in the classroom have ICT in front of them, not just see the board, there's something on the board, I think in that way they're also more engaging and we learn from each other. So they for example ask a question and then you would say but I don't know and they'll be like oh I'll Google it.

IV Okay, and you mentioned that your role is potentially going to be different to, a facilitator rather than a traditional transmission chalk and talk so you've answered that one.

IE Mm.

IV Are there specific rules that apply when using ICT that don't apply in a face to face lesson?

IE Just ah elaborate on that.

00:19:09

IV Like is there, like for example do not surf the web, do not move out of this program. Are, are there specific rules that you put in place for the children?

IE You would need to.

UF Yes.

IE You would need to. Yes, definitely.

IV Um and does the use of technology impact on pace, sequence and selection? So does it, does, if you use technology is it slowed down, is it fast?

IE I think it's, I think it's faster because you don't have to write necessarily in that way. The, the note-taking of, of the content would be much fewer, it wouldn't be that much because you would, you would actually make them grapple with the content for example on a game.

Um so then they would understand and you just give them the most important notes um and then obviously on paper because they need to write the test so you need to give them examples, you know and all that. Um I think so they, the pace would be faster in that sense because then you don't have to do the chalk and talk all the time. Because if you do division the next day you find, you see, you figure that they don't even remember what you said yesterday. But even the most important thing in that lesson um they don't remember.

00:20:33

Some of them it's like two or three. So yes, the pace would be faster, um yes.

IV Okay, um and the final question that I would ask you, are parents and the community in this, involved in this school with ICTs?

UF Not yet.

IV Not yet? Okay.

IE Not yet, yes.

IV Fantastic. I'm going just press stop there because that was, that was…

00:20:59

APPENDIX C: Research Participant Consent Form

University of Cape Town

Faculty of Humanities / School of Education

CONSENT FORM

Title of research project:

GRADE 6 MATHEMATICS TEACHERS' PERCEPTIONS OF PEDAGOGICAL VARIATION WITH INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS) IN NO-FEE PAYING SCHOOLS: A CULTURAL HISTORICAL ACTIVITY THEORY (CHAT) ANALYSIS

Names of principal researcher:

SAKAFUKU T. TSHINK

Contact details of principal researcher:

E-MAIL: sakafuku1@gmail.com

Mobile number: 063 468 53 76

Names of supervisor:

Prof. JOANNE HARDMAN

Research purpose / focus:

The purpose of this research is on teachers' perceptions on whether pedagogy alters with ICTs and whether this impacts positively on students' outcomes in mathematics. This study emphasizes the role of ICTs in education and explores some of the research participants' (teachers') insights to advise whether there is a potential shift in pedagogy and track what this looks like?

Names of participant:

- ❖ I agree to participate in this research project.
- ❖ I have read this consent form and the information it contains and had the opportunity to ask questions about them.
- ❖ I agree to my responses being used for education and research on condition my privacy is respected, subject to the following:
  - I understand that my personal details may be included in the research / will be used in aggregate form only, so that I will not be personally identifiable (*delete as applicable.*)
- ❖ I understand that I am under no obligation to take part in this project.
- ❖ I understand I have the right to withdraw from this project at any stage.
- ❖ I understand that this research might be published in a research journal or book. In the case of dissertation research, the document will be available to readers in a university library in printed form, and possibly in electronic form as well.

Signature of participant : _____

Date : _____

Signature of principal researcher : _____

Date : _____

Signature of supervisor : _____

Date : _____

APPENDIX D: Ethics Form

SCHOOL OF EDUCATION

Professor Azeem Badroodien

University of Cape Town, Private Bag, Rondebosch, 7701
Level 5, Neville Alexander Building, University South Avenue, Upper Campus
Tel: +27 (0) 21 650 2774 Fax: +27 (0) 21 650 3449
E-mail: Azeem.badroodien@uct.ac.za
Internet: www.education.uct.ac.za

Clearance number: EDNREC20180603 25th June 2018

Mr Sakafuku Tshink
M.Ed Program
University of Cape Town

Re: Ethical Clearance for Research Project

Dear Sakafuku,

I am pleased to inform you that ethical clearance has been granted by the School of Education Ethics Review Committee of the Faculty of Humanities for your M.Ed research project entitled: *Grade 6 Mathematics teachers' perceptions of pedagogical variation with information and communication technologies (icts): A cultural historical activity theory (chat) analysis*

We wish you all the best with your study.

Yours sincerely,

Signature Removed

Prof Azeem Badroodien
Chair: School of Education Research Ethics Committee

APPENDIX E: Research Approval Letter (Western Cape Education Department)

Western Cape Government
Education

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20180629–3898
ENQUIRIES: Dr A T Wyngaard

Mr Sakafuku Tshink
Room 514, School of Education
Neville Alexander Building
Upper Campus, UCT
Private Bag X3
Rondebosch
7701

Dear Mr Sakafuku Tshink

RESEARCH PROPOSAL: GRADE 6 MATHEMATICS TEACHERS' PERCEPTIONS OF PEDAGOGICAL VARIATION WITH INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS): A CULTURAL HISTORICAL ACTIVITY THEORY (CHAT) ANALYSIS

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **25 July 2018 till 25 August 2018**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 29 June 2018