Exploring the use of technology-based teaching methods when teaching shape and space in grade 10 Mathematical Literacy

Sharda Hansraj

Student No. 208526202

A thesis submitted for the degree of Doctor of Philosophy in the School of Education: Mathematics and Computer Science Education

University of KwaZulu-Natal

Edgewood Campus

Supervisor: Professor J. Naidoo

March 2021

Declaration

I, Sharda Hansraj, declare that the research reported in this thesis, except where otherwise indicated, is my original work, and has not been submitted for any other degree or examination at any other university.

[redacted] **28/03/2021**

…… **……**

S Hansraj **Date**

[redacted] **30/03/2021**

…….. **……**

Prof J Naidoo: Supervisor **Date**

Dedication

To my husband, Mr Mukesh Hansraj,

my daughter, Dr. Kajal Hansraj

and my son Mr. Yauvan Hansraj

Acknowledgments

I am deeply indebted to the Supreme Lord for the strength and guidance.

In presenting this thesis, I wish to express my sincere gratitude and appreciation to each of the following individuals for their invaluable assistance**:**

My supervisor, Prof Jayaluxmi Naidoo, for the constant motivation and the excellent guidance from the inception of this research study to the preparation of the final thesis. The patience and expert advice offered by Prof Naidoo was phenomenal. Her insight in Mathematics and research methods helped me to achieve my goal. I am still amazed at her quick turn-around time when she offered feedback to me.

My husband, Mr. Mukesh Hansraj for his constant motivation and dedication. He has been my pillar of strength during these very demanding years. I salute Mukesh for his unselfishness in shouldering all the family responsibilities during this period. I remain in his debt for all the sacrifices he has made. I am very grateful to him for all the interest he has shown in my work.

My daughter, Dr. Kajal Hansraj, thank you for encouraging me to persevere and for reading through my work despite your own commitments and hectic schedule.

My son, Mr. Yauvan Hansraj, for having the patience to help me and to teach me when I needed tables and figures edited. He constantly spoke to me about my study and was keen to help and offer invaluable advice.

My colleagues and many friends for their encouragement and constant support.

The learners of Sunshine High School who participated in my study, for their cooperation, time and patience during my lessons and interviews.

The PhD cohort for the important debates and useful feedback.

Angela Bryan for her expert editing and suggestions

Abstract

It is increasingly essential to the South African education system that effective curriculum delivery is intensified. The integration of technology in the teaching and learning process has become increasingly important in view of the advent and accessibility of technology in the school milieu. The South African government has embarked on the rollout of the Fourth Industrial Revolution to align the country to the technological advancements that occur internationally.

This study explored how technology-based teaching and learning impacted grade 10 Mathematical Literacy learners whilst teaching shape and space in a suburban public school. The recent changes in the mathematics curriculum in South Africa is an important endeavour by the Department of Basic Education to ensure that no learner is left behind in the quest to produce mathematically literate learners countrywide. Mathematical Literacy was introduced as a subject in South Africa in 2006 at grade 10 level. Technical Mathematics was introduced at grade 10 level in 2016.The rationale to such inclusions in the curriculum was that mathematical skills become available to all learners. The challenges experienced in the Mathematical Literacy classroom resulted in the quality of the Mathematical Literacy passes declining instead of improving.

The exploratory nature of this research study is informed by strategies recommended by educational researchers and literature on the use of technology in teaching and learning. The intention of this study was to explore what technology is being used currently in a Mathematical Literacy classroom and whether the use of technology-based teaching methods when teaching shape and space in a grade 10 Mathematical Literacy class has an impact on the learning process. Activity Theory was used as the framework in which the study was located. All activities were interrogated within the interpretive paradigm. The interpretative study engaged with a mixed-method approach to generate data. Qualitative and quantitative methods were used to collate and analyse the data collected. The data generation tools consisted of two sets of questionnaires, focus group interviews, a pre and post-task and reflections sheets. All the data were aggregated and then analysed thematically.

A key finding to this research study is that technology-based teaching and learning did indeed impact the teaching and learning process positively. The learners' ability to consolidate their understanding of the concepts taught on shape and space, which were taught using the YouTube videos, Powerpoint presentations and worksheets, helped to improve learner performance when they handled the tasks covering shape and space. The technological tools utilised in the delivery of the lessons were a computer, a white board, a data projector and the internet facilities.

The study offers suggestions on how technology can be integrated with the teaching and learning process to meet the needs of the millennial learner especially when teaching concepts such as shape and space in Mathematical Literacy. It recommends that teacher retraining and reskilling is imperative to equip teachers to integrate the use of technology effectively in the classroom situation. Teaching methods and techniques need to be refreshed and aligned to the dynamic nature of curricula and the context in which the school finds itself. The findings of the study showed that although technology is available at this public high school, it is currently not being adequately integrated in the classroom.

Although the small sample used in this research prevents the study's results from being generalized, these findings may influence the education sector particularly curriculum managers responsible for teacher development. A veiled finding is this study suggests that a school cannot function in isolation and that it needs the support and the collegiality of all government departments and the support of communities in order to function effectively and efficiently. This exploratory study concludes with recommendations for further research.

Table of Contents

List of figures

List of tables

List of Appendices

CHAPTER 1: INTRODUCTION

1.1 Introduction and orientation to the study

This dissertation reports on a research project conducted amongst Mathematical Literacy learners at a high school in Durban. This study examines whether technology-based teaching has had any impact on Mathematical Literacy learners in respect of the teaching and learning of shape and space in the grade 10 class.

With the introduction of the Further Education and Training (FET) curriculum in South Africa in 2006, learners who terminated their study of Mathematics at the end of grade nine will have to study Mathematical Literacy, an applications-based Mathematics course, or Technical Mathematics from grade 10 onwards. Mathematical Literacy is a key competency as highlighted by the Organisation for Economic Cooperation and Development (OECD) (2000, 2003), and there it is described as “an individual’s capacity to identi and understand the role mathematics plays in the world to make well founded judgements and to use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen” (OECD, 2003, p. 15).

The Mathematical Literacy results at the grade twelve exit examination have been criticised by many sectors of the community for the generally poor performance at the National Senior Certificate (NSC) examinations even though learners only need to score 30% in order to pass this subject.

This study undertook to determine whether the use of technology when teaching space and shape in the Mathematical Literacy curriculum, could improve the understanding of the concepts thereof. Various methods of data generation were used to ensure that the credibility of the study was maintained. Questionnaires were administered to grade 10 learners who were studying Mathematical Literacy. Lessons were taught to learners on the aspects pertaining to space and shape in line with the annual teaching programme. Reflections sheets were filled in by the learners after each lesson in which they commented and offered feedback on the lessons. Data were also obtained from three focus group interviews with learners which were conducted at intervals during the planned teaching schedule. The analysis of all the data generated was situated within the Activity Theory.

The researcher's experience as a Mathematical Literacy teacher at a previous school served to inform her that learners generally have great difficulty in grasping spatial concepts in Mathematical Literacy. They experience challenges with aspects related to space and shape. This study is supported using Activity Theory which helps the researcher to analyse the context within which the teaching activity occurs and then to report on the interactions of the learners with each other as well as the interaction of the learners with the teacher. Activity Theory is discussed in chapter three.

In this study the researcher will attempt to assess what skills and knowledge pertaining to space and shape the learners may bring to the Mathematical Literacy classroom.

1.2 The purpose of the study

I have encountered many teachers and learners who have expressed dissatisfaction with the intermittent changes that have been introduced into the South African curriculum. Many Mathematical Literacy teachers have complained about the lack of support material to assist with the curricular changes and about the learners lack of motivation at the classroom level. Perhaps this research study will serve to encourage teachers to explore new methods and techniques in the Mathematical Literacy classroom so that knowledge and competence in all Mathematical Literacy contents can be consolidated.

The research studies and the literature available on Mathematical Literacy in the South African context further consolidated the suitability for this study. The numerical incompetence of South African school leavers has a negative effect on employment and economic development; therefore it was incumbent on the Department of Basic Education to take appropriate action to address this issue. In 2006 all learners in grade 10 in South Africa could choose between either Mathematics or Mathematical Literacy as part of their National Senior Certificate curriculum. Mathematical Literacy serves an important role in supporting learners to fulfil their roles in modern society. One needs to support the process by strategising how best one can implement the syllabus so that the learners can fulfil their professional roles in society with confidence (Jojo, 2019). However, in 2016 the Department of Basic Education introduced a third option in the field of mathematics. Technical Mathematics was introduced into the curriculum starting at grade 10 level as an FET subject which is aligned with vocational, artisanal and vocational programmes (DoE, 2014).

Initially the rollout of the Mathematical Literacy programme was supported by the local universities in equipping the teachers to teach Mathematical Literacy effectively. However, many teachers are also not quite keen to teach Mathematical Literacy because of the stigma which this subject carried. It was regarded as a watered-down study of Mathematics. There is also the view that only academically weak learners choose to study Mathematical Literacy. Teachers are also not so techno-savvy and they struggle to integrate the Mathematical Literacy concepts with any available technology in order to make the content more practical (Botha, 2011).

In spite of having Mathematical Literacy teacher training (Advanced Certificate in Education) conducted over a 2 year period by the university wherein teachers were equipped to effectively handle the Mathematical Literacy syllabus, a report released by Umalusi and the Department of Basic Education indicates that there has not been any significant change in the learner competency in respect of Mathematical Literacy (Volmink, 2015). This report serves as a warning, which forced and conscientised educationists to take note of serious teaching and learning problems at the classroom level.

The statistics as presented in the tables below forces one to look at the reality concerning the results of Mathematical Literacy as obtained from the National Senior Certificate results. The following statistics that appeared in the National Senior Certificate Examination Report 2015 and 2018, are contained in Tables 1.1. and 1.2.

The information indicates that from 2012 to 2015 the number of learners opting to do Mathematical Literacy instead of Mathematics, increased significantly. Based on the information provided, 26925 more learners did Mathematical Literacy instead of Mathematics in 2015 as compared to 2012. Mathematical Literacy has had the biggest increase with the number of learners sitting for the grade 12 National Senior Certificate going up by 79 638. When one examines the National Senior Certificate results, one notices the decline in the Mathematical Literacy results from 2012 to 2015. There is a 16% drop in the average results in these years.

Table 1.1 *Adapted from the DBE 2015 National Senior Certificate results.*

Mathematical Literacy

2012			2013			2014			2015		
Wrote	Achieved 30% and above	% Achieved	Wrote	Achieved 30% and above	% Achieved	Wrote	Achieved 30% and above	% Achieved	Wrote	Achieved 30% and above	% Achieved
291341	254 611	87.4	324097	282 270	87.1	312054	262495	84.1	388845	277595	71.4

Mathematics

2012			2013			2014			2015		
225874	121970	54	241509	142666	59.1	115458	120523	53.5	263903	129481	49.1

Table 1.2 *Adapted from the DBE 2018 National Senior Certificate results.*

Mathematical Literacy

2016			2017			2018		
Wrote	Achieved 30% and above	% Achieved	Wrote	Achieved 30% and above	% Achieved	Wrote	Achievd 30% and above	% Achieved
361 865	257 881	71.3	313 030	231 230	73.9	294 204	213 225	72.5

Mathematics

2016			2017			2018		
265 810	135 958	51.1	245 103	127 197	51.9	233 858	135 638	58

The information provided in Table 1.2 was extracted from the Department of Basic Education Report (2018) and it provides further insight into the performance of Mathematical Literacy up until 2018. In 2016. One notices a further decrease in the average results with only a 2.6% increase in 2017 and then a 1.4% decline in 2018. It is a cause for concern that the average results of Mathematical Literacy dropped from 87.4 % in 2012 to 72.5 % in 2018. This is a decrease of 14.9 %. Tables 1.1 and 1.2 indicate a positive trend for the national average results for Mathematics which increased by 4% from 2012 to 2018. Although this study does not concern itself with Mathematics itself, it is heartening to note the improved results.

In South Africa, Mathematics and Mathematical Literacy relate to each other, but differ in terms of their nature and aims. Mathematics 'enables creative and logical reasoning about problems in Mathematics itself, which leads to theories of abstract relations' (DOE, 2003a, p. 9). On the other hand, Mathematical Literacy equips and sensitises learners with an understanding of the relevance of Mathematics in real-life situations (DOE, 2003b, p. 9). The purpose of Mathematical Literacy is to apply Mathematics to make sense of the world. Mathematical Literacy was specifically introduced as an intervention to improve numeracy skills of South African citizens in response to poor performance in Mathematics in the past (Bansilal, Mkhwanazi & Mahlaboratoryela, 2010).

The ultimate purpose research of this study is to find strategic ways to improve the learners' understanding and application of concepts in the Mathematical Literacy class

1.3 Focus of the study

The focus of this study is to gauge whether the lessons taught with the use of technology during the data collection stage has an impact on the teaching and learning of shape and space in the Mathematical Literacy class. According to the Department of Basic Education (DoE, 2003b) studying the subject Mathematical Literacy was intended to help the learner to contribute to economic success. Learners will become citizens who can negotiate and function in the economic world with everyday mathematical calculations and problems. Learners are expected to use their skills "to enact their citizenry in a rapidly advancing scientific and technological world once they leave schooling" (Vithal & Bishop, 2006, p. 3). Since the National Senior Certificate

exams have recorded dwindling results in Mathematical Literacy over the years, this dissertation wishes to explore how the use of technology can impact the teaching and learning process when working with shape and space in the Mathematical Literacy classroom.

1.4 Rationale for the study

Having served as a Mathematical Literacy teacher from 2008 until 2015, I am aware of the challenges that the learners and the teachers endured with the introduction of a new subject. Mathematical Literacy is not just a skill or a level of competency that the learners must acquire in the South African education scenario, it is a subject. The researcher saw the challenges which learners faced with certain aspects of the Mathematical Literacy curriculum. One such difficulty was how learners struggled with identification, deconstruction and mathematisation (the ability to process between the Mathematics and reality) of shapes and space. Although shape and space is only one aspect of the Mathematical Literacy curriculum, in my experience as a Mathematical Literacy teacher, I knew that if I explored other ways of teaching in the Mathematical Literacy class, this could motivate other teachers to investigate other ways of curriculum delivery.

The desire to help other Mathematical Literacy teachers and the need to help improve the National Senior Certificate results at my school further spurred me on to conduct this research study. Grade 10 was the most logical level at which to conduct the research since Mathematical Literacy commences at grade 10 level.

The gap in the literature available encouraged me to explore how I could perhaps impact the teaching and learning of shape and space content in the Mathematical Literacy class. A few studies exist on the actual teaching and learning of the concepts taught in the Mathematical Literacy curriculum, but more studies are needed to provide teachers and learners with sound information on research studies conducted in the field of the Mathematical Literacy in the South African context and to offer them firm alternative teaching and learning principles and strategies.

The rationale to this small study is to explore and investigate whether one can impact the teaching and learning process of the shape and space content in the Mathematical Literacy class using technology despite the finding of Muthusamy (2015) which stated

that were that teaching in the South African milieu is indeed a challenge. I agree with him when he points out that the teacher is responsible for many tasks in the teaching context and in many circumstances these responsibilities are punctuated with great challenges.

The quandary that one finds oneself in, is that it was expected that the quality of results in Mathematical Literacy would improve given the fact that local universities have supported the Department of Basic Education in its rollout stage of Mathematical Literacy. The researcher is of the opinion that Mathematics teachers should not just be given a Mathematical Literacy class to teach simply to fill up a teaching load. This opinion is based on an article which suggests that “It is a widely held opinion that Mathematical Literacy is more difficult to teach than the ‘normal’ school-going mathematics” (Julie, p.63). Retraining and orientation of non-Mathematical Literacy specialists are necessary before they enter the classroom. This will assist with teacher competency and encourage teacher commitment.

In order to increase the value of this research study, scholarly articles which examined the use of technology whilst teaching Mathematical Literacy in the South African context were examined. The researcher also looked at scholarly articles which speak to the improvement of results in Mathematics using technology. Many articles with a Mathematics bias were examined in order to give impetus to this study. Since the researcher did not have specific or similar studies with which to compare this research process which examined the use of technology whilst teaching shape and space in a gr 10 Mathematical Literacy class, she used the tool of daily feedback to ascertain whether the research process was indeed unfolding as it should.

Since Cloete (2017) concedes that technology-based teaching improves the teaching and learning process, the researcher decided to incorporate the use of technology in the teaching process and then examined the effect this has had on the learners’ understanding of the concepts. Roschelle et al. (2007) added that teachers can use technology to advance the teaching and learning of Mathematics. For example, teachers can focus less on memorizing facts and performing routine calculations and more on developing ideas, exploring consequences, justifying solutions, and understanding connections which is the essence of Mathematics.

The researcher knows from her teaching experience that learners struggled to identify simple shapes when stacked together into making complex real life objects and this realisation is supported by Roschelle et al. (2000). Learners were unable to see the part which makes up the new shapes e.g., that a cold drink can is a rectangle that has been rolled into a cylinder with a circle at the base and on the top of the can. The learners may know the properties of a shape, but the stumbling block arises in the identification of a shape when it is altered from its original shape (combined with or altered by another shape).

1.5 Context of the study

The researcher has used Activity Theory on which to ground and frame this research study. Activity Theory emphasises the cultural role of the teacher and the activities with which the community members engage. The physical setting that constrains and affords certain actions and tools which mediate activity, are pillars of Activity Theory. Hardman (2005) alludes to the fact that the strength of Activity Theory is in its ability to enable the researcher to understand that learning is a complex result of an interaction which is mediated by tools. An activity based teaching method is a technique adopted by a teacher to emphasize his or her method of teaching through activity in which the learners participate rigorously which brings about efficient learning experiences. It is a child-centered approach. The focus of Activity Theory is that learning occurs by doing.

This research study was conducted in a public secondary school, Sunshine High School,[1] which has internet access in the administration block. In January 2017, this school was split from its status as a combined school and it officially became a high school with its own principal and management staff. The entrance facilities, administration block, and the staff room continued to be shared by the primary and the high school.

The location of this school is in an impoverished area and has an enrolment of approximately 800 learners. The school does not have a library. The school has a

[1] This is a pseudonym for the school

computer room with 25 computers, but the computer room does not have internet access. This room is only accessible to the learners who study Computer Applications Technology (CAT). In grades 10 to 12 less than 20% of the learners study Mathematics as a school subject. The teachers, however, have access to 3 computers with internet access available to them in the administration block in order to do the necessary planning for lessons.

The school is a recipient of 25 tablets, docking station, a projector and an interactive whiteboard which was sponsored by a cellular network provider in 2017. The interactive whiteboard was installed in the Life Sciences laboratory.

The school is on the Department of Basic Education funded feeding scheme which is formally known as The National School Nutrition Programme (NSNP). It relies on donors and sponsorships to keep it afloat because many of the learners are indigent. Approximately 85% of the learners at Sunshine High School are mother tongue isiZulu speaking learners. There are currently 5 teachers who service the Mathematics/Mathematical Literacy department. None of these teachers have been specifically trained to teach Mathematical Literacy but all these teachers have qualifications in Mathematics.

I am employed at Sunshine High School as a departmental head for languages. I do not serve in the Department of Mathematics, Science and Technology. Having obtained an Advanced Certification in Education (ACE: Mathematical Literacy) from the University of KwaZulu Natal and having taught Mathematical Literacy until 2015, I chose to use Sunshine High School as the venue for data collection after following all the necessary protocols via the university and the school principal.

1.6 Concept clarification

1.6.1 Mathematical Literacy as an FET subject

Booyse, Grussendorff, Houston, Singh, Ntenza, and Hough, (2014) conducted the comparative study of the National Curriculum Statement (NCS) and the Curriculum and Assessment Policy Statement (CAPS) and they provided the following definition of Mathematical Literacy as a subject. The report cited from the NCS and CAPS

documents and the definition which was used for Mathematical Literacy emerged as follows:

> "Mathematical Literacy involves the mastery of elementary mathematical skills in order to make sense of, participate in and contribute to the twenty-first century. The subject requires learners to read text, tables and graphs with insight and understanding, to reason and make decisions, to analyze and draw conclusions, to critique arguments and interpret complex representations of information. All of these skills and competencies are for the express purpose of solving real life quantitative problems. Mathematical Literacy is not another level or type of Mathematics. It differs from Mathematics in that the aim is not to solve problems of an abstract and theoretical nature, using conceptual mathematical understanding and to master sophisticated techniques and tools. The essence of Mathematical Literacy is to gain confidence and skills in navigating modern life with its complex financial transactions and contracts, global trade and travel, statistics-based arguments and advertising, exchange rates, consumer pressure, and much more." (p. 23)

Undeniably, Mathematical Literacy does not have a long history in the South African education system. It was initially introduced in the FET phase at grade 10 level in 2006. The intention in including it into the FET curriculum is to give those learners who would drop Mathematics at the end of grade 9, a useful, challenging and highly relevant alternative. Booyse et al. (2014) states that the "the 21st century requires that people have both an understanding of, and a competency in quantitative and numeracy issues in a wide range of contexts. Mathematical Literacy is entirely based on authentic, everyday contexts, most of which are familiar to learners" (p. 23).

The noble intentions of the Department of Basic Education to capacitate learners with mathematical skills even when they felt that they were not able to cope with Mathematics as a school subject, is noted in the policy documents when they planned the curriculum. The rationale and the intention of the Department of Basic Education is encapsulated in the following citation:

> "Mathematical Literacy provides learners with an awareness and understanding of the role that mathematics plays in the modern world. Mathematical Literacy is a subject driven by life-related applications of mathematics. It enables

learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyze everyday situations and to solve problems. (DoE, 2003b, p.23).

1.6.2 Shape and space

In the traditional Mathematics curriculum, shape and space is classified under the section of geometry. The space that these shapes occupy, and the measuring of these shapes is integral to the study of geometry. With the advent of Mathematical Literacy in South African schools, the study of shapes is done within a context base. Learners are expected to use real -life shapes and determine their perimeter, area, surface area and volume. This initiative is to align the study of these concepts to real life, thereby equipping the learner to make a meaningful contribution in the world of work and in the social setting. For the purposes of this study, shape and space is described as the study of real-life shapes that are used in our everyday lives. Their properties as well as the relevance and impact that these shapes have in our everyday lives are part of Mathematical Literacy. An example of this definition will be the example of a toothpaste box. The learners need to understand the rectangular (length and breadth) shape of the box, its platonic shape (6 sides), the perimeter of one side, the surface area (the area of all the sides added up), as well as what size toothpaste tube can be accommodated in that box (volume). A more detailed discussion on this aspect will follow in the literature review section of this study.

1.6.3 Definitions of technology

Bain (1937) offers a broad yet suitable definition of technology which will be the springboard for the research. He said, “technology includes all tools, machines, utensils, weapons, instruments, housing, clothing, communicating and transporting devices and the skills by which we produce and use them” (p. 860).

For this study many views, opinions and definitions on what technology is, will be discussed in greater detail under the section of literature review.

1.6.4 Using technology in the teaching and learning environment

As mankind makes rapid technological advancements, one is enthralled by the magnanimous ease by which the younger generation embrace the operation of technological devices and the advanced display of their skills.

Shahneaz, Akhter and Yasmin (2014) assert that the use of technology by the teachers in the teaching and learning environment will reestablish the teachers' role and add value in the classroom. The focal points in this article suggest that teaching should be learner-centred whilst the teacher simultaneously enters a partnership with technology.

Whilst Schuck (2016) maintains that the use of technology allows learners the freedom to discover solutions to problems both independently and collaboratively, he advocates that this is a force for good. The researcher believes that technology should enhance the teaching and the learning process, but it should never replace the teacher. Teachers endeavour to engage learners with the subject content beyond a superficial level and to make learners active participants in the learning process, learners who have a thirst for discovery and knowledge. Teachers serve as the link and the bridge between the knowledge and the learner. They have the knowledge which needs to be transferred by various means and using a variety of tools, to the learner. Technology places the world in the hands of every learner inside the confines of the classroom.

1.6.5 How is technology currently being employed in the classroom?

Naidoo (2014) in her study conceded that the value of visual tools has a place in the teaching of Mathematics. She states that many teachers use visual tools unknowingly and inadvertently in the teaching process. She concedes that the incorporation of visual tools and technology add value to lessons. Although Naidoo's (2014) study was done in the field of Mathematics, many of her findings are relevant and applicable to Mathematical Literacy.

Shahneaz et al. (2014) argued that the use of technology in the classroom could be more extensive if the appropriate guidelines and strategies are made available to teachers as to how they should integrate the use of technology into their own practice.

This study found that the use of technology should be intertwined into the instructional delivery of a lesson. Technology should not be treated as a separate entity.

Many schools have been blessed with equipment and data from cellular network companies via a rollout programme. This sponsorship was done to encourage the integration and enhancement of the teaching and learning partnership. The actual statistics of how many schools are in receipt of this equipment and how effectively it is being used is known to the cellular companies. Sunshine High School is also the recipient of this technology. They have 25 tablets and a docking station. They have an interactive white board installed in a Science laboratory. I am aware that the tablets are housed in the school's strong room for safe keeping. I am also aware that the school has been burgled during the December holidays of 2018 and all the computers were stolen from the computer laboratory. Through the kindness and generosity of sponsors, Sunshine High School's computer laboratory was fully functional by April 2019. Although there are issues surrounding learner and school safety nationally, the researcher attempted to preserve the focus of this research study which examines the impact of technology-based teaching and learning in the Mathematical Literacy classroom whilst engaging with the concepts of shape and space.

Whilst some teachers believe that if Mathematics is integrated with technology-based lessons, then learners will become mathematically competent. I agree with Litowitz (2009) that many activities commonly found in technology classrooms have the potential to develop learners' Mathematical Literacy competence

1.7 Research questions and objectives

The critical questions used to substantiate this research are:

1.7.1 Critical research question

1. What technology is currently being used in the teaching of space and shape in Mathematical Literacy and how effective is its use?

2. Does the use of technology when teaching shape and space in Mathematical Literacy influence the teaching process?

3. Why technology should/should not be used in teaching shape and space to grade 10 Mathematical Literacy learners?

1.8 Theoretical framework

The theoretical framework which I have chosen for this study is Activity Theory. Activity Theory was initially developed by a Russian psychologist, Leont'ev who was a disciple of Vygotsky. This multidisciplinary theory "seeks to understand the unity of consciousness and activity" (Cravens, 2011, p. 17). Activity Theory is an ideal tool for any given activity system like traditional secondary education when a major innovation is introduced, such as the use of technological resources in the teaching process. It allows the researcher to conceptualise what works and what does not in the concepts being taught, what impedes change, at what level and in relation to which factors. Activity Theory also allows the researcher to restructure the research based on the feedback from the activities completed. Thus, this implies that the researcher can make data driven decisions about the instructions given. Since this is a new learning experience, learners may have difficulty understanding the instructions to complete given tasks. Instructional technology can be adapted to meet individual learners' needs. This can be done by the researcher assigning different applications to accommodate learners' needs or adaptive programmes automatically adjusting challenges to match learners' demonstrated skills. The knowledge gained from this study can be further applied to the improvement of grade 10 learners' understanding of shape and space.

Naidoo (2014) in her research focused on pedagogic strategies within classrooms across various contexts wherein she admitted that there is currently a gap with respect to research focusing on the pedagogic strategies of teachers in South Africa. She explored the teaching and learning of Mathematics within the framework of Activity Theory study. Both Naidoo (2014) and Shulman (1986) allude to grey areas in the pedagogic structure and both concede that more research and academic literature in this regard is needed. In chapter four the theoretical framework is discussed in detail.

1.9 Research design and methodology

This study employed a mixed-method approach. Qualitative and quantitative methods were used to collate and analyse the data collected. The qualitative research methods

in this approach are preferred in dealing with an already vulnerable groups of learners who feel that they are not clever enough to take Mathematics as a subject at school. Mathematical Literacy learners quite categorically state that they are treated differently because of their inability to grasp Mathematics concepts effectively (Graven & Venkatakrishnan, 2006). Qualitative studies are appropriate as they allow the participants to vocalise their experiences and emotions through the learning process.

The data generation methods will yield rich data which are commensurate with qualitative methods and they allow the researcher to situate the study in the interpretive paradigm. The researcher intended to interact extensively with the participants in order to gain full insight into the learning experience of the Mathematical Literacy learners. Since case studies are useful, as they allow for an in-depth study of a phenomenon, it is suitable to use one to investigate the schooling experiences of the Mathematical Literacy learners at a selected school (Sunshine High School).

The use of the quantitative research method complemented the qualitative method because it allows for the social phenomena to be systematically investigated by using computational techniques. Quantitative research is widely used in social sciences and in this context, it is referred to as empirical methods. Quantitative research allows the researcher to ask specific and narrow questions. It allows for numerical data to be generated from the participants in order to answer the research questions. This method intended to yield an unbiased set of results so that the results can be generalised to some larger population.

The researcher used a multimodal approach to research the Mathematical Literacy learners' learning and schooling experiences. This varied use of data generation methods yielded thick, rich data.

In chapter three, the research design and methodology are elaborated on further.

1.10 Outline of the study

This study is organised into seven chapters. The summary that follows is designed to give the reader an overview of the subsequent chapters.

Chapter one offers a background to the study and explains the purpose, focus and rationale. The report and studies reveal that Mathematical Literacy is not proving to be the solution that it was envisaged it would be (DoE, 2019). On page 57 of this report, it is revealed that of the 294 204 candidates who sat for the Mathematical Literacy papers in the National Senior Certificate 2018 examination, only 213 255 scored 30% and more. This calculated to a 72,5% pass rate in 2018 as opposed to the 73.9% pass rate in Mathematical Literacy in 2017. In an attempt to find some solution to the poor NSC results for Mathematical Literacy, the study looked at a grade 10 class with a view to explore whether a varied teaching method will have an impact on the teaching and learning process. The aim of this study is to gain a deeper understanding of how learners are impacted when technology-based teaching and learning is conducted.

Chapter two offers a detailed literature review and the theoretical framework for the study. The literature review examines the definitions of technology and the reasons for researching the use of technology in the teaching of shape and space in Mathematical Literacy. Although there are not many studies or articles on the use of technology when teaching Mathematical Literacy in the South African context, I have examined similar studies done in the field of Mathematics. The current teaching trends in respect of the engagement with technology will also be espoused.

The focus of chapter three is on the important aspect of the theoretical framework to be used for the purposes of this study. Activity Theory provide a lens for analysing tasks and settings and it also provides a framework for designing constructivist learning environments. Moreover, Graven (2011) maintains that this framework highlights the three mutual relationships involved in all activities which are mediated by the various tools, rules and roles.

Chapter four explains the methodology used to conduct the research. This includes the research approach or design, as well as the data generation and data processing techniques employed. The study adapts a mixed-method approach and makes use of case studies; the sampling process in selecting the school and the learners for this study is clarified. The discussion of the validity and reliability of data, ethical considerations and informed consent concludes this chapter.

Chapter five presents the data collated for questionnaires 1 and 2, the focus group interviews, the reflections sheets and the pre- and post-tasks. The discussions which

emerged through the data presentation, were analysed and interpreted in the following chapter. Thus, chapter six begins with a discussion of the findings of the study. In response to the critical questions asked in this study, the themes that emerged from the findings include the language policy of Sunshine High School, the profile of the research participants, the language preference of the learners and the issue of the first additional language. An analysis of the learners' academic performance is followed by a discussion about academic progress. The chapter concludes with a discussion of the semi-structured interviews, questionnaire analysis and a discussion of the feedback received after each lesson on shape and space. The challenges that learners experience on a daily basis in the Mathematical Literacy classrooms are also discussed.

Chapter six analysed and interpreted the data which was presented in chapter five. The data were examined with a view of developing patterns and making generalisations to the larger population of similar studies. The data which were presented, were aggregated intentionally to extract the common themes. The varied data generation tools helped elicit a vast body of rich data. The mixed -method approach favoured the triangulation process. Chapter seven presents an evaluation of the study and provides concluding remarks. It presents a model constructed by the researcher to assist the teacher to undertake a smooth and effective transition to embrace and adopt the use of technology in the classroom. It also offers suggestions to education officials on how it is they can support, empower and inspire Mathematical Literacy teachers to integrate their content with resources which are already available. New knowledge to the field that emerged from this study is also presented and discussed.

1.11 Limitations of this study

The Department of Basic Education is quite rigid about teachers following the Annual Teaching Plan (ATP) therefore the data could only be generated when the ATP allowed for the sections of perimeter, area, surface area and volume to be done with the grade 10 learners. The researcher had to be mindful not to encroach on the allotted time required by the subject teacher and therefore could not usurp the allocated time of the subject teacher. The learners were advised that their "free lessons" would be used and after school sessions would be convened to conduct the lessons on shape

and space. If they were keen to be part of the study then they would have to comply with the times. This had an influence on the number of learners who volunteered to be part of the research study.

The internet access was limited to the administration block of the school, so the lessons had to be tailored such that if the use of the internet was required, then the researcher had to download the tools and store them for use during the lessons.

Although the researcher is a qualified (two year ACE course at UKZN) Mathematical Literacy teacher and has taught Mathematical Literacy from 2008 until 2015, she does not teach Mathematical Literacy at Sunshine High School. The fact that the researcher was not the resident Mathematical Literacy teacher, meant that learners were initially suspicious of her ability as a Mathematical Literacy teacher. The greatest limitation of this study is that only one aspect of the Mathematical syllabus was conducted with the learners. If the study were done over a longer period covering more topics, more conclusive findings could be made. Sunshine High School's code of conduct for learners forbids learners from carrying cellphones, tablets, laptops or any other electronic equipment to school, so it was not possible for them to use their own devices whilst the lessons were conducted. They had to follow exclusively on the projected material.

1.12 A summary of the chapter

The next chapter (chapter two) interrogated the literature available on the use of technology in the educational setting. It scrutinised the concepts of shape and space in the context of Mathematical Literacy. A detailed examination of these concepts helped to explore whether the use of technology when teaching shape and space had any impact on the effective learning of these concepts.

CHAPTER 2: LITERATURE OVERVIEW

2.1 Introduction

This chapter reviews literature related to Mathematical Literacy as a subject within the South African curriculum as well as the equivalence of Mathematical Literacy in some first world countries. It also explores literature on traditional teaching methods and the use of technology when teaching Mathematical Literacy. There is a special focus on teaching and learning of space and shape in Mathematical Literacy whilst using technology. The chapter also examines how technological related experiences of other researchers in other academic contexts may be used to inform this study.

Mathematical Literacy is a relatively new subject in the South African curriculum, therefore there will not be vast amounts of research literature available on the different aspects of Mathematical Literacy. The researcher realised that this could present as a limitation to this study, therefore research articles regarding the influence of technology on education from a range of educational contexts was examined.

In order to reach the upper echelons of this academic process, the researcher looked at the concepts of teaching, learning, Mathematical Literacy in the international and South African climates, the traditional classroom, the 21st century classroom context as well as the concept of technology as well as how technology is used when teaching and learning in the Mathematical Literacy classroom. A further attempt was made to determine what technology, if any, is being used when teaching and learning shape and space in the Mathematical Literacy classroom. These concepts form the foundation for the literature overview and have also been the focus of many researchers over time. Not all the researchers cited in this research study are educationists. This literature review draws from the contributions of educationists, psychologists, technologists, and the world of commerce. It is evident that the field of education is not an autonomous island which functions separately of all other disciplines. It is also heartening that the inter-disciplinary factor is pushed into the forefront of this discussion because the goal of education is to prepare the learner for the world of work.

Contentions and debates have surrounded many of these concepts, particularly that of the introduction of Mathematical Literacy into the South African curriculum. That

debate is not contained in this research study, however the rationale of introducing Mathematical Literacy into the curriculum is an integral part of this literature review. The researcher hopes that through an examination of the available literature on the issues of Mathematical Literacy, and technology, that a better understanding of the effects (if any) on the use of available technology when the teaching of shape and space in the grade 10 class, will arise. The researcher will attempt to critically discuss the available literature and bring to the reader's attention possible areas which require further investigation and research.

The teaching and learning process is a complex phenomenon and according to Shahneaz, Akter and Yasmin (2014) teaching is also a demanding profession. It is the initiative of the teacher to construct a metaphoric bridge in order to ensure that learning occurs. A researcher cannot study the phenomenon of teaching Mathematics literacy if he/she cannot focus simultaneously on the learning process.

The researcher's view on the how teaching and learning ought to materialise, is captured by Wilson and Peterson's (2006) sentiment that "… good teachers must think hard about what they want their students to learn, contemplating a myriad of questions: What is interesting about this subject for my students?" (p. 9). One notices that the learning and teaching processes are inextricably interwoven.

2.2 Various conceptualisations of Mathematical Literacy

The literature study revealed Mathematical Literacy, Realistic Mathematics Education (RME), Mathematisation, Mathematical modelling, as well as Mathematics in action as different concepts which bear some similarity, therefore it is necessary to discuss these concepts. Whilst the similarities between these concepts are not obviously transparent the likeness exists and can be perceived as each concept is explained.

2.2.1 Realistic Mathematics Education (RME)

Realistic Mathematics Education (RME) is an instruction theory for Mathematics, which has been developed in the Netherlands. The distinguishing feature of RME is that it embraces the use of realistic situations in the learning process. These realistic situations assist as a basis for introducing the growth of mathematical concepts, tools, and procedures and as a context in which learners can at a later point apply their mathematical knowledge, which then progressively becomes more formal and general

and less context specific. Although realistic situations are important in RME, “realistic” has a broader meaning here. It means learners are offered problem situations which they can imagine.

Freudenthal’s (1991) theory of RME hinges upon five components and some of these concepts share a similarity to the South African subject of Mathematical Literacy. One similarity is that Freudenthal (1991) used a real-world context as an initial point for learning. RME attempts to bridge the gap between abstract and applied Mathematics by using visual models. RME also encourage learners to develop their own problem-solving strategies rather than memorise rules and procedures.

When one examines the essential didactic principles on which RME is based, one realises that the teaching of Mathematics, and the traditional school Mathematics instruction are too formal, and less context based. RME promotes and encourages the development of learner thinking (van den Heuvel-Panhuizen, 2003).

2.2.2 Mathematisation

Loc and Hao (2016) described Freudenthal’s belief that the attention should not be on Mathematics as a closed structure, but on the activity, on the process of mathematisation and that Mathematics should be perceived as a human activity that is linked to reality and relevant to society. Freudenthal (1991) offered a detailed explanation of the concept of mathematisation. He explained horizontal mathematisation as going from the world of life into the world of symbols, while vertical mathematisation means moving within the world of symbols. Vertical mathematisation refers to the more formal mathematics while horizontal mathematisation denotes the informal Mathematical Literacy part.

In the horizontal mathematisation the learners derived mathematical tools which can support them in organising and solving a problem positioned in a realistic situation. The vertical mathematisation is the course of reorganising within the mathematical system itself. This encourages learners to explore many methods and arrive at shortcuts and thereby discovering relationships between concepts and approaches. The learner is then empowered to apply these realisations. Mathematising is a term used by The Organisation of Economic Cooperation and Development (OECD). It also

involves five fundamentals which are very similar to the tenets of Mathematical Literacy in South Africa.

It commences with a problem whose origins are situated in reality. The information and data are then organised according to mathematical concepts. A real-world, concrete application is transformed to an abstract problem whose roots are situated in Mathematics. The mathematical problem is then solved. The learner is expected to reflect from the mathematical solution to the real-world situation to determine whether the answer makes sense.

2.2.3 Mathematical modelling

Mathematical modelling and Mathematical Literacy bear a stronger and a more obvious resemblance. Both Mathematical modelling and Mathematical Literacy dictate an application of Polya's four basic steps in problem-solving namely understanding the problem; designing a plan; carrying out the plan; and looking back on the problem (Carrejo & Marshall, 2007). The different conceptions of Mathematical Literacy are based on the relationship between Mathematics, reality and the society. It is also believed that the learners' abilities can be developed by experiencing mathematical approaches of thinking, by probing for patterns, organising, formalising and symbolising, seeking inferences of premises, testing estimations, arguing, and thinking propositionally which form the basis of Mathematical modelling.

2.2.4 Mathematics in action

McCrone and Dossey (2007) are researchers who regard Mathematical Literacy as a fundamental requirement for all people. They recognise its critical value to learners in contexts which form part of their everyday living. They also believe Mathematical Literacy is not about studying higher tiers of formal mathematics, but about making Mathematics pertinent and empowering for everyone.

Mathematical Literacy is referred to as Mathematics in action by Skovsmose (2004). He considers the role of Mathematical Literacy in both mathematicians' and non-mathematician's lives. Skovmose (2004) based his study on two types of literacy; being either functional or critical. He described functional literacy as defined by skills a person owns to accomplish a specific job function while critical literacy speaks to themes such as work settings and political issues.

2.2.5 Mathematical Literacy in some international school curricula

In South Africa the phenomena when referring to the competency of applying mathematical knowledge to life-related problems is called Mathematical Literacy. In Australia and the United Kingdom this phenomenon is generally referred to as “numeracy”, while the United States refers to it as “quantitative literacy”. It is evident that South African educationists who found themselves positioned in a third world country also saw the need to help their learners develop the skills and knowledge that they required to assist them in becoming meaningful contributors to a community and a society.

In Australia numeracy is clearly a central component in the Queensland school curriculum, however there is no hint or account of a link between Mathematics and numeracy in this curriculum. The Queensland Studies Authority (2009) provided a succinct clarification of Mathematics and numeracy and said the focus of Mathematics is on the development of learners’ knowledge and ways of working in a range of situations from real life to the purely mathematical where numeracy refers to the assured use of mathematical familiarity and problem-solving skills not only in the Mathematics classroom, but across the school curriculum and in everyday life, work or further learning.

In the Curriculum and Leadership Journal, (2007), the Queensland Government defines numeracy as the ability to be numerate and to use Mathematics to meet the general demands of life at home, work, and for involvement in the community and civic life. Mathematics and numeracy are interconnected, and it is the obligation of the Mathematics curriculum to introduce and develop Mathematics which fortifies numeracy.

In the United Kingdom a document addressed to learners, schools and families, called the Primary Framework for literacy and mathematics makes recommendations on how literacy should be combined in daily Mathematics lessons (Primary National Strategy, 2006). The secondary curriculum concentrates on developing the skills and abilities that learners need not only to succeed in school, but also in the broader civic society.

2.3 Mathematical Literacy in South African schools

With the advent of the South African democracy there came many changes. The period 1994-2011 ushered in many changes in respect of school education. A new curriculum was developed and implemented. This new curriculum which was called Curriculum 2005 had three very distinct features. Its first feature was that it was based on a philosophy of learner-centredness. The second feature was that it used Outcomes Based Education as its mode of delivery i.e. the method of teaching. The third feature of Curriculum 2005 was that it adopted an integrated approach to knowledge (Chisholm et al., 2000). The rationale for the implementation of this new curriculum was to move away from the apartheid curriculum and to add skills, knowledge and values into the new curriculum. However, there were various shortcomings and many implementation challenges that hindered this process.

The changes which inclusive education brought to the table were rooted in our constitution that being, equal opportunities for all. The attempts by the Department of Basic Education to level the playing fields in a very unequal educational terrain is laudable however, they encountered many obstacles since change is not easily embraced.

The South African school curriculum in the post-apartheid era has undergone many changes and is still undergoing changes. Curriculum 2005 was subsequently replaced by the National Curriculum Statement and then by the Revised National Curriculum Statement. The reality was that there were approximately 40% of South African learners who were not studying Mathematics between the years 2000 and 2005. (DoE 2015). Of the 60% who did choose to study Mathematics, half of those learners studied it at the standard grade level. Mathematics was offered at two levels: higher grade and standard grade.

Mouton, Louw and Strydom (2012) remind us that the National Senior Certificate (NSC) is the exit point for South African school leavers and these examinations serve as a benchmark for tertiary education. Of great concern is the fact that many learners pre-2008 matriculated without having acquired any mathematical skills. Learners had a choice of dropping Mathematics after grade 9. It was at this point that Mathematical Literacy was phased into the curriculum. One of the reasons for the introduction of Mathematical Literacy was to reach the thousands of learners who were matriculating

without acquiring any Mathematical skills, as well as to reach the thousands who were failing Mathematics (Christiansen, 2006).

Since Mathematical Literacy was a newly introduced subject and a fundamental component of the FET band, the Department of Basic Education identified training for this subject as a priority area. They engaged with the Consortium of Higher Education Institutions (HEI) and obtained registration for the Advanced Certificate in Education (ACE) in Mathematical Literacy. One educator per school in the FET band was trained in ACE (Mathematical Literacy). Many universities introduced formal programmes in order to ensure that the teacher was empowered and retained to teach Mathematical Literacy from grade 10 level onwards. This retraining and capacitation initiative was essential because some of the teachers who were identified to teach Mathematical Literacy have had no formal university training in Mathematics. They would have last studied Mathematics at grade 12 level.

Mathematical Literacy emphasises real-world connections and the application of knowledge. It was introduced in South Africa in 2006 to help learners to think numerically in order to ensure that they can cope effectively with the practical demands of daily life. It was assumed that Mathematical Literacy would capacitate the learners to think numerically and spatially in order to analyse and interpret everyday situations and to solve problems (DoE, 2003b).

Whilst the introduction of a new subject such as Mathematical Literacy did present some exciting opportunities for all the stakeholders in education, many challenges soon arose. The resistance and the feeling of trepidation which accompanied the phasing in of Mathematical Literacy was expressed by academics, educationists, parents, teachers and learners. Many commented that it was a simpler form of Mathematics and this sentiment was contradictory to the vision with which the Department of Basic Education embarked on the rollout for the subject Mathematical Literacy (Bansilal, Webb and James, 2015).

As was expected, the various dialogues regarding the concerns around the introduction of Mathematical Literacy in the South African school context, did contribute to the stigmatisation of the subject. Mathematical Literacy was compared to Mathematics. The attitude of the teachers contributed to the stigma that Mathematical

Literacy is an inferior, unimportant subject which was introduced into the curriculum for learners who had failed Mathematics (Mbatsha, 2013).

Amid all the furore, the first group of grade 12 learners wrote Mathematical Literacy for the National Senior Certificate examinations, in November 2008.

Incidentally, the concept of Mathematical Literacy is not exclusive to the South African educational context. The equivalence of Mathematical Literacy in the United Kingdom is called Numeracy (Askew, 2002) whilst in the United States of America it is known as Quantitative Literacy (Steen, 2001).

2.3.1 The positive spinoffs from the implementation of Mathematical Literacy in South African schools

There is useful knowledge to gain from a subject like Mathematical Literacy and it is disappointing that much of this has been lost in translation between the Department of Basic Education, teachers, learners and parents. It has become that subject which learners are embarrassed to take, causing serious motivation and confidence issues which result in less effort being made by the learners (Bowie & Frith, 2006). They aim below their potential and score poor marks. With knowledge sharing and teamwork, we can change the perception of Mathematical Literacy as being a subject that is a waste of time to something truly life changing. Mathematical Literacy is not simply a subject to pass, it is a subject designed to equip learners with real life skills, giving them the confidence to step into the world and achieve at life (Vithal and Bishop, 2006).

As mentioned in chapter one, the introduction of Mathematical Literacy was intended to provide learners with an awareness and understanding of the role that Mathematics plays in the modern world. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems.

The various debates and controversy surrounding the introduction and implementation of Mathematical Literacy, is indeed a positive spinoff. This disagreement forced the various stakeholders to engage in positive discussion. Any engagement can only benefit the learner.

Every Further Education and Training (FET) learner is being skilled in some mathematical concepts whether he/she is studying Mathematics or Mathematical Literacy. Graven and Venkatakrishnan (2006) interviewed a learner who expressed positive sentiments regarding the introduction of Mathematical Literacy as a school subject. The learner believed that Mathematics was impeding progress and that certain sections of Mathematics were not necessary in the lives of learners. The learner went on to express his gratitude that Mathematical Literacy as a subject is available, by saying “with Maths Literacy I think it really is boosting a lot of South Africans’ needs, they’re achieving their goals more” (p. 30).

The phobia which many learners have for Mathematics has manifested in their mental block towards the subject Mathematics. The researcher questions whether a learner who cannot master Mathematics, qualifies for a university education. This is a rhetorical question because there are students who study at South African universities who did grade 12 Mathematical Literacy and who have gone on to study in the field of law and education.

One needs to ponder this thought that maybe it is not the subject Mathematical Literacy itself that is posing an academic challenge but the implementation thereof. These thoughts make one revert to the study at hand. Buytenhuys, Graven and Venkatakrishnan (2006) in their study admit that the role and attitude of the teacher is crucial to the success of Mathematical Literacy. The study states at “this identification with my own learning experiences helped me to realise that I was dealing with a whole group of ‘mathematically abused’ young adults. These learners seemed to have only experienced failure in a maths class” (p.31).

Mbatsha (2013) made an astute finding in his study of the learners’ perceptions of Mathematical Literacy at three selected high schools. The learners felt that studying Mathematical Literacy was a victory of personal empowerment for them. They felt that they benefited personally by sitting in a classroom and being able to understand the concepts being taught to them. Many of these learners alluded to the fact that the study of Mathematical Literacy benefitted them greatly. They were able to make sound financial choices thus increasing their entrepreneurial skills.

Learners in the Mathematical Literacy class also felt a boost of their self-confidence and they believe that this may have much to do with their ability to achieve

academically. The concepts of Mathematical Literacy are within the range and the experience of the learners therefore the learner views the learning process as personal and relevant. This finding is aligned to the doctrine as promulgated in the NCS document (Spangenberg, 2012).

The integration of subjects as espoused in the NCS document, is evident by the fact that learners can see the overlap of some content from Geography, Accounting, Economics, Business Studies, English even Engineering and Graphic Design. Integration renders the education process holistic and plausible to the learners. Mathematical Literacy contributes to the entrepreneurial skills development of the learners and equips them to identify and solve problems creatively and critically.

Perhaps the most positive aspect of the implementation of Mathematical Literacy in South African schools will have to be the fact that learners see Mathematical Literacy as a subject that they chose. If a subject is chosen by a learner, then the chances of him/her taking ownership of that choice may be greater. They are not forced to do a subject such as Mathematics. They are given a viable option or alternative.

Mathematical Literacy is taught in a context which is based on real life situations and from Mbatsha's (2013) study we glean that many learners claimed that their use of the English language as well as their comprehension levels have improved.

2.3.2 The drawbacks and challenges as a result of the implementation of Mathematical Literacy within the South African school context

Botha (2011) in her study highlighted some of the challenges in the implementation of Mathematical Literacy in South Africa. She stated that many learners, teachers and parents displayed negative attitudes towards Mathematical Literacy and regard it as an inferior subject. It was reported that some teachers regard the subject as a dumping ground for Mathematics underperformers. We are reminded of the common attitudes wherein Mathematical Literacy learners are ridiculed for having to take a subject that is considered a waste of time. Mathematical Literacy is a relatively new subject in which an entirely different teaching approach is required: mathematical content should be taught in terms of real-life situations. For this to occur successfully, specific skills are required of the Mathematical Literacy teacher. Many teachers who teach Mathematical Literacy are not trained to teach the subject. They may have

Mathematics qualifications, but they may not have the acumen or the will to teach Mathematical Literacy. Many Mathematics teachers are frustrated at the fact that they have been asked to teach Mathematical Literacy, but they are not well versed with the Mathematical Literacy curriculum. Many learners who have difficulty learning and have behavioural problems, are simply placed into a Mathematical Literacy class. This can be frustrating for both the teacher and learners. We then have a situation where we have learners who have challenges with learning and disruptive learners in a single classroom (Nel, 2012).

Many learners and parents are aware that it is more difficult to get into university if you have taken Mathematical Literacy at school. It is common knowledge that one needs a good competency level in Mathematics if one wants to enter the fields of Engineering, Science, and Health and Computer Science.

If the angle of focus and concentration is on how traumatic this process of teaching and learning Mathematics Literacy is for both the learner and the teacher, one must concede that some change needs to be mediated in order to improve the way things are, hence the rationale of this study. The stigma of Mathematical Literacy, the phenomenon of the dumping ground, the behavioural challenges, the hurdles which Mathematical Literacy as a subject establishes and the resistant and frustrated teacher, make implementation of Mathematical Literacy highly challenging (Clark, 2012).

The burning and highly sensitive issue of English as the language of learning and teaching in many South African schools continues to be a contentious one. Many of the learners from previously disadvantaged backgrounds continue to receive their education in a language that may be their second language. This is the exact scenario in my research milieu. Many of the learners are mother tongue isiZulu learners who receive instruction in the medium of English. Since the teaching of Mathematical Literacy is based on a context, contextualising the concepts requires the explicit use of language (Mthethwa, 2007). If the learner is not mother tongue English speaking, then the learner's progress will continue to be hampered by the language issue. The learner may not have a limitation in terms of grasping concepts, the issue may well be a language barrier.

2.4 Traditional teaching methods

One is inclined to think that traditional methods work effectively since we are all products of those traditional teaching methods. The researcher argues that many current teachers did not grow up using computers, yet they have embraced its positive role in our lives. Similarly, life is dynamic, and one should be brave to embrace change. It is not being suggested that we accept all the changes which are made but we can selectively embrace those aspects which enhance our lives.

The role of the traditional teacher is spelt out by Devlin, Feldhaus and Bentrem, (2013) wherein they categorise the traditional teacher as the behaviourist from the 20th century classroom. Traditional teaching methods focussed on the memorisation of discrete facts and was very textbook driven. Devlin, Feldhaus and Bentram (2013) concur with Major and Mangope (2012) on this claim of rote learning, which states that when learners do the rote learning it discourages critical thinking and the construction of their own knowledge because it is the teacher who is the one who provides the content for them. The concepts of memorisation in Botswana classrooms are very common as evidenced by previous researchers. Learning occurred passively in the traditional classroom and learners worked in isolation and the teacher was the provider of information. The printed word was the primary vehicle of learning and the teacher was the sole administrator/implementer of the curriculum who doubled-up as the sole judge of the learners' efforts.

Oddly enough, even though we find ourselves in the 21st century, many can claim that not much has changed in term of teaching methods. Shahneaz, Akhter and Yasmin (2014) observed that many teachers are isolated from other teaching colleagues and many are preoccupied, and they work in isolation.

'Chalk and talk' were the order of the day in the traditional classroom. Interaction was limited and initiated by the teacher only. The learners were expected to receive information whilst being docile and obedient. Recitation and the drill methods were favoured in the traditional classroom. Tasks were unrelated to learners' field of experience. This approach was a colonialist imported approach to teaching. (Devlin, Feldhaus & Bentram, 2013).

The traditional teaching methods focused largely on academic knowledge. Coercion, separation of learners according to race, gender, social class and academic achievement were the tenets of the traditional classroom. Upon examining the traditional classroom together with the traditional teaching methods, the reader is reminded of the rationale for change in the South African school context.

2.5 The role of the teacher in the classroom

The paradox in the South African education system is this: Curricula have evolved, they have changed and have become irrelevant over the years, yet by and large everything has mostly remained the same (Hoon, 2008). The resistance to Outcomes Based Education as a teaching method was overwhelming because change is very difficult to embrace (Giessen-Hood, 1999).

The active involvement of the teacher in leading and guiding the learning process is crucial to the success of the learning and teaching process. The role of the teacher is to ensure that curriculum is connected to the interests of the learners. The role of the teacher should be to focus on what the learners know and what the learners can do. The teacher needs to focus on what can be done in order to further develop the learners. Although the curriculum is quite examination driven Major and Mangope (2012) maintain that the lessons should focus on allowing the learners to think and construct their own knowledge.

The teacher is an integral component of the teaching didactic, so his/her role is pivotal to the way in which he/she engages learners. The teacher must connect the curriculum to the interests and experiences of the learner. This view is aligned with Hoon's (2008) thinking, wherein he makes a call that for teachers to evolve in their teaching practice so that they are not left behind as instructional technology evolves. The teacher must be able to embrace the fact that information can be sourced variously, and he/she should encourage collaborative, active learning in a real-life setting. The role of the teacher in the 21st century is to be the catalyst which encourages and promotes learning using a variety of methods. The teacher becomes the beacon which guides the learning process. The role of the teacher is to help the learners to capitalise on their strengths and to provide a constant source of learning, review and evaluation (Cravens, 2011).

2.6 What is technology?

The definition of technology is indeed vast. The definitions of the concept “technology” are also dynamic. The Merriam-Webster electronic dictionary (2017) defines the term “technology “as a noun, defined as follows:

(a) The practical application of knowledge especially in a particular area.

(b) A capability given by the practical application of knowledge

(c) A manner of accomplishing a task especially using technical processes, methods, or knowledge.
(d) The specialised aspects of a field of endeavour. (Electronic retrieval)

The Oxford Dictionary (2017) defines “technology” as a (*noun*):

(a)The application of scientific knowledge for practical purposes, especially in industry.

(b)Machinery and devices developed from scientific knowledge.

(c)The branch of knowledge dealing with engineering or applied sciences. (p.1188)

A concise definition for technology is offered by Safdar, Yousuf, Parveen and Behlol (2011). In their article it states that technology does not only encompass and include tools and machines, but that technology also embraces the impact technology has on processes and systems. The study also mentions that that technology is how these tool and machines and their processes impact on society.

Technically, technology is defined as consisting of both hardware and software (the knowledge required to produce and use technological hardware). According to Wahab (2012) technology is dynamic, however its changes are individual and peculiar to a culture and an environment. Wahab (2012) cites many definitions of the term “technology” however, he concedes that the latest definition of technology as provided by Marcus (2003) broadens the concept of technology where it is defined as “the information necessary to achieve a certain production outcome from a particular means of combining or processing selected inputs which include production processes intra-firm organisational structure, management techniques, and means of finance, marketing methods or any of its combination” (Wahab, 2012, p. 62). Existing

technology is constantly replaced or upgraded by newer technology. The rapidly evolving technology can create a general feeling of uneasiness among people because it is seen as something large, opaque, and pervasive, which constrains rather than enhances choices (Cloete, 2017). It is important to present the broad continuum of conceptualisations of technology at the outset.

Tshuma (2016) reminds us that technology cannot be separated from the economic and social context out of which it evolves, which is responsible for its production and its use. Tshuma (2016) uses the phrase that "technology has ubiquitously invaded the academic, business, government and private spheres" (p. 4) as a reminder that technology has revolutionised how business is done, how we work, manage our lives and how we communicate. Through technology humans have acquired powerful capabilities to transform their natural environments locally, regionally, and more recently, globally.

If one must encapsulate all the definitions of technology then it would have to sound like this - the technical means which people use to improve their surroundings and their ability to do work, finding a new and better way of doing things.

2.7 Technological tools in the classroom

Technology in education has a broad range of communication, information and related technologies that can be used to support learning, teaching, and assessment (Young, 2008). One immediately thinks of a computer when technology tools are mentioned. However, if we examine the various definitions mentioned thus far, we realise that technological tools in the classroom refer to a range of items. In the broad sense of the word, technology tools refer to any items that can assist the learner with the learning process. Everyday equipment which is already in the classroom can be categorised as technology according to this definition e.g., a protractor, a ruler, a calculator. These are a few examples of technology which can be used in the learning and teaching of Mathematical Literacy. Technology in one form or the other has always been used in the pedagogic environment. The printed page, the overhead projector, chalk, the chalkboard, filmstrips and any other device that was used and continues to be used in the pedagogic environment are categorised as technology. These

examples of technology are regarded as devices which are used in a confined teaching and learning environment (Duhaney, 2000).

The emergence of newer forms of technology and its uses have filtered down into the educational sector. For the purposes of this study we will look at all technology related information and communication technology. Examples of this technology are, the computer/laptop and computer projection functions, the use of the internet, tablets and cell phones. Sometimes technological tools for the classroom can be referred to as educational technology.

Many schools across South Africa use technology to enhance learning and teaching. Tools such as internet access, interactive whiteboards, computers, computer projectors, and sometimes course specific software that supports the curriculum. According to Young (2008) technological tools are more in the classroom situation than ever before. Young (2008) goes on to question whether these technological tools are being used to improve education. In South African higher education, the challenges of educational technology use are further compounded by its economic status as a developing country, as well as the "the damaging legacy of colonialism and apartheid" (Grant, 2014, p. 522). This legacy, which threatens to impede the effective and sustainable use of educational technology, is evidenced by poor internet access in some universities, scarce educational technology support expertise, the lofty aspiration to use educational technology to open up access for previously marginalised groups and a lack of an educational technology policy at the national level (Czerniewicz, Ravjee, & Mlitwa, 2006).

2.8 Effective teaching methods

Effective teaching is a relative term. However, all the research articles consulted with regard to effective teaching, concur that teaching methods must be varied, and that teaching must be learner-centred. They call for stimulation of learners by employing different teaching methods and teaching aids.

Mupa and Chinooneka (2015) argued that the concept of effective teaching as being very difficult to define. Some researchers and educationists argue that effective teaching is essential for improving learner achievement. The benefit of effective teaching is described as one that produces results that can be demonstrated in

terms of the cognitive and affective development of the learners. This is an essential component for every teaching professional. Effective teaching involves much more than presenting content and methods used to convey that content. Effective teaching methods are those that are employed in the classroom that should promote learner creativity and learner proactivity. Teaching methods that are learner-centred aim to improve learner academic achievement.

Zenda (2017) in her study on effective teaching methods for Physical Science found that effective teaching methods ensure that topics and sections are discussed and explored through interaction and sharing of perspective, views and values through which new learning can emerge. When one looks at effective teaching methods from this perspective, one realises that there is a need to create a stimulating and enriching teaching and learning environment for the learner. In order to create a focused environment for learners, teachers need to create a conducive learning environment using multiple teaching methodologies.

In order to improve the learners' academic achievement, it requires also that the teachers develop new skills and ways of teaching the subject. Improving learner academic achievement requires an approach to improve the skills of teachers as well, which focuses on the effective use of teaching methods. This implies an attempt to change the attitude of teachers to regard the processes of teaching and learning as central to their role and as their core duty. Collaboration, problem-solving and hands-on activities are effective teaching methods to improve learner academic achievement (Ogunkola, 2012).

In order to address the injustices that prevailed in education pre-1994, it was imperative that teachers in the South African context consider the methods they use to accommodate the diversity in the classroom.

King (2003) advocated that amongst other techniques that teachers could employ to accommodate learners from a diverse background is that the methods of instruction could be varied in the classroom. This article further advocates that the teaching and learning process should be learner-centred, where learners are active participants in the development of their knowledge. Learner-centred teaching embraces a variety of methods of instruction and assessment.

Mothofela (2017) declared that teachers should thoroughly plan their teaching, learning and assessment activities. Although this study was based on Economics and Management Sciences (EMS), it is relevant to this study which explores the impact that the use of technology has on the teaching and learning process. Learners have certain knowledge and skills with which they come to the classroom therefore lessons should build on learners' prior knowledge. Learners must be actively involved in their learning and the classroom environment. The teaching and learning process should move from that which is known to the learner and then proceed to explore the unknown. In promoting learner-centredness in the classroom a greater amount of time must be spent on the teaching and learning process. Furthermore, this study advocates the use of different learning media, such as television and videos.

In order to be an effective and a strategic teacher, he/she must be able to link teaching and learning. A thorough knowledge of subject content coupled with a deep understanding of how learning takes place, is paramount to be an effective teacher. The skill on how to blend learning content and learning functions effectively is the key to unlocking academic progress (Grösser, 2007). Innovative teaching strategies will not automatically improve the quality of learning. However, if teachers are supported and encouraged, then they will be more inclined to persevere in the adoption of new teaching methods. This will encourage the confidence of learners to become lifelong learner (Grösser, 2007).

2.9 Integrating technology and content in the classroom

We are reminded by Young (2008) that technology does not teach, it is the teacher who teaches. It is how the technology is used that facilitates the teaching and learning process. The availability and the accessibility of technology have made the process of integrating the teaching and learning process with technology possible. The challenges however arise when one looks at the fact that teachers, who are expected to initiate and implement the integration process, are all not on an equitable level of technological capability. So, we may have varied levels of integration of content with the available technology. This phenomenon will render the educational playfields even more unequal. The teachers' competence and adeptness when integrating technology with the content can be an advantage to a particular school. If the teachers realise the

importance of integrating technology into their lessons and if they receive the necessary professional development, then they can be empowered to initiate and implement the integration of their subject matter with technology. Teacher education programmes play a crucial role in developing teachers to integrate technology successfully into the curriculum.

Learners are familiar and comfortable using technology. In order to facilitate the effective integration of technology in the teaching and learning process, teachers should be skilled and workshopped on how to effectively use technological equipment and resources which are available. It would indeed undermine a teacher if he/she were confronted with a group of learners who were to take the lead in the classroom only because the teacher is not confident enough to handle the technology (Cravens, 2011).

Technology does not replace the teacher. It is considered a supplement and enhancement for the teaching and learning process. Ghavifekr and Rosdy (2015) in their study based in Malaysia, claim that almost all subjects can be learned more effectively with the use of technology-based tools and equipment and that integration assists in making the learning and teaching process more portable. Instead of the education process being restricted to the classroom setting, integration of content with technology serves as a catalyst in ensuring that learning can occur anywhere and everywhere.

The integration of content with technology is meant to provide tools the learner will use to create meaning. Jonassen (1996) argued that technology-based learning occurs when learners use computers as mindtools that enable them to represent what they know and then they organise their knowledge in meaningful ways. Mindtools are tools that help and extend the user's thinking capabilities and can be used for knowledge construction and problem solving.

2.10 The impact of technology on learning

The challenge is to ensure that technology is used to enable, or make more efficient, effective teaching and learning practices. The integration of technology in the education system warrants strategic planning in order to ensure that the integration with content is indeed effective. Researchers have found that the use of technology

when teaching has had an impact on the learning process. The nuclear goal of the teaching contour is to sustain learner interest and motivate him/her to learn. By integrating technology in the teaching process, the teacher will be able to maintain the interest on the learner and thus keep him/her engaged with the topic (Canough, 2013).

Higgins, Xiao and Katsipataki (2012) arrived at many findings with regard to the impact that technology has on the learning process. The collaborative use of technology when learners are working in pairs or group may teach them teamwork. The benefits of collaboration and how to work responsibly will be one of the initial skills that learners will acquire.

We are aware that the rationale in adapting teaching methods is always to improve the understanding of concepts and ultimately to improve the achievement ability of the learner with regard to academic work. Technology, when used as a short yet focussed intervention tool, can be extremely powerful and impactful in the learning process. It can be used to summarise a concept, or it can be used as a revision tool. Technology can also be used as an instrument for learners who struggle to grasp concepts quickly. The technology used is constant and available so the learner can access the information repeatedly and easily which will automatically improve academic performance by the learner. This accessibility of the technology used in the teaching process can help learners from disadvantaged backgrounds and special needs learners. The benefit thereof is that the learner can work at his/her own pace and eventually catch up with the rest of the class (Jonassen, 2006).

I have stated at the inception of this study that technology supplements the normal teaching process and is not a replacement of the teaching process. The teacher should find suitable technology or technological supplements in order to make his teaching effective. The technology should be used to enable the learners to grasp the content more succinctly and poignantly (Jonassen, 2006). The technology cannot provide feedback to the learners which is provided by the teacher in the learning process.

A finding by Higgins, Xiao and Katsipataki (2012) which makes a phenomenal contribution to this study is that the tested gains in attainment from the integration of

technology into the teaching and learning process tend to be greater in Mathematics and Science than in the languages.

One needs to focus on the fact that the teacher does not have to integrate technology into the teaching and learning process for the sake of it. The integration must enhance or facilitate the process of teaching and learning. The engagement with technology in the teaching process must make the teaching and learning process more efficient and effective. Caution should be exercised in the integration of technology in the teaching process. Learners are quite techno-savvy and when they realise that the teacher is unable to engage effectively and confidently with the technology, this may open avenues for the undermining of the teacher in the classroom (Kafyulilo, Fisser & Voogt, 2016).

2.11 Integrating technology effectively in the teaching and learning environment

In the South African educational setting, the gap between the poor and the affluent public schools has become greater in terms of resources. There are so many technology and technologically powered apps available in some public schools but some schools do not have the basic technology. Some schools are equipped with smart boards, internet access and many facilities which promote and encourage the integration of technology with teaching and learning. The great divide in terms of technological resources can become a colossal barrier in levelling the education playing fields in South African schools. One needs to also remember that not all schools have all the necessary technology available to work effectively. The disparity in available resources in schools will feature as a limitation to this study.

With the arrival of new technology into some schools, the internet, available websites, the smart board and other forms of technology are becoming a staple feature of the classroom. It stands to reason that teachers be equipped to navigate and manipulate the technology effectively so that it meets their curricular needs. This implies that training and professional development courses for teachers should be coupled with the advent of new technological resources. However, the technology available at a certain school may not be the best tool or may not be the appropriate software required to integrate the concept which needs to be taught (Kafyulilo, Fisser & Voogt, 2016).

If support is provided by the Department of Basic Education and by all other stakeholders in education, this support will promote the effective integration of technology in the classroom effectively. The support can take on the form of workshops where teachers are trained on how to use the technology at hand discerningly. A mentorship programme of new teachers and an in-service facility for seasoned teachers can also help with the effective integration of technology in the teaching and learning space.

Mishra and Koehler (2006) suggest that each teacher adapts the technology to fit his/her own style of teaching if he/she is to be effective in his/her integration of technology. Since the teacher is also mindful of the social setting within which the learner finds him/herself, the teacher can tailor the integration of technology with the curriculum to make the teaching and learning process more effective and personal. Knowing the technology is just one component of the didactical setting as knowing how to use it as a tool for education is of paramount importance. The content, the pedagogy and the technology are the components which must be examined holistically to ensure that good learning and teaching occur.

Effective integration of technology in the teaching and learning scenario hinges on three aspects concerning the teacher. Firstly, the teachers' attitude towards technology in the classroom is a major determining factor towards the implementation of technology in the education process. The second point to consider is the teachers' flexibility and professionalism in embracing technology into their classrooms. Finally, is the teacher able to engage with the learners and create a learner-centred environment for the teaching and learning process to unfold (Canough, 2013)?

The role of the teacher is pivotal to effective integrating of technology in the teaching and learning environment. From the discussion regarding the effective integration of technology in the teaching environment, one becomes aware of the challenges and barriers which could creep into the integration process.

2.12 The barriers to the integration of technology into the teaching and learning setting

Morelock (2015) in his study, found that there are many factors which could affect the integrating of technology in the educational setting. The stark reality is that inaccessibility to technology is a reason that was cited in this research study. South Africa is a classic example of how schools are very unequal in term of infrastructure and resources. In the South African context many rural schools do not have the basic facilities such as toilets not to speak of computers and internet connections (Lekalakala, 2018).

Many teachers who have achieved successful academic results throughout their teaching career find it difficult to understand and accept the need to integrate technology into the curriculum. The aspect which creates a major barrier to the integration of technology into the learning and teaching space is teacher perception and attitude. The reason this is construed as the single most debilitating barrier is because it is the teacher who is entrusted with the task of bringing in changes to the learning and teaching process Ghavifekr and Rosdy (2015).

Gina and Kubayi, (2014) chaired a joint portfolio commitee[2] meeting which was attended by all telecommunications companies in South Africa. At this meeting, the rollout of computer laboratories consisting of tablets, a docking station, a white board with a data projector and some internet access to schools were discussed. The Department of Basic Education had on its agenda that the sole purpose of the meeting was to hear from different telecommunication companies on their roles in the field of e-education in South Africa. A representative from each telecommunications company briefed the meeting on the extent of their rollout campaign in bringing Broadband connectivity in South African schools using Information and Communication Technology (ICT), and the role which it could play in the educational and socio-economic development of society.

The purpose of delivering Broadband connectivity in schools was basically to ensure that ICT was used to enhance learning and teaching. This campaign was initiated against the background of the global recognition that information and communication

[2] Committee for Basic Education and Portfolio Committee for Communications

technology (ICT) could help to improve efficiencies in commerce, government, social interaction and education. It was important for both Department of Basic Education and the Department of Communication to ensure that the gadgets that were provided in schools were used effectively, to improve the quality of education in the country.

MTN (Mobile Telephone Network), one of the telecommunication partners in South Africa sounded the warning at this meeting which highlights some of the reasons why integrating technology into the teaching and learning setting could be hampered. Mr Ahmed Farouk, Chief Executive Officer, MTN, informed the meeting of the challenges that were encountered. He stated that after installation of the equipment he visited many of the schools to follow-up and found that the computers had been stolen or were not operational. He also found that there was no sense of accountability and care towards the equipment that was installed. There were no dedicated ICT educators available, therefore, the facility was underutilised or not used at all. In many schools, the modems were available, but the SIM cards were removed and unaccounted for. Teachers did not use the whiteboard and the data projector, and they claimed that they were inadequately trained to use the equipment. Mr. Farouk revealed that laboratories were locked away and only the principals had access to the equipment. He cited an example of one school where the principal had removed all the equipment immediately after installation and locked it in a strong room for safety. The learners were not aware that there was a computer laboratory available to them.

Many teachers who feel challenged in using technology and technological tools in their everyday teaching may feel quite embarrassed if the learners must coach them on how to handle the technology. Teachers who may not have the confidence to integrate technology with teaching, may otherwise simply avoid using the available technology. If administrators or technical support staff are available to teachers on site, the issue of helplessness can be eradicated (Hennessy, Ruthven & Brindley, 2005).

In the South African context, the CAPS document offers time frames for the completion of the curriculum. Teachers may be reluctant to deviate from traditional teaching methods because of time constraints. Hoon (2008) is also empathetic in the description of how much time it requires of a teacher to sift out large amounts of information in order to unearth only what is needed for the integration of technology into the teaching and learning setting.

2.13 What are the criticisms against the use of technology in the classroom?

For this literature review, I believe that it is imperative that I offer a balanced view on what the research articles are articulating about the use of technology in the classroom. There has been a dramatic change in how technology is being used in the classroom in the last few decades. Many research studies indicate a definitive improvement in the quality of the teaching and learning processes since the use of technology has been incorporated into the classroom. There are a few research studies which warn against all the hype of introducing technology into the classroom.

Flanagan (2008) found the use of technology has not always been favourable within the classroom. Her studies found that there were numerous articles that showed that the use of technology in the classroom showed small to no effect on learner achievement. There is also the issue that technology is dynamic and as such schools may struggle to keep upgrading their equipment.

Vogel, Greenwood-Ericksen, Cannon-Bowers, and Bowers (2006) concurred with Burbules and Callister (2000) who claimed that despite this prevalent confidence that the use of technology in the classroom is generally good, this may not always be the case. Their studies suggested that technology can be used well or poorly, and its effectiveness is dependent on how it is used, by whom and for what purpose. The power of using technology in the classroom is dependent on the premise that the technology is well integrated into the existing pedagogy.

In the South African context, the issue of vandalism and disregard for property may seriously affect the positioning of technology in the classroom. The misuse of equipment and the blatant damaging of technological resources could pose a very real challenge to introducing technology into some South African classrooms (Mottiar & Bond. 2011).

The disparity in the financial status of any school going children will certainly create a further divide in accessing technology and the learners' competency at handling technological equipment. Those who have laptops and cellular phones will be more inclined to handle the technology available at school. Those learners who are not so familiar and competent with the use of technology may be overwhelmed when

exposed to it (Herold, 2017). The danger of distractions arising amongst learners as a result of the uncontrolled availability of technology resources in the classroom is also a reason that many academics caution against technology being freely accessible in the classroom space. Distractions can result in security breaches occurring at school level. Cheating during school examinations and accessing age restricted sites are very real temptations that lurk in the unsupervised and uncontrolled technology-rich school site.

There is also the sentiment that features in some articles that the teacher's attitude and the teacher's competence may serve as a hindrance to the effective integration of the teaching technology with the pedagogy. The innuendo is that if the teacher is not enthusiastic to integrate the pedagogy with technology, then the technology is just a device present in the classroom (Lynch, 2016).

2.14 Teaching learners of the 21st century

Bickham et al. (2008) wrote for 'The International Education Advisory Board' in its white paper titled "*Learning in the 21st Century: Teaching Today's Students on Their Terms"* which offers help to teachers so that they can understand and embrace ICT in order to create a better learning environment for their learners. This article defines the 21st century learners and teachers and presents the challenges educators face as these learners and their accompanying technology cross the classroom threshold. The article defines the current group of learners as millennials since they were born between the years 1980 and 2000.

The 21st century learners do not like to be bound by traditional schedules. They prefer to use technology to study and they like to be in control of the available technology. They also use technology to complete their tasks. Since the 21st century learners have been exposed to the world via the media, they tend to be more group-orientated and social in their demeanour. Current learners are highly collaborative. They share what they learn with others and this helps them create their own personal identities.

Learners are quite inclusive in their approach and have been taught to be tolerant of all races, religions and sexual orientations. They use the Internet to search for information worldwide and use hypertext links to divert from original searches and learn about new subjects. Since our current learners are practiced users of technology,

they are surrounded by digital media. The 21st century learners expect technology to support their learning and are known as the *digital natives* (Duhaney, 2000).

Millennials can perform more functions with mobile phones, handheld devices and other wireless equipment than they can with traditional computers. Technology does not amaze the 21st century learners. They simply accept technology, adapt to it and use it and are also more daring with its use (Young, 2008).

There are challenges which arise from teaching the *Millennials*. It becomes imperative that the teacher must make learning more relevant and practical to the learner. The 21st century learners crave information and do not see the need to learn the information because the information is readily available and accessible. Although 21st century learners respond best to technology, they often become distracted by the technology itself. This may result in a high learner dropout from the schooling system. In South Africa, only 60 percent of learners advance through the country's school systems (Bickham, et al., 2008).

2.15 Other research on the use of technology when teaching

Each research article or study surrounding the issue of technology and education is based in its own peculiar setting. Since the studies were conducted in different countries, the anomalies and the factors which affect that background may be irrelevant in another setting. However, the findings and the recommendations of all these research studies serve as points to ponder at an international level.

Higgins, Xiao and Katsipataki (2012) made many positive findings on the impact of digital technology on education. Simultaneously, many concerns were raised about the impact of technology on education. The view was that technology is not a replacement for the teaching process. Instead, the idea is that the use of technology serves as a supplement to the teaching process. The question which arose was whether the technology integrated teaching would help the learners for longer and would the learning process be more productive. The point raised by Canough (2013) serves as a reminder to all members of the education fraternity that the educational technological revolution is still very much in its infancy stage. The warning is that there are many challenges and obstacles in changing any system, the key is to continue to endeavour to use technology in the classroom in order to ensure proficiency.

Vrasidas, and McIsaac (2001) called for more funding and greater involvement from all the stakeholders in education in the quest for effective technological integration in education. The point raised above is echoed in research conducted by Phurutse (2005) where he points out that to improve education, we need to also examine broader factors and greater involvement within the community.

PISA (Programme for International Student Assessment) (2015) concurred with other research that the computer is the primary mode of delivery for all domains, including Mathematical Literacy. However, paper-based assessment instruments are provided for countries that choose not to test their students by computer. The Mathematical Literacy component for both the computer-based and paper-based instruments are composed of the same clusters of Mathematics trend items.

2.16 What is shape and space in Mathematical Literacy?

In Mathematical Literacy space and shape incorporates a wide range of phenomena that are encountered universally in our visual and physical world: patterns, properties of objects, positions and orientations, representations of objects, decoding and encoding of visual information, navigation and dynamic interaction with real shapes as well as with representations. Geometry serves as an essential foundation for space and shape, but the category extends beyond traditional geometry in content, meaning and method, drawing on fundamentals of other mathematical fields such as spatial visualisation, measurement and algebra (OECD, 2012)

Measurement formulas are central in this field. The handling and explanation of shapes in locations that call for tools extending from dynamic geometry software to Global Positioning System (GPS) software are included in this content category. PISA (2015) assumes that the understanding of a set of fundamental perceptions and skills is important to Mathematical Literacy's relation to space and shape. Mathematical Literacy in the field of shape and space involves a range of activities such as understanding perspective (for example in paintings), creating and reading maps, changing shapes with and without technology, inferring views of three-dimensional scenes from various viewpoints and building representations of shapes.

2.17 Teaching and learning of shape and space in the Mathematical Literacy classroom

Research has been conducted in Mathematical Literacy within the South African context and internationally, however limited research has been done focusing on the issue of technology when teaching shape and space in Mathematical Literacy. Hence it is important to conduct the current study so as to bridge the gap in the literature. The current study will add new knowledge in this field.

Mclachlan (2018) recommends that shape and space content be taught differently from the normal 'chalk and talk' method. A finding from her research article, which is significant to this research study, declared that teachers should implement various innovative teaching methods to enable active involvement to ensure that learners could make their own sense and understanding of the mathematical content of shape and space. This view is synchronous the researcher's view, which was mentioned earlier in this thesis, that the nature of teaching and learning is inextricably interwoven. Although Mclachlan's (2018) study only generated data from five grade R teachers' experiences, views, ideas, opinions and perceptions on teaching the mathematical concepts of space and shape, it is still relevant to the discussions in this study and is a source of information from a South African context. She also felt that grade R teachers would benefit greatly if they gained a deep understanding of how to implement the mathematical content knowledge of shape and space effectively.

This study conducted in Indonesia by Lestariningsih, Amin Lukito and Lutfianto (2018) described the experience of four undergraduate students' use of mathematisation in solving mathematical literacy problems with shape and space contents. The concept of mathematisation was described in detail in section 2.2.2. The findings of this study pointed out that students were able to verbally describe, use mathematical symbols that have been understood, and use appropriate modelling to obtain mathematical solutions. They were able to summarise results obtained from the operations that have been performed and they could state that the mathematical solution obtained is correct by raising logical reasons. Since mathematisation was a main process in solving mathematical literacy problems with space and shape contents, it was evident that students' mathematisation needs to be developed in the mathematical teaching space during everyday activities.

Fauzana, Dahlan, and Jupri (2019) engaged with 32 learners in Indonesia, to find out their mathematical literacy ability in shape and space content. The ages of the learner participants were similar to the participants in this research study. Data was collected by using a test and the study result presented showed that their mathematical literacy mathematisation knowledge which covers the content of shape and space is still problematic at the stage of "formulating into mathematic models, applying suitable concept and reinterpreting problem solution obtained in context." (p. 316). The study recommends that in order to overcome the problem of mathematical literacy ability, the learners can use realistic mathematic approach. This can stimulate them to be active and creative and will assist them to understand the concept.

The literature which was examined on studies conducted on shape and space content in the Mathematical Literacy classroom, resonate one common recommendation i.e. the use of innovative ways to make the teaching and learning process more creative. One is cognisant that research articles were obtained from studies which focused on both the learners/students and the teachers who were engaged with the shape and space content in Mathematical Literacy.

2.18 Using technology to teach and learn in the Mathematical Literacy classroom

The initial idea was to gather literature on how technology is used to teach the contents of shape and space in the Mathematical Literacy classroom. This was however challenging because many studies exist on how technology is used in the Mathematical Literacy classroom, but limited research has been done with the focus on teaching and learning the content on shape and space. Here are a few types of technology application in a Mathematical Literacy class that were investigated. Abidin, Mathrani, Parsons and Suriadi (2015) investigated the willingness of teachers in integrating mathematical literacy subject content using mobile technologies. This study was conducted to identify prospects and challenges for mobile learning in the Mathematical Literacy classroom. A finding of this study indicated that most schools prohibit the use of mobile devices in classrooms as they are cautious of inappropriate use of mobile devices. Many teachers felt that mobile devices distract learners from learning.

Papanastasiou and Ferdig (2006) explored the existing and prospective relationships between the use of the computer and Mathematical Literacy teaching. The focus of this study was on educational practices whilst using the computer to teach contents of Mathematical Literacy. The findings of this study differentiated between different types of activities that are done on the computer and how they are related to different levels and types of thinking which accompany different types of results. The study called for more investigative research in Mathematical Literacy and its relationship to technology.

Earlier in this chapter the various definitions of technology was provided. Information and Communications Technologies (ICT)is another broad term used to describe the term “technology”. Minty’s (2011) study which was conducted in Gauteng, South Africa, investigated the experiences of teachers in the Mathematical Literacy class in respect of how they used Information and Communications Technologies (ICT) when teaching, assessing and administrating in the Mathematical Literacy classroom. The focus of this study was conducted to gain insight on whether the use of ICT could motivate those learners who were not keen to learn in the Mathematical Literacy classroom. Two benefits mentioned by all the participants in this study are: that the use of ICT caters for all learners who have diverse learning techniques and that the use of technology in the Mathematical Literacy class engaged the learners actively in the lessons. Minty (2011) used only face-to-face interviews with Mathematical Literacy teachers, however she encouraged that “future studies could perhaps use mixed methods of data collection” (p. 118) in order to close the gap of the literature available.

The study done by Minty (2011) has great value for this research study because both studies are based in a South African milieu.

2.19 A summary of the chapter

In this chapter the crucial mechanisms of the overall aspects of Mathematical Literacy as a subject in South African schools was discussed. Particular reference to the background knowledge concerning the introduction of Mathematical Literacy was made in this chapter. A basic conceptualisation of international trends regarding this subject was mentioned. An attempt was made to locate where Mathematical Literacy is situated in the international and national milieu.

Mathematical Literacy was then positioned in the South African context and a description of the benefits of Mathematical Literacy and some of the challenges and drawbacks have been given in order to present a balanced view of the subject in the South African context.

The role of the teacher in the classroom as described in the literature was provided by defining the term “technology” and by placing parameters within which it needs to be understood. It offered an avenue to focus on whether technology does in fact have any impact on the teaching and learning process particularly when teaching the concepts of shape and space to grade 10 learners.

By examining what technological tools are available and what effective teaching methods are employed, a framework was provided by which the responses from the engagement with the participants can be analysed in terms of how they feel about the learning process when being taught shape and space. It also contributed towards arriving at a theoretical framework for the concepts of integrating technology and content in the classroom effectively.

Research indicates that barriers to the integration of technology in the learning environment, exist, therefore it was incumbent on the researcher to explore what it encompasses when one teaches learners of the 21st century. The concept of what shape and space involves was discussed based on the current literature.

In the next chapter, an effort will be made to describe in detail the research design that was employed in order to provide responses to the critical question and the two secondary questions of this study.

CHAPTER 3: THEORETICAL FRAMEWORK

3.1 Introduction

Activity Theory was developed many decades ago and the basic concepts were formulated before the word “computer” came into being. Activity Theory is a conceptual framework which has been nurtured by many academics over the years (Roth, 2012). In order to fully comprehend the effectiveness of Activity Theory as a theoretical framework for this research study, it is imperative that one examines the history or the background of Activity Theory.

Engeström’s (2016) Activity Theory is an umbrella term for a group of extensive Social Sciences theories and research. Its origins are in the Soviet psychology theory initiated by Vygotsky and Leont’ev. Activity Theory was initially known as the Cultural-Historical Activity theory (CHAT) and is applied around the world in various disciplines and areas of practice. Activity theory has its roots in the work that was pioneered by Vygotsky and Leont’ev decades ago from a single triangular model to a multi-triangular mode. The initial model has evolved to suit the academic, social and technological changes which have descended upon society (Barnard, 2010). The evolution of this theory as well as its graphical representations reassures the researcher that Activity Theory is current and relevant. It has embraced the contextual changes that are synonymous with education and the research into educational topics. According to Engeström (2001), Activity Theory is proving to be a useful tool for studying work settings and collaborative activity amongst other things. The use of Activity Theory as a theoretical framework in the field of educational research has increased significantly.

Activity Theory is characterised by its triangular model of an activity system (Engeström, 2016) which is depicted as a graphic model used in the interpretive studies as a conceptual lens to analyse data. In order to fully understand the rationale for choosing the Activity Theory as the theoretical framework for this study, one must understand what Activity theory is. The nature of Activity Theory will then be described. The ability of Activity Theory to enlighten the study, will then be deliberated upon. In order to offer an unbiased view of the theoretical framework, I will explain the limitation that Activity Theory poses to this study.

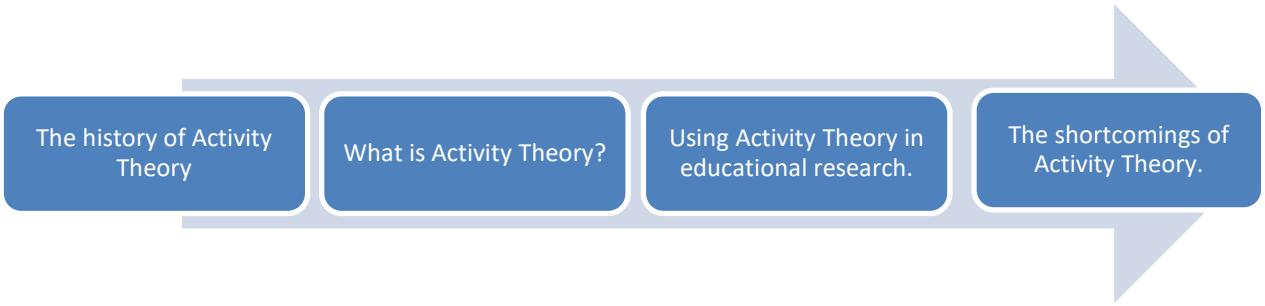


Figure 3.1: The researcher's plan on how to explain Activity Theory under the relevant themes

3.2. Tracing the historical development of Activity Theory

Activity Theory has its origins in Russia. The Russian researchers, Vygotsky, Leont'ev and Luria are the brainchildren behind the origins of this theory. Vygotsky founded cultural-historical psychology, an arena that became the foundation for the modern version of Activity Theory (Yamazumi, 2006).

3.2.1 The first-generation Activity Theory

Vygotsky, a researcher in psychology used the ideas of Marx and Engels to produce a model in order to explain human behaviour. This model depicted a triangle of interdependent components which illustrated the action which was mediated. This is referred to as the "mediated act". The components of this triangle are the subject, the psychological tool and the object. This mediated act model is currently known as the first-generation Activity Theory (Nunez, 2009).

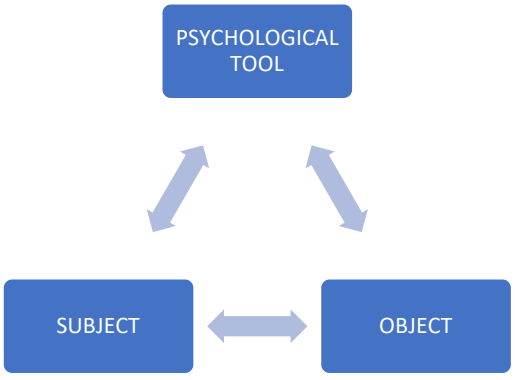


Figure 3.2: Vygotsky's model of the "Mediated Act" (Nunez, 2009, p. 54).

3.2.2 The second-generation Activity Theory

After Vygotsky's demise, Leont'ev became the leader of the research group. He later further developed and extended Vygotsky's research framework in significantly new ways. Leont'ev first observed the psychology of animals. He examined the different steps to which animals can be said to have mental developments. Leont'ev arrived at a conclusion that Pavlov's theory of reflexivity was not an adequate clarification of mal behaviour and that animals have an active relation to reality, which he called "activity". Leont'ev asserted that the behaviour of higher primates could only be explained by the ape's development of multi-phase plans using tools (Engeström & Miettinen, 1999). His study progressed to human beings and he pointed out that people engage in actions. Leont'ev then stated that the action itself does not satisfy a need, but it does contribute towards the eventual satisfaction of a need. He contextualised this by stating that these actions only make sense in a social context of a shared work activity. He drew an extra difference between activities and actions. Activities fulfil a necessity whilst actions comprise the activity (Hashim & Jones, 2007).

Leont'ev also claimed that the activity in which a person is involved is reflected in their mental activity, that is material reality is "presented" to consciousness, but only in its vital meaning or significance. The development of Activity Theory was catalysed by Russian scientists Anokhin and Bernstein who were more involved with neurophysiological studies. Eventually the evolved version of Activity Theory in neurophysiological studies came to be known as the systemic structural Activity Theory (Hardman, 2005).

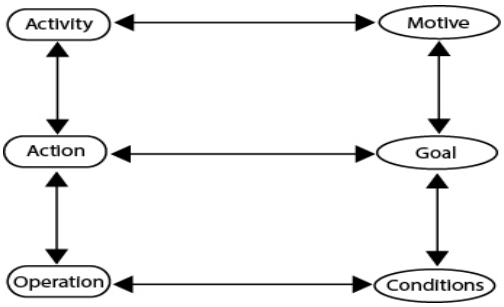


Figure 3.3: Hierarchical Activity Structure (Nunez, 2009, p. 54).

3.2.3 The third generation Activity Theory

The introduction of Activity Theory in the Western world, is primarily outlined within the Scandinavian Activity Theory strand, advanced by Yrjö Engeström. Engeström projected a scheme of activity different from that by Leont'ev and contains three interrelating units - the individual, the object and the community. Engeström's model of three interrelating models differed from Leont'ev's model which has two components - the individual and the object (Hasan & Kazlaukas, 2014).

The introduction of changes arose by importing notions from human-computer interaction theory. The concepts of "notion of rules" and: "collective subject" were introduced by Engeström into the theory. Engeström's version of Activity Theory also included groups as activity subjects. This made Activity Theory more favourable and versatile for use in the classroom setting. The Activity Theory model is useful because it helps in understanding how many factors work together to impact on an activity (Engeström, Miettinen, & Punamäki, 1999).

For an outcome to be reached or achieved, it is essential to produce certain objects, some components of which are experiences, knowledge, and physical products. Artefacts mediate human activity which is mediated by artefacts. Activity is also arbitrated by an organisation or community which may enforce rules that affect activity. The subject works as part of the community to achieve the object. An activity usually features a division of labour. (Yamazumi, 2006). Engeström's description of the Activity system will be deliberated on further in the next discussion.

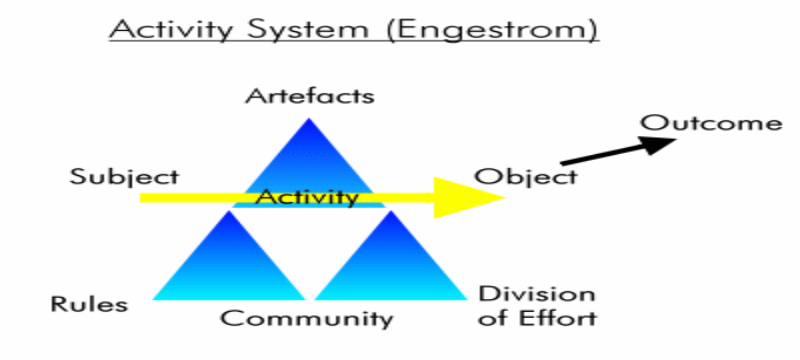


Figure 3.4: The collective Activity system as illustrated by Engeström (1987, p.136).

3.3 What is Activity Theory?

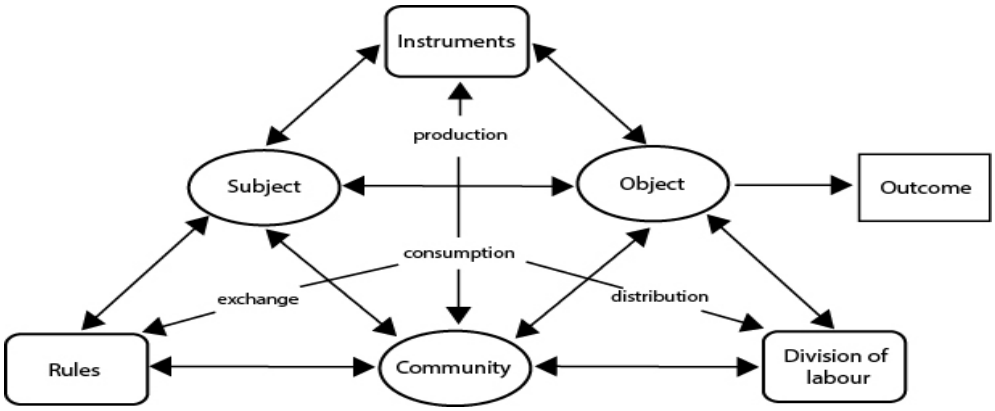


Figure 3.5: The Activity system as illustrated by Engeström (1987, p.78).

Zurita and Nussbaum (2007) posit that Engeström's Activity Theory model is elucidated effectively in an Activity system. They used the representation of the Activity system to explain how this system operates. It serves as an explanation of the framework as well as a graphic tool. Engeström's model reveals a system that has evolved over the years. The evolution of the Engeström's model displays interrelatedness as well as connections between the various stakeholders and the numerous facets which form an essential part of education. Learners, teachers and parents are nucleic components of the educational didactic. These components are not products of a mechanical system. All three components are socially and culturally embedded. All three components are regarded as "actors" in this model (Khiok-Seng, 2003).

Activity Theory can be considered a context theory or a descriptive meta-theory. It is regarded as descriptive theory because it takes cognisance of not only the engagement of the "actors" with each other but also recognises the entire scenario of education. It examines how teams/organisations influence the learning and teaching process. It also examines how the environment influences the process of education. The role of artefacts or instruments as well as its operational role in the learning and teaching process is examined (Lieberman & Miller, 2004).

The only arrow which extends beyond the triangle of pedagogy is the outcome. This indicates that the most essential feature of this model is the outcome i.e. what knowledge, skills and values with which the learner has been empowered. Engeström's model is useful and effective in order to understand how the wide range

of factors work together to impact on an activity. The unit of analysis is inspired activity directed at an object (goal). It includes cultural and technical mediation of human activity, artefacts in use (and not in isolation). Activities consist of goal-directed actions that are conscious. Elements of activity are not immobile; they can vigorously transform.

In order to attain an outcome, it is compulsory to produce certain objects (knowledge, experiences and physical products). Human activity is arbitrated by artefacts e.g. tools used, and documents. Activity is also mediated by the organisation in which it occurs such as a community which could impose guidelines which may impact on the activity. Division of labour is also a feature of an activity (Kaptelinin & Nardi, 2006).

In order to fully comprehend how the Activity system operates, it is vital to explain each component's role by way of examples. The operationalisation of Activity system's components is explained by the Mathematical Educational Community as it is utilised in the Mathematics classroom. The subject may be a single learner or a group of learners and could even constitute a class of learners. Zurita and Nussbaum (2007) explain further that the subject could also be a teacher. The object of the activity may be defined as the long term or short-term goals to advance teaching and learning of mathematical practices. The goal may even be to advance the teaching and learning of a concept or a section of work in Mathematical practices. It could be a goal located to achieve a pass in an examination. The community may comprise teachers or learners and could also constitute policy makers, the parent components as well as other community members who are interested in the education process. (Venkat and Adler, 2008). The instruments may epitomise mathematical concepts, approaches, language, gesticulations procedures, group work and the use of technology and technologically related devices (Coupland & Crawford 2006). Rules may be characterised by the employment of the correct language, assessments, curriculum protocols, assessments and questioning techniques. Division of labour may be represented as assigning tasks, interventions, cooperative arrangements and authentication of answers (Ramirez, Juárez & Remesal, 2012).

3.3.1. The three levels of Activity Theory

Hardman (2005, p. 381) promulgates that for Activity Theory the basic unit of analysis is an activity system. She goes on to explain that Activity Theory occurs on three levels viz:

- Activity towards an objective (goal) carried out by a community. This level may be as a result of a motive (need) that may not be a conscious social and personal meaning of activity. This level of Activity Theory answers to the question why the activity is being conducted.
- Action towards a specific goal (conscious), carried out by an individual or a group possible goals and sub goals, critical goals. This level of the Activity Theory answers to what is being achieved.
- Operation structure of activity typically automated and not a conscious tangible way of implementing an action in accordance with the exact circumstances surrounding the goal. It answers the question how the goal will be achieved.

3.3.2 The four principles of Activity Theory

The four principles of Activity Theory are object-orientedness, internalisation/ externalisation, mediation and development. These principles structured by Vygotsky, are concisely explained by Kaptelinin (1992. p. 11).

3.3.2.1 Object-orientedness

People live in a reality that is impartial in a broad sense. The things that constitute this reality have not only the properties that are considered objective according to natural sciences but also socially/culturally defined properties.

3.3.2.2 Internalisation/externalisation

Internal activities cannot be understood if they are analysed separately from external activities, because they transform into each other. Internalisation is the transformation of external activities into internal ones and provides a means for people to try potential interactions with reality without performing actual manipulation with real objects (mental simulations, imaginings, considering alternative plans, etc.). Externalisation transforms internal activities into external ones. Externalisation is often necessary when an internalised action needs to be “repaired,” or scaled. It is also important when a

collaboration between several people necessitates their activities to be performed externally in order to be synchronised. Whilst internalisation is closely related to the production of knowledge and the training and socialisation of learners during the activity process, externalisation is considered the carrier of new instruments that change the wider culture. It provides innovative and deliberate solutions in the activity process.

3.3.2.3 Mediation in Activity Theory

Mediation Activity Theory emphasises that human activity is mediated by tools in a broad sense. Tools are shaped and transformed during the expansion of the activity itself and convey with them a specific culture – historical remains from their growth. The use of tools is an accumulation and transmission of social knowledge. The use of tools influences the nature of external behaviour and the mental working of people.

3.3.2.4 Development in Activity Theory

Development is not just an object of study; it is also an overall research methodology. The basic research method in Activity Theory is not traditional laboratory experiment but the formative experiment which combines active participation with monitoring of the developmental changes of the study participants. Ethnographic methods that track the history and development of a practice have also become important in recent work.

All four of the above basic principles should be considered as an integrated system, because they are related to various features of the whole activity.

3.4 Activity Theory in education

As maintained by Sannino, Daniels and Gutierrez (2009), the teaching and learning process is set in a cultural and social setting. The participants in education are the learners, the teachers, the parents and the Department of Basic Education. The location of a school is influenced by the culture that is prevalent in that locality. The values of that neighbourhood are inclined to spill over into the classroom setting. The learners' collaboration with each other as well as their interaction with the teacher will be influenced by their cultural and social environment. The teacher must be mindful that everything in the classroom and the broader school campus has a cultural and a social meaning.

Yamazumi (2006) maintains that this interaction is also influenced by the classroom setting, the atmosphere in the classroom and the tools and equipment used in the teaching and learning space. Learning occurs in this milieu and through very precise activities and tasks. The tasks and activities through which learning occurs need to be pertinent and appropriate to offer the learners a degree of challenge that encourages engagement with content on a social level. The goal is for all the learners to be able to construct meaning of the content whilst engaging on a social level. The tools that the teachers engage with must be able to inspire social collaboration amongst the learners which in turn encourages effective learning. Although the focus of Naidoo's (2014) study was of the act of teaching and learning in the Mathematics classroom, it informs this study which concentrates on the teaching and learning of shape and space in Mathematical Literacy.

3.4.1 Using Activity theory in educational research

Roth (2012) is empathetic in his assertions that over the last three decades, radical and social constructivism were the predominant theories used in Mathematics education which theorise knowing and learning. It is only until recently that some Mathematics educators have emphasised the need to combine psychological and sociological approaches to theorising mathematical learning. It was then that researchers started to draw from the Cultural-historical Activity Theory. This theory emphasised that the locus of all mathematical sense is historical and political praxis and this helped overcome the problem which other theories posed because it negates the opposition between the individual and the collective, the body and the mind or the individual and its environment. The use of cultural-historical Activity Theory has grown exponentially in the last decade particularly with respect to learning in the workplace including mathematical practices at work and human-computer interaction. The Activity Theory system which Engeström explains by way of a model displays the organisational aspects of activity. This system has previously been explained in this chapter. The depictions foreground the fact that we cannot comprehend any action of a subject on the object of activity outside of all the relations to the other aspects of the activity. These relationships negotiate every moment and every connection in the pedagogic environment.

When one uses Activity Theory, the basic unit of analysis is the activity system, (Hardman, 2005), therefore in the field of educational research, Activity Theory fosters and encourages the study of a phenomenon which occurs in all its complexities. It also promotes the study to occur in a real-world situation such as in a place of learning. The language and a set of frameworks is provided to help the researcher to make sense of what it is that is discovered about the study through the various data generation methods employed by the researcher. Activity Theory supports the analysis of interviews, observations and a multitude of other data generation tools which are employed in educational research. The analysis of reflections sheets is also supported by the employment of Activity Theory.

3.4.2 Using Activity theory to explain the study

This research study is situated in the context of an educational setting. From the studies conducted by Scanlon and Issroff (2005) there is abundant evidence that Activity Theory is appropriate for research in education studies. One needs to examine the propensity of Activity Theory to accurately explain the study. This research explored whether the use of technology when teaching shape and space in Mathematical Literacy influences the learning process and it examines what technology is currently being used when teaching shape and space in Mathematical Literacy.

In using Activity Theory, this study adopted the use of technology as the tool in the community of a high school, the subject was the learner and the object was the purpose of the task. The desired outcome is to explore the impact that the use of technology had on the learning process (if any) when teaching shape and space to grade 10 Mathematical Literacy learners.

The Activity System was drawn by taking the perspective of the teacher. These concepts allowed the researcher to explore the impact (if there were any) and examine different outcomes that have been influenced by the collaboration between structures of the learning situation. This research adopted Activity Theory, as a basis for examining and analysing the data. It also provides a means for observing the emergence of patterns in human activity in terms of achieving goals and purposes, awareness, focus of attention and tools. In other words, Activity Theory views the fundamental within a dialectic development between bias and impartiality, learning and

doing, specific and shared, technical and social, and unspoken and obvious knowledge (Crawford & Hasan, 2006).

As was discussed previously, Activity Theory comes from the cultural-historical activity paradigm. This perspective allows the researcher to take cognisance of the history and culture of the context. People are placed as agents of change within that context. They define the culture through their actions using tools and they could comply with or break rules (tacit and explicit). They operate within a community that is directed by tasks through the explicit division of labour. This general system takes account of all aspects of activity in the workplace, multiple realities and interacting systems (Daniels, Edwards, Engeström, Gallagher, & Ludvigsen, 2010).

The socio-cultural aspect of Activity Theory as extended by Leont'ev (1981) advocates the study of groups of people rather than of individual people. Any activity is rooted in an immediate organisation. Definite learning and teaching approaches are fixed into the activity system of classroom learning. This is in turn embedded into the activity system of the school. Within these entrenched systems, the cultural life of the school (or other setting) is established and upheld. They argued that collective activity systems have a specific purpose or object, which participants achieve through various forms of mediation, even if individual participants are not always fully aware of the goal or object which the activity system aims to achieve. The identification of the object of an activity system is an important concept within Activity Theory research. Activity systems are not inert units. The benefit of the Activity Theory is that it deals with the method to study the process or activity of engaging with a task and the subject of an activity system is the person, or group of people whose perspective is the focus of the analysis e.g. a teacher or a group of pupils. The object is the goal or motive of the activity system (not necessarily that of individual members), e.g. improving learner outcomes (Ellis, Edwards, & Smagorinsky, 2010).

The subject and the object are influenced by the mediating tools. The rules and the division of labour determine and define how the participants are expected to behave and who is expected to do what in the achievement of the object of an activity system. Tsui and Law (2007) explain the concepts which appropriately describe this study as when a class teacher (subject who wishes to improve the results of the learners - object) positioned within a specific school (community) who might want to introduce a

new strategy and tactic for learning (tool). The management structure within the school (division of labour) regulates whether, the teacher may be constrained on the basis that the new idea is seen as deviating from unspoken norms (rules) or encouraged if the attitude within the school is to support innovation - also an implicit rule.

Engeström's (1999) argument that the variable nature of the Activity Theory allows for the various elements within the activity system to change position and settings over time and this variable nature aligns to this research study. The study advocates that should the new method for learning be successful, it may be espoused by other teachers and its implementation may become acceptable within that school. The interaction between the elements of an activity system or between different systems can provide opportunities for new learning, and for change. The continuous modification and movement within systems act as a catalyst of change to bring about transformation in education by fostering the dynamism of teaching methods.

Gifford and Enyedy (1999) maintain that, Activity Theory is an appropriate framework which comprises models of knowledge building, perspectives and artefacts to guide the design of computer-supported collaborative learning activities. The 21st century classroom supports and encourages technology-based and technology driven learning. The discussion in chapter two alluded to the increase in computer and technology supported collaborative learning as new tools of learning. Activity Theory expounds the crucial attributes of collaborative activities and stipulates how people can interact on a social level.

Liaw, Huang and Chen, (2007) used Activity Theory to investigate learners' attitude towards e-learning systems. The findings of that research study demonstrated that Activity Theory is an appropriate theory to be used in understanding and solving problems involving e-learning systems and the related environment using technology. A research study conducted by Zurita and Nussbaum (2007), went into greater detail and presented a conceptual framework and design method for the analysis of a Mobile Computer-Supported Collaborative Learning system using Activity Theory. This research study used a framework which was designed for teaching basic Mathematics skills for children aged 6 to 7 years' old. It combined human practices using artefacts such as software design and the characteristics of handhelds and it studied how they interrelate with technological artefacts such as structure, components, and

interrelationships of collaborative activities using wireless interconnection handhelds. The results of this research study showed a significant increase in participation activity and interest of basic Mathematical knowledge by the learners. Another finding was that the usage of wireless interconnected handheld computer facilities improved the participants' communication and social skills. It offered an opportunity to change classroom pedagogical practice in collaborative activity while receiving the support of wireless computer technology. Mobile devices connected to the internet are considered as Activity Theory tools that best describe and support Mobile Computer-Supported Collaborative Learning.

Activity Theory as a theoretical framework allows for its specifications to be used for any Mobile Computer-Supported Collaborative Learning activity. The examples of research and those which occur in the field indicate that Activity Theory with its focus on accumulating factors positively affects the subjective interpretations, the purpose, and the sense making of individual and group actions and operations. It also provides a useful paradigm for understanding the ways in which human experience, needs and creativity shape the design and effectiveness of emerging technologies. The Activity Theory framework has proved to be useful in describing the multi-faceted system of information and its users regardless of its contextual environment.

The amendments and extensions to Vygotsky's and Leont'ev's Activity Theory or Cultural Historical Activity Theory allowed the theory to evolve into a framework which can provide a cross-disciplinary framework for the study of how humans purposefully transform themselves, their natural and social reality through a materially and socially mediated process (Grigoryan & Babayan, 2018). The success of Activity Theory remains in the fact that when analysing human activity, it allows the researcher to examine the kinds of activity that people engage in. It continues to examine what the goals and intentions of the research study are and what objects or products result from the activity. Activity Theory also examines the rules and norms that delineate the activity as well as the greater community in which the activity occurs. Teachers should ensure that the activities are relevant and iterative, providing the learners with gradual challenges that they can engage with at a social level, so that the entire community of learners extends its collective knowledge through the construction of meaning. Teachers should also be aware that tools can limit as well as enable social interaction,

so it must be applied wisely and appropriately to promote the most effective learning (Engeström, Mietinnen, & Punamäki, 1999).

Activity Theory has an exclusive and stimulating angle in the way it shares the difficulties which are experienced in the learning and teaching arena. *Tacit knowledge* in learning has often been presented in an abstract way and it is seperated from the work processes to which the learning should apply. Activity theory provides a corrective measure to this tendency. Human activity is an essential part of work practices and it shapes work practices. Engeström (2001) reviewed the work by many theorists including Nonaka's and Takeuchi's (1995) work on *knowledge creation*. Engeström (2001) suggested enhancements to Nonaka's and Takeuchi's (1995) proposals based on the Activity Theory. He suggested that the organisational learning process should include preliminary stages of goal and problem formation which were not evident in their work. Of particular importance to the study of learning in organisations is the problem of *tacit knowledge*, which Nonaka and Takeuchi (1995) claimed to be highly personal and as difficult to formalise. They also claimed that tacit knowldege was difficult to communicate or to share with others. *Internalisation* has been described by Engeström (2001) as a key psychological mechanism which was discovered by Vygotsky , as the key term of *the theory of tacit knowledge.* It is clarified as a process of incorporating explicit knowledge into *tacit knowledge.*

Collaborative group activity in the classroom is vital in encouraging learner collaboration in the teaching space. The learner is encouraged to question, explain and justify opinions, enunciating reasoning, and expand and reflect upon the knowledge received. Edwards and Protheroe (2003) in their research study on student teachers offer some valid guidelines in the application of Activity Theory to the field of education. They show how applying Activity Theory as the framework as an analytical tool elucidates how the individual acts of mentors are linked to the specific contexts in which they occur and the more general activity of the school. The method of analysis provided by Engeström (1999) allows me to espy how individual acts are positioned within broader sets of relationships and expectations. The mentors were also located in schools as activity systems with urgent goals in a national system of highly public accountability. Edwards and Protheroe (2003) also argued that the mentor may simultaneously have two objects viz passing on her own perception of good practice,

to enhance professional development, and/or ensuring continued curriculum coverage by emphasising the importance of sticking to the plan. The question as to which of these two possible intentions is the stronger, may be answered when one considers the community within which this action takes place.

Activity Theory as a mechanism for professional change, is both a method of analysing data collected using a range of approaches, and a methodological approach used to help practitioners increase understanding of their own practice and those of others, in order to bring about change. Whilst we are shaped by the sociocultural context in which we live, we are not necessarily determined by it. Consequently, if we are mindful of the ways in which knowledge is socially constructed within our context, we can progress our understanding of the activity concerned through the examination and analysis of interactions and relationships within an activity system. This in turn can lead to decisions about where and in what ways change might be necessary.

Research and development work initiated by Engeström (2001), aims to support practice development through engaging participants directly in the analysis of their own activity system. It is claimed that through this process they are helped to understand the various cultural and historical dimensions of their existing practices and discourse in a way that would not necessarily happen using approaches such as action research. The vision is to interrogate their current practice and to model ideas for possible change. This can support the improvement of practice within a single activity system, and support practitioners in different activity systems to consider different perspectives on a given context, using this as a tool.

3.4.3 The metacognitive contribution of Activity Theory

It has been established that Activity Theory does not only include the process of learning through activities within the confines of a classroom. Learning is constructive and functional only when the learners interact with the social changes and the social interaction that is applied in the classroom (Miettinen, 2003). The teaching process, the act of teaching and the role of the teacher are mediated and re-adjusted continuously by the teachers themselves. This obviates the problem of the role of the teacher being taken for granted as knowledge changes. It is vital to develop the learners' ability for social interaction and the peer environment simultaneously in order to establish an imminent synchronicity.

Gumpel and Colan, (2000) maintained that because there is a framework for formal education and a process of instruction, the designing and the adoption of effective teaching actions is obligatory. Learners develop their social skills through differentiated teaching methods and these differentiated teaching methods enable learners to interact with each other and with the wider social environment.

Activity Theory allows the teacher the latitude and autonomy to identify and isolate the level of individual learner knowledge of each learner and the level of achievement he/she can reach. The teacher finds him/herself in that place wherein support and guidance can be provided to learners with the use of the appropriate tools, knowledge and methodology in order to teach effectively. The teacher is advantaged in that he/she can now avoid the use of a single teaching method. The teacher may encourage innovation and alternative methods in order to achieve better teaching (Campbell, et al., 2014). Activity Theory allows for the combination of various methods to facilitate the teaching of concepts. The existing knowledge social factors, the issue of feedback, communication and self-evaluation are aspects which are factored in when one applies the Activity Theory in education research. Learning is the product of an evolutionary process deeply rooted in the relations among the individual and social history (Vygotsky, 1978). Activity Theory is a socio cognitive theory and in order to implement it, one needs to awaken one's emotions and understanding before acting. Since Activity Theory advocates the use of collective activities and the expansion of existing knowledge, it serves as a framework to the teaching of socio-cognitive subjects. The combination of the collective and differentiated instructional style with the Activity Theory serve to offer the learners the prospect of building upon their prior knowledge whilst manipulating their own skills, interests, styles and talents.

Mitsi and Papasyrou (2017) in their investigative study on Activity Theory mentioned that the implementation of alternative activities in the classroom situation by the teacher aims at improving the quality of the recently acquired knowledge. It also endeavours to transform and consolidate the learners' initial cognitive knowledge which was previously referred to as existing knowledge. This approach of using alternative teaching methods is also referred to as the framework of differentiated theory where learners' profile, interests and talents are factored in when teaching them new concepts (Mitsi & Papasyrou, 2017). The framework of differentiated theory is defined as the transition from standardised teaching methods to differentiated teaching

methods, from routine and rigid teaching methods to more flexible teaching methods. The definition also embraces the concept of moving from passive guidance to individual thinking. In activating new teaching methods that are based on individuality and the acquisition of knowledge, Activity Theory aims at changing people's socio-cultural attributes of reality by constructing new ones. Its goal is to change people's natural and social reality.

3.5 The limitations of Activity Theory

There are limitations and shortcomings of Activity Theory. As one would expect, many challenges may arise in the application of a theoretical framework when one attempts to apply it to a very specific context and subject area. When one examines what criticism and comments researchers resonate regarding any theoretical framework, this exercise inadvertently makes the researcher mindful and cautious about how one engages with a selected theoretical framework. By criticising a theoretical framework or simply by highlighting its limitations makes the researcher aware of the drawbacks which could arise in the research study. It also makes the researcher circumspect about how she plans to use the strengths of the theoretical framework to advance and analyse the research data at hand.

Perhaps the first and the most mentioned limitation of the application of Activity Theory is how to accomplish a goal as a group. The activity system encourages collaborative activities hence one may not have anticipated specific contradictions which are likely to allow the activity to evolve in a direction that forces the participants to adapt (Bakhurst, 2009). The claim that Activity Theory in itself is relatively new and therefore has some abstract ideologies that may make it difficult to comprehend and apply fully, has also been levelled as a limitation.

Probably the most vocal critic against the value of Activity Theory in research is Toomela (2000). He poignantly claims that the most significant limitation of Activity Theory is the fact that it allows for the over socialising of the individual. He maintains that Activity Theory concentrates on an analyses of activities without concurrently factoring in the individual involved in the activity. The assertion is that while participation in many social activities may be valuable to one participant, other participants may favour private activities due to disposition differences. He claims that

while in general an activity can be advantageous; the activity must be meaningful to the individual. Engaging in activity that is not meaningful to the participant can basically lead to detrimental consequences. The fact that Activity Theory is rigidly structured, can hinder creativity in carrying out an activity. One of the characteristics of Activity Theory is its focus on specific and localised social patterns therefore the criticism that it does not examine society is justified. Activity systems can be intertwined within each other to a certain extent however, it is not possible to extend this notion of implanting of systems since Activity Theory is based on the principle of examining the culture and the history of the select group of participants.

By engaging with Activity Theory, the critics maintain that the universal element of the findings is eroded. Critics also point out that issues of class, race and gender tend to be subordinated within Activity Theory and that relatively little attention is paid to a single individual. Toomela (2008) claims that there are five fatal faults in Activity Theory. He claims that Activity Theory relies on a one directional view of the relationship between culture and the individual. He suggests that there should be a dialectical view of culture and individual relations. The claim is that Activity Theory focuses on specific and localised social patterns and practices and does not examine society. There is the belief that Activity Theory lacks consideration about other factors that may influence the relationship between activity and individual elements such as personality traits, socio-economic status, and lifestyle characteristics. He criticises that Activity Theory underestimates the role of signs, that it approaches the study of the mind fragmentally and it overlooks understanding the holistic nature of the mind. He also feels that since Activity Theory is basically a developing theory it is consequently inappropriate for understanding emerging phenomena such as the mind.

Critics of the Activity Theory suggest that there is a need to move closer to actual work practices rather than a replicated situation. These critics request that Activity Theory be used in a long-term process. They are vocal in stating that they do not want a theory that just helps them to make inferences. They would instead prefer a theory which helps them to make inferences which will lead to insights for design. This will serve as a bridge from description to design (Bakhurst, 2009). When a researcher employs Activity Theory, it demands that he identifies the components and the dynamics required of the research study because Activity theory does not prescribe specific

methodologies or data generation methods which must be employed. It is incumbent on the researcher to choose methods which fit the purpose of the research study. Some critics claim that this factor is a shortcoming of Activity Theory, however, the researcher sees it as a strength.

3.6 A summary of the chapter

In this chapter the theoretical framework that formed the lens with which the data was analysed, has been provided. The role of Activity Theory was explained. The historical development of Activity Theory was traced from the first-generation Activity Theory until the third generation Activity Theory, thereafter the concept of Activity Theory was then explained. Since this research study sought to explore what impact technology may have when teaching shape and space to grade 10 Mathematical Literacy learners, the focus was situated in a social context i.e. the classroom. This chapter therefore examined the 3 levels of Activity Theory as well as the four principles of Activity Theory.

The discussion of these aspects serves as an organising principle to catalyse the understanding of the cultural complexity of the classroom milieu so that the complexity of the milieu is understood rather than it being dismissed as noise. The role that Activity Theory plays in education was examined and then the researcher delved into how Activity Theory is used in educational research. Thereafter, an explanation followed on how Activity Theory was used to explain this research study. The metacognitive contribution to the field of research was also discussed. Since Activity Theory's focus on contradictions is a strength as well as a potential weakness, it was incumbent upon the researcher to discuss the limitations which Activity Theory carries as a conceptual framework. Activity Theory allows for the researcher to determine the boundaries for the activity which they explore and examine.

In the next chapter, an attempt will be made to describe in detail the research design that was employed in order to provide answers to the three critical questions of this study.

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

The aim of this chapter is to deliberate on the measures and stages used to gather and examine data to increase the understanding of the topic of this research study. This chapter also offers an overview of the research design and methodology employed as well as how each research instrument was used. Aspects covered include the research paradigm, the research method, strategy of enquiry, data generation tools, data analysis and specific information around trustworthiness and ethical issues. This chapter describes in detail the research design that was employed and the development of the research instruments. It provides justification for the use of the strategies employed in this research study.

This study explored the use of technology-based teaching methods when teaching shape and space in the grade 10 Mathematical Literacy class. This study is located within the interpretative paradigm and used a mixed method approach to conduct the research process.

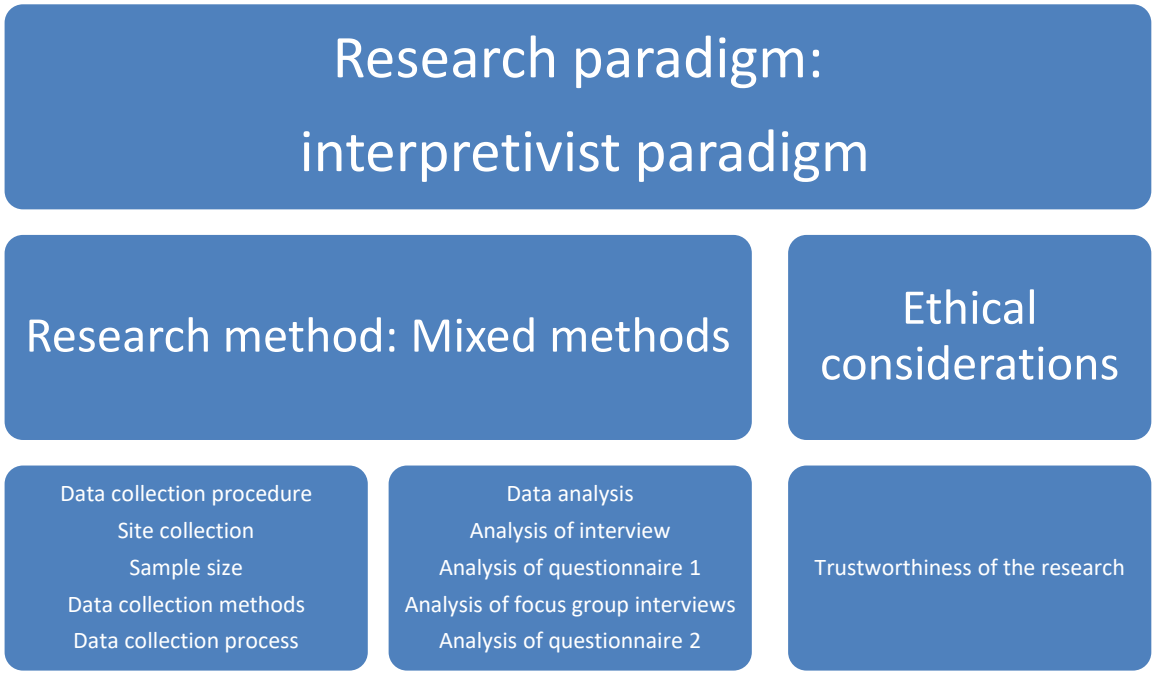


Figure 4.1 Relevant headings under which chapter four will be discussed.

4.2 Research paradigm

The use of an interpretivist paradigm in this research study is based on the belief that the participants become actively involved in all the stages of the processes. Creswell, Hanson, Plano Clark and Morales (2007) declare that participants pursue an understanding of the world in which they live therefore the interpretivist paradigm allowed me to view the world through the perceptions, experiences and contributions of the participants. I used the learners' experiences to assist me to construct and interpret my understanding from the data which was generated. An understanding of the context in which this research was conducted is critical in the interpretation of the data. The belief is that reality is socially constructed. Whilst the interpretative paradigm allowed the researcher to focus on making meaning in a context, it also allowed her to focus on understanding what is happening in a given context (Carson, Gilmore, Perry & Gronhaug, 2001).

No inflexible methods were used in this research to gain an understanding of the impact of technology on the teaching and learning phenomena and its interventions. The researcher employed methods that facilitated the in depth understanding of the lived experiences of the participants therefore engaging with various data generation methods in order to generate rich and reliable data. The researcher found support in Creswell's claim (1999) that there is no specific, right or correct method to obtaining knowledge.

As a researcher situated in the interpretive paradigm, I saw myself as if I am within the circle of the participant whilst they interpret the world around them. I felt that I enjoyed an epistemological position of one co-creating and sharing knowledge, as well as creating relations and promoting the participants understanding of different points of view. This research study carried out can be subjective, therefore the results of the study can be influenced by the opinions of the researcher (Peshkin, 1993). Data generation methods in interpretive research yields rich and thick data. The data collated in the interpretivist paradigm are usually qualitative data. However, I have used both quantitative and qualitative data collections methods within this paradigm.

The focus of this study is to explore the impact (if any) on teaching and learning when using technology-based teaching methods to teach shape and space to grade 10

Mathematical Literacy learners. Many researchers express scepticism at the engagement of the mixed method approach. However, the reservation surrounding this will be dispelled in the ensuing discussion. Cohen, Manion and Morrison, (2011) mention that for the interpretive researcher, the purpose of research is to describe and interpret the phenomena of the world in order to get shared meaning with others. Activity Theory, the conceptual framework that is used in this research study, assists the researcher in arriving at the shared meaning of this study by understanding the role and the value of the technology used when teaching Mathematical Literacy.

Since the study aims to establish if the use of technology does have an impact on the teaching and learning process, a variety of data generation techniques were used in order to ensure that the data generation processes yield thick and reliable results. A mixed method design was chosen as an approach which focussed on collecting, analysing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches, in combination, provide a better understanding of research problems than if just either one approach was used.

The characteristics of mixed methods research is basically to collect and analyse both quantitative and qualitative data. This approach mixes two forms of data in different ways. It can give priority to one or both forms of data collected. It can also allow for the data to be used in a single study or in multi phases of a study (Onwuegbuzie & Leech, 2004).

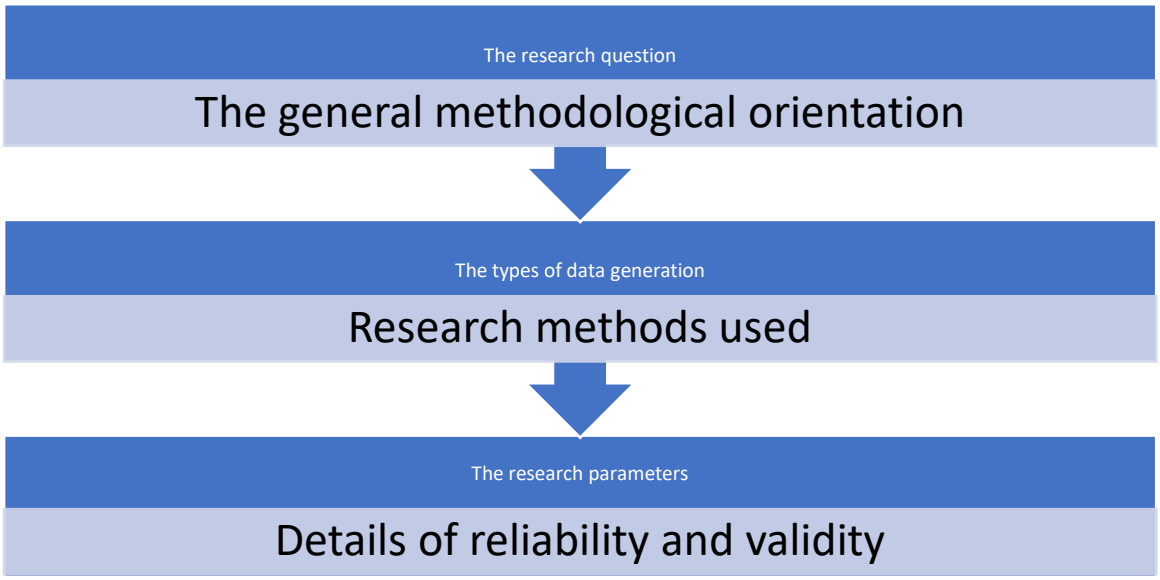


Figure 4.2: Phases of data generation.

4.3 The critical questions

This study addresses the following critical questions:

1. What technology is currently being used in the teaching of shape, space and measurement in Mathematical Literacy and how effective is its use?
2. Does the use of technology when teaching shape and space in Mathematical Literacy influence the teaching process?
3. Why technology should/should not be used in teaching shape and space to grade 10 Mathematical Literacy learners?

Since 2006 many research studies have been conducted in South Africa on various phenomena regarding Mathematical Literacy; however, this study focussed on a specific combination. It explored the use of technology-based teaching methods when teaching and learning shape and space content in Mathematical Literacy in the grade 10 classroom.

The rationale for these questions is as follows: The first focus was to establish what technology is currently being used when teaching space and shape in the grade 10 class.

Except for the use of the scientific calculator, no other technological tool or devices are prescribed for use in the delivery of lessons in the Mathematical Literacy class. I

am aware of this because of my involvement in Mathematical Literacy classes until 2015. A teacher is however expected to use tools and visuals to give learners the best possible opportunity to overcome the challenges which they encounter in the learning process. The teacher is expected to provide opportunities for the learner to engage with direction-finding technologies and the necessary skills in order to construct meaning and understanding in a given field (DoE, 2003b). Incorporating technology and technological tools into the teaching and learning situation is the prerogative of the altruistic teacher who wants to make the concepts more accessible to the learner.

There are no prescribed technological tools and devices recommended for the Mathematical Literacy classes, it rests upon the creativity of the teacher to engage with available games, visuals, tools and devices to foster the learning of any concept in the Mathematical Literacy class. This research study attempted to ascertain what technology is being employed in the grade 10 Mathematical Literacy class at Sunshine High School.

The second question sought to examine whether the use of technology when teaching shape and space in the grade 10 Mathematical Literacy class influenced or impacted the teaching and learning process. I chose to use technology and technological tools which were already available at Sunshine High School, but the actual planning of the lessons was done at my discretion. I chose some resources which were already available, but I also designed tools which could enhance the learning and teaching process of shape and space content.

The third aspect of the study scrutinises whether technology should or should not be used in the Mathematical Literacy class. In order to answer this critical question, I had to teach the lessons, then gauge learner performance and interaction during the lessons, and analyse their attitude towards the teaching and learning process from all the data generated.

4.4 Research approach

The researcher approached this study with caution because she had to deal with a vulnerable group of learners. Liamputtong (2007) advocates the use of the qualitative approach when dealing with a vulnerable group such as learners who feel stigmatised because they are doing Mathematical Literacy at school as opposed to studying

Mathematics. According to Creswell (1998), qualitative studies are appropriate since they allow the participants to vocalise their experiences and their emotions thereby allowing the researchers to collect rich, thick data which is commensurate with qualitative methods. Liamputtong (2010) believes that qualitative research is important when there is a dearth of knowledge of the chosen research area.

The quantitative aspects of this study served to strengthen the discussion and served as a means of triangulation. When collating and analysing the data, computational techniques were employed to generate unbiased data that were exclusive to that set of participants. Cohen, Manion and Morrison (2011) suggest that a mixed-method research can increase the accuracy of the data and provide a complete picture of the phenomenon which is being studied. It also assisted the researcher in analysing the data that were generated. The mixed method approach is a young discipline which serves to integrate the numeric and the narrative approaches and is fit for purpose for this study.

4.5.1 The mixed-method approach

The researcher situated herself within the interpretive paradigm in order to engage dialogically with her research questions and with her participants for the purpose of this study. Mixed methods studies are grounded on the credence that there are dominant difficulties whose complexity cannot be fully explored when the quantitative and qualitative approaches are not combined as instruments of the study. The complexity of the problem cannot be interpreted or fully understood from a single approach. The term mixed methods are increasingly used in Social Science to clarify the class of study where the researcher combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study (Johnson & Onwuegbuzie, 2004).

The truth of the study is that the experiences and challenges that the Mathematical Literacy learner faces can only be explained/verbalised by the participant. The teacher can listen to the experiences and challenges and act on it with the intention of assisting and supporting the learner. It was hoped that this will give rise to multiple realities as experienced by the Mathematical Literacy grade 10 learners at Sunshine High School. Flick (2006) champions the value of the reconstruction of subjective viewpoints that

will become the instrument to analyse the social world of the Mathematical Literacy learner. The interpretive paradigm is categorised by a concern for the individual, and it serves to create understanding in the "subjective world of human experience" (Cohen, Manion & Morrison, 2011, p.17).

The mixed-method approach employed in this study attempts to offer a balanced study without leaning towards either the qualitative or the quantitative approaches. Rather, the attempt is to use both the qualitative and quantitative data that are generated to synchronise the findings of this study. The idea is not to polarize the qualitative and quantitative approaches but to use them both to produce rich, thick data for the purpose of analysis. Denscombe (2008) confirmed in his study that the mixed method approach research can increase the accuracy of the data collated and that it can also provide a more rounded view of the phenomena which is being studied. This will obviate the challenges, the weakness and the bias which a single approach could yield. The researcher concurs with McKim (2017) when he asserts mixed methods add more value than a single method but do require more time to analyse the data because two different types of data are being analysed. Hurmerinta-Peltomaki and Nummela (2006) argued that despite the additional time required in data analysis for mixed-methods, this approach helps to gain a deeper understanding of the phenomenon being studied. The integration of the qualitative component with the quantitative component gives the reader more confidence in the results and conclusions that are drawn from the research study.

In this research study, the use of the questionnaires and the scores that the learners achieved on their pre and post-tasks, favour the quantitative approach. The use of daily reflections sheets and the focus group interview favour the qualitative approach. This approach focussed on action as it sets out to understand the Mathematical Literacy learners' interpretations of the challenges they face in the classroom as well as in their learning experiences. In so doing, some theory may emerge which may inform the Department of Basic Education and perhaps some intervention can be put in place to assist the teachers who teach Mathematical Literacy as well as the Mathematical Literacy learners. Since the interpretive paradigm is at home in the qualitative research method, it sanctions study of things in their normal locations, endeavouring to make sense of or understand phenomena in terms of the meaning that they bring to them (Jones, 1995). Whilst the subjective experience of participants

can be explored, the qualitative research also allows for a close-up, in depth study of individuals in their natural settings. Since the participant is the “human-as-instrument” (Cohen, Manion & Morrison, 2011, p.220), the qualitative method is compatible with, allows for and promotes the use of the mixed method approach.

The quantitative aspect of the mixed-method approach allows for the correlation of data. Associations can be examined between any consolidation of constant and categorical variables derived from the questionnaire. Qualitative methods might be used to understand the meaning and conclusions produced by quantitative methods which can offer precise and testable expression to qualitative ideas (Small, 2011).

Mixed methods are emerging as an essential method structure for educational research. The concept of mixed methods has rational foundations entrenched more in philosophy than in empirical reality (Terrell, 2012). Current and new research projects design is enclosed into one of the three research paradigms: quantitative involving only numbers, qualitative involving anything else, and mixed methods involving both numbers and anything else. No consideration is given of why and how the barriers between them are there, and of what advantage there may be in breaking these boundaries (Ponce & Pagán-Maldonado, 2015).

4.5.2 A brief history of mixed methods

Mixed methods began when Campbell and Fiske used multiple quantitative measures in a single study and referred to this as multitrait or multimethod research. Creswell and Plano Clark (2007) stated that these numerical beginnings helped to establish validity by comparing the outcomes of multiple methods. Different sides of a phenomenon can be identified and was later formalised as a concept known as ‘triangulation’. Triangulation is regarded as a concept which increases validity when many conclusions either confirm or confuse each other. This reduces the chances of inappropriate generalisations. Another argument for triangulation is that all methods have essential partialities and restrictions, so to use only one method to assess a phenomenon will certainly yield biased and partial results (Greene, Caracelli & Graham, 1989).

Before mixed methods were used as an approach in research, many studies used multiple methods to achieve the benefits of triangulation without restricting themselves

to any model or methodological category (Tashakkori &Teddlie 2003). However, there was still awareness of the difficulties present in producing results based on multiple data types.

With the advent of mixed methods came the argument that the epistemological differences between the qualitative and quantitative paradigms made them basically incompatible. This created a quandary for researchers who used methods of both qualitative and quantitative orientation in their studies. In order to validate use of multiple methods, the idea of triangulation as a superior approach was brought to the forefront. Mixed methodologists had an advantage in being able to capitalise on the strong point of each paradigm whilst offsetting their weaknesses. Hence, a central idea of mixed methods became the practice of quantitative and qualitative approaches. In combination, these approaches deliver an improved understanding of research problems than either approach unaided (Creswell & Plano Clark, 2007). This is grounded on the logic that a researcher cannot detach methods from the larger process of research of which it is a fragment (Tashakkori & Creswell, 2007). Mixed methods research is quite commonly known as the third paradigm in which a researcher or team of researchers combines the fundamentals of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data generation, analysis, inference techniques) for the extensive purpose of breadth and depth of understanding and validation. The focus of this approach is on collecting, analysing, and mixing both quantitative and qualitative data in a single study or succession of studies.

4.5.3 The case for mixed methods research

The epistemological justification for mixed methods in this study is that all singular methods of data generation and data types can be classified under one of two distinct paradigms (quantitative and qualitative). Furthermore, the elements from each of these two paradigms can coexist in a single study. The quantative data generated from the study can be supported, narrativised and explained using the qualitative data that was generated.

The empirical justification for mixed methods is that there should be a special focus on mixing or integrating when using elements from both quantitative and qualitative paradigms in the same study, as these are fundamentally different in method. The fact

is that the triangulation of epistemologies/methodologies/methods of mixed methods provides better quality data than a single approach (Onwuegbuzie & Collins, 2007).

4.5.4 The shortcomings of engaging with mixed methods

Just as one would experience the strengths and weaknesses of any approach to a research design, it becomes incumbent on the researcher to be mindful of the shortcomings which the research approach or methodology could pose in this study.

In applying several standard validity checks to the construct of mixed methods as envisioned here, the researcher concedes that mixed methods have low hypothesis validity and are more purely a perspective on how research can be done, and not on what research is. Mixed methods can lead to bias against other real-life forms of research and are likely to limit the research community's potential for creating new and more effective methods (Creamer, 2016). There are several distinct challenges that face any researcher who decides to use mixed methods for his/her research study. The first challenge concerns the skill of the researcher. It is critical that researchers are aware of their abilities and whether they can cope with the demands of utilising a mixed methods approach (Creswell & Plano Clark, 2007). The second, and the most pressing challenge, is that of deciding which mixed method research design is most appropriate for your study. This will depend upon where you feel your project lies on the range of research approaches. The question remains as to how your approach will be handled. Will it be purely mixed which gives equal status to both quantitative and qualitative information or will it be dominated by one approach or the other (Johnson, Onwuegbuzie, & Turner, 2007)? In order to make sense of the host of mixed method research designs, Creswell and Plano Clark (2007) have synthesised these into four main typologies—the triangulation design, the embedded design, the explanatory design and the exploratory design.

4.6 Data generation procedure

The most constructive manner to elucidate whether a data generation technique is effective or non-effective, is to focus on the purpose of one's research study. The data generation methods and techniques employed must be able to collect the empirical data concisely and answer the research questions. The researcher was mindful of these principles whilst employing and engaging with the interpretivist paradigm. The

researcher focussed on data generation methods which set out to understand the participants' interpretations of the world around them in the context of the Mathematics Literacy grade 10 classroom. and their engagement with the shape and space content. The chronological order in which the researcher set about generating data is listed below.

A summary of the data generation sequence which was followed by the researcher:

- Addressing the Mathematical Literacy learners and inviting volunteers.
- Handing out of consent and indemnity forms to the learners (Appendix B)
- Collection of consent and indemnity forms
- Completion of questionnaire 1 (Appendix E)
- Focus group interview 1 with volunteers (Appendix D)
- Pre-task activity
- Presentation of 3 lessons
- Reflections sheets to be completed at the end of each lesson (Appendix G)
- Focus group interview 2 with volunteers (Appendix D)
- Presentation of 3 lessons
- Post-task activity
- Focus group interview 3 with volunteers (Appendix D)
- Completion of questionnaire 2 (Appendix F)

Upon the invitation of the resident Mathematics Literacy teacher, I visited the class and briefed the learners on the research study. I explained the format of the data generation stage and I encouraged them to think about being part of the research study and to discuss this study with their parents/guardians. The consent and indemnity were handed out to all 35 learners. In the week that followed 31 learners agreed to participate in the study and returned the completed consent and indemnity forms. The 31 participants were addressed for a second time. The exact sequence of the rollout of the research study was explained. Learners were also encouraged to participate in the focus group interviews. Volunteers to the focus group interviews indicated their willingness to be part of it by a show of hands. A schedule of the focus group interview questions was handed out to the volunteers so that they could ponder over the questions before the interviews were conducted.

Questionnaire 1 (Appendix E) was handed out to the learners and I oversaw the process as they answered the questionnaire. This was done to assist the learners should they require any clarity regarding the questions on the questionnaire. The use of the questionnaire 1 with 25 questions served as a means for the researcher to understand the participants better. The nature of the questions helped to extract biographical details, the personal experiences of the participants, information on their social life and information on how they use technology. From these responses, the researcher gleaned personal information about the participants as well as information about their academic standing.

The pre-task was conducted subsequently. The researcher was careful not to encroach on the teaching time of the class.

The task at hand was to identify what technological resources were currently in use in a grade 10 Mathematical Literacy class whilst shape and space was taught. The best source of this information would be from the learners themselves. The researcher used the focus group interviews (Appendix D) in order to learn more from the participants about the current situation at school regarding the use of technology in the Mathematical Literacy classroom.

Since I serve on the management team at Sunshine High School, I cannot just assume to know how lessons are taught in all departments at Sunshine High School. It is also outside my jurisdiction to question teachers who do not fall into my ambit of administration. It would be illicit of me to report on any information during this research study that I may acquire via our management meetings. The focus group interviews allowed the participants the freedom to communicate about their experiences at school, in the Mathematical Literacy class and in general to the researcher. Any information obtained from the focus group interviews would be legitimate data because all research protocols and procedures were followed.

The researcher conducted lessons with the grade 10 learners on the topic of shape, and space. Each lesson covered an aspect of shape and space. The initial lesson was a pre-task exercise. The actual lessons encompassed the following:

- calculating the perimeter of the square, rectangle, triangle and circle.
- calculating the area of the square, rectangle, triangle and circle,
- calculating the volume of the square, rectangle, triangle and circle.
- calculating the surface area of cube, box. cylinder and the triprism
- problem solving when the shapes are combined.

The actual teaching time spanned over 6 lessons. These lessons were planned such that they incorporated the use of technological resources in the teaching process. An application task was prepared per lesson. At each lesson, participants were expected to do an application task and to complete a reflections sheet based on the lesson. After all lessons were completed, the participants completed a post-task and the volunteers to the focus group interview were interviewed again.

Three focus group interviews were conducted with volunteer learners from that class. One focus group interview was conducted at the beginning of the data generation process i.e., before any lessons were taught, the second one was conducted midway through the process i.e. after 3 lessons had been taught and the final one was done after all the lessons had been taught.

The planning phase of the lessons was extensive. I know that the content of shape and space is part of the grade 9 geometry syllabus and the learners had already been taught lessons on shape and space in the current grade 10 Mathematical Literacy class. The data generation took place at the latter part of October into November. The syllabus in Mathematical Literacy had been completed so the content of shape and space had already been taught. I acknowledged that it is my responsibility to teach my allotted lessons according to the prescripts of the CAPS document whilst not encroaching on the teaching time of the resident Mathematical Literacy teacher.

The lessons were designed according to the requirements as per the CAPS documents. The analysis of questionnaire 1, the analysis of the scores of the pre-task and the information gleaned from the first focus group interview conducted with the learners, gave a clear indication of the extent of planning which needed to be infused into the lesson.

Based on both my experience as a Mathematical Literacy teacher and the information sourced from questionnaire 1, the pre-task scores and the first focus group interview, I planned and prepared my lessons to cover the content of shape and space. Some aspects of lessons such as the power point presentations were designed purposely i.e., to create a visual depiction of how a solid shape is formed e.g., a cube is formed by 6 exact sized squares. I am aware that one cannot just use technology and technological tools in a lesson and expect that the learner performance will improve. Technology and technological tools must be fit for the purpose of the lesson. They must be used to enhance the teaching and learning relationship. The teaching tools, aids and devices must complement the lessons and must be used strategically to consolidate the concepts of the lessons that are being taught. Since one should use teaching tools purposefully, a great deal of consideration and planning precedes the actual teaching and learning process.

Although there are so many videos, resource packages and workbooks available on the internet which covers content applicable to school curricula in education systems across the globe, some of these are not prescribed, vetted or recommended resource material which can be used per se by the subject teacher. The researcher, when previewing these resources, had to ensure the fitness of the resource for the purpose of this study. In South Africa there are Professional Learning Communities (PLC) formed by subject teachers and they design tools, techniques and resources to ensure greater productivity in the classroom. These committees are supported by subject advisors and by lead teachers. Perhaps these committees can preview, recommend and sanction suitable available technology, technological tools and resources for use in the Mathematical Literacy classroom.

The nature of this study is exploratory so the researcher investigated what design and what technological tools and resources can effectively impact the learners as they engage with the content of shape and space. I was also careful to engage with technology and technological resources which are already available at the data collection site. This would make the research study laudable and realistic. It would only be the planning and the design of the lessons which would be influenced by the input and effort of the researcher.

The researcher sourced some material from the internet which she felt could enhance the aspects which she wanted to teach. One may ask why available material was used as part of the research study. I felt that if a good tool, resource or technique exists and if that tool, resource or technique captures the essence of the lesson, then why should the teacher reinvent the proverbial wheel to teach a given concept. I am cognisant of the millennial learners need to learn visually. The concept of the millennial learner and how they learn was deliberated upon in chapter 2.

The available material on the internet which could enhance the lessons was previewed e.g. YouTube videos. I only used videos which captured the objective of the lesson succinctly. Previewing of the resource is part of the planning. I also safeguarded that the video was of a suitable length. The 55-minute lesson could be punctuated with the teacher's instructions to the learners and teaching of concepts and techniques for the lessons, followed by the YouTube video/PowerPoint presentation and finally the completion of the application task for the lesson. I had to be mindful of the accent of the presenter/teacher in the video and I had to ensure that the terminology used in the videos were aligned to South African Mathematical Literacy terminology with regards to the content of shape and space.

Links to the videos, which were selected and previewed for the lessons, were copied and stored in an electronic folder which contained all the resources needed per lesson. This was done to ensure a smooth flow in the lesson. The research also ensured that she had mobile data available in case there was a disruption in the internet connectivity during the lesson. It was mentioned that internet accessibility is not available to learners at Sunshine High School, but it is accessible to the staff. Hence, I was able to use the internet during the lessons. The use of a computer/laptop, the internet, the data projector and the white board were the technological tools which were used during the data generate phase. These tools are available at Sunshine High School.

The YouTube videos, the PowerPoint presentations and the worksheets with application activities were designed to consolidate the aspects that were taught during the lesson. The application tasks would support the researcher in assisting the learners to strengthen their grasp of the concepts. The researcher would also be able to assess whether the learner understands the content or whether the learner requires

extra support. The researcher is aware that learners learn at their own pace and that each learner must be afforded support in order to master the application of a concept.

The worksheets based on the content were designed to allow for scaffolding in the teaching process. A new concept was taught at each lesson, building on one that was already taught. The daily reflections sheets served as a conduit for the researcher to ascertain whether the concepts were being grasped effectively and whether the learners were benefitting from the lessons. The researcher's intention in using a reflections sheet was multifold. One reason was to ascertain whether the learners understood the lesson and it allowed her to gauge their experiences during the lessons. Another reason was that the researcher planned to use the feedback from the learners to tweak the future lesson should the learners' responses indicate that they were struggling to understand the concepts being taught. This data generation method was designed very specifically to examine the teaching and learning process however, it gave the researcher some insight into the learner's ability to express himself and it revealed the learners command of the English language at grade 10 level. Although this information may not have any bearing on this research study, I believe that when one teaches a subject to a learner, one needs to have a holistic understanding of the learner's strengths and weaknesses. I am of the belief that any subject teacher should approach his interaction with the learner by fully engaging with the learner and not just to fulfil the academic objectives (Alber, 2018).

Questionnaire 2 was completed at the end of all 6 lessons. Questionnaire 2 helped the researcher to glean whether the sentiments echoed by the focus group participants, was the same/similar sentiment shared by the rest of the class. This greatly assisted the researcher in answering critical questions two and three. The twenty questions asked in questionnaire 2 served as a means of triangulation to this research study.

4.6.1 Site collection/setting

The researcher was guided by the research questions in determining the location at which the data needed to be collected. Many factors contributed to determining the criteria for identifying the most suitable location at which the research study should be conducted. The choice of a public high school that offered Mathematical Literacy from grade 10 level was a prerequisite. The school had to have internet facilities and a data

projector available on site. Although the internet facilities are available at Sunshine High School, the learners have no access to it. The computers had to be accessible to the learners. Sunshine High School does have these facilities, but the computers are accessible to the CAT learners only. Arrangements were made with the departmental head of Mathematics, Sciences and Technology for access to be granted to the computer room.

Since the researcher needed to ascertain what forms of technology were currently being used at Sunshine High School to teach Mathematical Literacy to grade 10 learners, the researcher had to divorce herself from her role as a member of the management team at school and rely on the feedback from the learners to answer that question.

The next question which needed to be answered was how the use of technology would influence the teaching and learning process when one engages with the teaching of shape and space to the grade 10 learner. This influenced the next criteria, viz that the school had to have technological resources such as computers, a data projector, a white board and internet access. The issues of expense, time, accessibility of the venue, and the frequency with which the researcher needed to interact with the participants, determined the choice of the school at which I conducted my data generation phase. Since the researcher needed to interact with the learners on a regular basis, the need to be near the participants, necessitated the choice for the location. Sunshine High School was chosen because the researcher is a member of that staff. The researcher had obtained written permission from the University of KwaZulu-Natal and the principal of Sunshine High School before any form of contact could be made with the learners. Copies of the permissions slips and gatekeeper's permission (Appendix A) are included at the end of this research study. To safeguard the collegial relationship which I enjoyed at Sunshine High School, I also obtained oral consent from the departmental head of Mathematics, Sciences and Technology from Sunshine High School as well as from the teacher whose learners I interacted with.

All lessons were conducted outside of the learners contact time with the subject teacher. Lessons were conducted in the learners "free"[3] period or after school hours. Focus group interviews were also only conducted at the convenience of both the learners and the researcher. The learners' contact time was not compromised

4.6.2 Sample selection

Once the researcher was allocated a class of grade 10 Mathematical Literacy learners by the resident Mathematical Literacy teacher, permission was sought from the parents of the learners who volunteered to be part of the research study (Appendix B) The parents had to complete a reply slip and the learners handed it in to the researcher before the data generation phase could commence. For the purposes of this study, a convenient, plenary session was conducted with the learners to invite the participants to be part of the study. The learners were informed of the nature and format of the research study. Some of the learners seemed keen when they heard that the lessons that would be taught would cover the content of shape and space. Their eagerness to be part of the lessons was that these lessons would serve as revision for the upcoming final examinations. Some learners were not happy that the lessons and the focus group interviews would be conducted outside of class time. The researcher felt that those who volunteered after knowing all the facts about the research study were more likely to attend all the lessons and to co-operate during the lessons.

Employing purposive sampling in data generation is critical in research because the data generated is expected to provide a better understanding of the theoretical framework. Purposive sampling technique is also referred to as the judgment sampling. This is when the researcher consciously chooses a participant because of the qualities the participant possesses, in this case the participants were Mathematical Literacy learners in a grade 10 class. When the researcher embarks on the research study, he proceeds to find individuals or groups of people who can and are keen to offer the evidence/data via knowledge or experience These individuals or groups of people have to be identified by the researcher and they have to be conversant with the expectations of the research study. Of far greater importance is that they need to

[3] This is normal teaching and learning/contact time for the learner but the subject teacher is absent/unavailable to conduct the lesson.

be available and willing to be part of the research study. The idea of purposeful sampling is categorised further. One such category is homogeneous sampling. This form of sampling focuses on prospective participants who share similar traits or specific characteristics. For example, participants in homogenous sampling in education would be similar in terms of ages, grades, subjects which they study at school etc. The technique is to concentrate on the specific connection needed to promote the research study and how it connects to the research topic (Etikan, 2016).

4.6.3 Sample size

An average class size in a public school is about 35. For the purposes of this scale of study, a group of 35 participants was deemed enough**.** Although all the learners in the Mathematical Literacy class were invited to participate in this research study, only 31 learners responded favourably.

4.6.4 The role of the researcher

The general role of a researcher in educational research is to examine and enhance educational practice for personal development and to review current practices. Whilst conducting the research study, my role was to ensure that data is collected in a credible manner. Credible data collection will help validate the finding of the research study. My role is to expand the body of knowledge in research whilst attempting to improve the teaching and learning milieu. Just like Suryani and Widyastuti (2015), I believe that another role which I assume in this research study is to illustrate how my role of the teacher has evolved since my teacher training was done in the 1980's.
My role as the researcher was to ensure complete compliance to all ethical considerations throughout this research study.

4.7 Data generation tools

As the researcher entered the classroom of the Mathematical Literacy learner, she needed to be cautious of, and sensitive to the vulnerable status of learner who sits in a Mathematical Literacy there. General attitudes to learners who study Mathematical Literacy was discussed in chapter 2. Sensitive research can be a potential threat to those who are involved in the research process. The researcher designed research tools such that she could interact strategically and intensively with the learners. This

multimodal design of data collection tools was necessitated by the nature of the research study and I was inspired by Hayes (1992) who advocates that multimodal approach to data generation yields substantial, rich data from research carried out in the participant's natural setting.

To address the research questions, data were collected using the following data generation tools. A discussion follows on how each data generation tool was deployed in this research study.

- Learners task scores (pre-task)
- Questionnaire 1
- Focus group interview no. 1.
- 3 Lessons were taught.
- Daily reflections sheets were completed by the learners
- Focus group interview no. 2.
- 3 Lessons were taught.
- Daily reflections sheets were completed by the learners
- Focus group interview no. 3.
- Learner task scores (post -task)
- Questionnaire 2

4.7.1 Questionnaire 1

I agree with McMillan and Schumacher (1993) that the questionnaire is a popular technique to elicit data from participants. It is a cost-effective collection tool and the standardisation of questions can yield reliable data). All the Mathematical Literacy learners who volunteered to be part of this research study in the class completed the questionnaire. Anonymity was ensured and the researcher explained that should a learner not understand any question from the questionnaire, they could ask for clarity. This was to assist the mother tongue isiZulu speaking learners in case they experienced challenges when answering the questionnaire which was constructed in the medium of English. The learners were invited to complete the questionnaire on a voluntary basis. The fact that they were keen to fill out the questionnaire indicated their willingness to be part of the study.

The first four questions attempted to extract biographical information from the participants. Questions 5 to 18 focussed on the participants' personal experiences in education whilst the last six questions focussed on the participants' social life and their interaction with technology. Some of the questions required the learner to simply tick the appropriate block whilst three of the questions require the participant to tick the appropriate block and explain his/her choice. The standardised questions will assist the researcher in gathering data addressing the critical questions of the research study. The inferential statistics from the Science Planning and Scheduling System were used to generate graphs and tables to arrive at significant findings. The results were used to introduce a theme or to integrate the information with a theme or a trend in the data analysis stage of the research project.

4.7.2 Pre-task and post-task

To answer the second critical question effectively, a pre-task exercise on the concepts involved in shape and space sections of grade 10 Mathematical Literacy was given to the participants. This was assessed and kept aside. The task was repeated after all the lessons were taught to the class. The purpose of the pre-task exercise was to establish whether the participants understood these concepts since they had already been covered in the classroom as per the annual teaching plan (ATP). The scoring of these pre- and post-tasks served as quantitative data for the researcher in order to establish whether the use of technology utilised in the lessons had any effect on the learning of these concepts. As a researcher and foremost as a teacher, I found it incumbent on me to share the results of both the pre- and post- task with the participants just as an exercise of remediation.

Long and Blackwell (2015) advocated that pre-task activity has a major function in making learners aware of the aims of a task. The pre-task is used in order to simplify the target tasks. This task also stimulates the learners' schema or prior knowledge to perform a task in the more limited time. For the purposes of this research study, the pre-task was used for a twofold purpose: to activate the participants into participating in the research study and to measure their level of understanding of the concepts. There are different types of pre-task activities which activate learner participation which have been classified into three groups: previewing activities, pre-reading

discussion through group work and brainstorming (Yusuf, 2011). Previewing activity was used in this context.

There are many pedagogic reasons afforded for the implementation of a post-task option. One reason is that the participants are given an opportunity for a repeat performance of a task. Another reason for a researcher to engage with a post-task activity is to encourage the participants to reflect on the tasks that were performed. This strategy also encourages the participants to focus on the problematic areas (Bygate, 2001). Conducting the post-task served to offer all the above opportunities to the participants. It also served to round-off and conclude the lessons and to give the participants a sense of completion.

4.7.3 Focus group interviews

The rationale in using focus group interviews was to enable the researcher to answer the first and the third critical questions. The participants would be able to explain and substantiate what technological resources are currently being used in their classrooms without any trepidation. They could also elaborate on how they would like a Mathematical Literacy lesson to be. The focus group interviews were purposively selected to insulate the participants from the vulnerability which they could experience as a result of being a Mathematical Literacy learner. They would be in a familiar group, offering opinions on aspects that they have in common.

Some researchers also refer to focus group interviews as focus group discussions. A focus group interview is an interview that is conducted amongst a small group of people wherein a specific topic is discussed. These scrupulously planned discussions are intended to obtain insights, observations, thoughts and sentiments on a distinct or a very specific area of interest, in an unobtrusive, non-threatening context (Patton, 2002). The participants are encouraged and allowed to respond to the responses of the other participants. Ideas and thoughts can be shared, disputed, debated, challenged and concurred with, amongst the participants. The characteristic feature of focus group interviews is that they catalyse the process wherein participants can discuss issues which they consider to be important. This characteristic, as highlighted by Struwig and Stead (2001) made this data generation method fit for purpose. The

participants who engaged with the moderator, were all Mathematical Literacy learners who can be regarded as being in a vulnerable position.

Litoselliti (2003) describes the individual who conducts the interview in the focus group context as the moderator. The moderator aims for similar levels of understanding therefore the group are special in terms of purpose, size, composition and procedures. The moderator did not aim for diversity. Hence, in this study only Mathematical Literacy learners from that specific class were invited to volunteer to be part of the focus group interview.

Focus groups usually comprise four to eight research voluntary participants. The motivation for this number is to ensure that the group does not get too large and unmanageable. The interview process is usually conducted in an environment or location that is comfortable, unintimidating and quiet. The prescript for the location in which the interviews are to be held, is understandable. One would expect that for the process to be effective, fruitful and for the recording to be clear, one would need to work in an environment that promotes interaction without any reason for distractions (Rana & Muhammed, 2013). The skillful moderator must have a set of pre-determined questions.

Since the researcher had stressed the value and importance of voluntary involvement in the study, it is the schooling experience of each Mathematical Literacy learner that gave shape and weight to the study. The question of the language barrier between the interviewer and the interviewee was carefully considered during the interview process. An interview schedule was presented to the volunteers well before the interview to ensure that any misconceptions or misinterpretations could be eradicated. A consent and indemnity form to be duly signed by the parent/guardian was handed out together with the interview schedule (Appendix D). A teacher who serves as a counsellor at Sunshine High School was present during all the focus group interview sessions. The counsellor's role was to safeguard the participants in case they felt overwhelmed or decided to recuse themselves during the sessions.

A very important factor to consider is the fact that focus group interviews are time consuming and personal interaction is not guaranteed to be cordial. The questions must be carefully worded so that one elicits the desired responses. The focus group interview allowed for flexibility and encouraged probing. A tape recorder captured the

interview process and transcripts of the interview allowed for thematic analysis of the data. The participants were informed that the entire process will be recorded and that the transcripts of the interviews will be made available to them. The confidentiality of the identity of the participant was guaranteed and anonymity was ensured during the entire process. Further explanations of this aspect will follow in the data analysis stage.

The focus group interviews were conducted at various points of the data generation stage. The commencement of the focus group interviews before the lessons were taught helped the researcher to familarise herself with the learners that would constitute the class group. The subsequent focus group interviews showed the promise of being easier for the participants since they were familiar with the researcher and the expectation from the researcher.

4.7.4 Daily reflections sheet

Each participant who was part of the lessons, was expected to fill in a daily reflections sheet. Although this research study is not a reflective study, the researcher used this tool to intensify her engagement with the learners. The researcher is known to the participants only as a member of staff. In order to get to know the participants and to understand how they felt about each lesson, the researcher saw the benefit of using the reflections sheet. The daily reflections sheet help gather data on the participants' response to the lesson. The use of this data generation technique provided regular feedback to the researcher. Based on the feedback the researcher could also gauge the level of understanding or non-understanding of the lesson taught. It served as an avenue to get the participants personally involved in the learning process. The participants' suggestions served to enhance the quality of the delivery of the lessons. The participants used these reflections sheets to express any shortcomings and gaps which they may have experienced during the delivery of the lessons. The researcher then uses the subsequent lessons to intertwine and weave the information and techniques which the participant may have noted as a challenge.

4.7.5 Questionnaire 2

Questionnaire 2 was the final data generation method used in this research study. The questionnaire was designed as a 5-point scale. The response system is as follows: Strongly Disagree (1), Disagree (2), Neutral (Neither Agree or Disagree (3), Agree (4)

and Strongly Agree (5). The participants simply needed to respond by indicating a degree of agreement or disagreement to the statement given. This is done in a multiple-choice format. The twenty statements in the questionnaire used in this study pertains to the issue of technology in the teaching and learning environment.

The greatest benefit of using this form of the questionnaire is that it does not force the participants to take a position on a given topic. It allows for a level of agreement or disagreement thereby making the responses easier for the participants (Cohen, Manion and Morrison, 2011). It serves to accommodate the participant who is also neutral on the topic. The responses in this questionnaire are also easier to code when accumulating the data. There are limitations of the use of this type of questionnaire and Hartley (2013) claims that respondents/participants may simply tick the same box for all items without carefully considering the meaning of each question/statement. The researcher's presence and assistance when the participants completed this questionnaire may have to an extent, circumvented this challenge.

4.8 Data Analysis

This research study generated a large amount of data. The rich, thick data which emerged required careful and thorough scrutiny in order to address the three critical questions. The data analysis is a process of bringing structure, order and meaning to the mass of collected data. The abundance of qualitative and quantitative data generated from the various data generation methods made the data analysis stage very complex. The questionnaire responses were analysed question-wise, and the data were captured for the information to be displayed by way of visual presentations which proved to be time consuming.

The analysis of the pre and post-tasks quantified the achievements of the participants. This evidence assisted the researcher to answer the second critical question. This process seemed to correlate with the feedback that the participants offered during the focus group interviews. The qualitative data generated was endorsed by the quantitative data which was already available. Johnson and Onwuegbuzie (2004) explained that when using mixed methods, upon the analysis of the qualitative and quantitative portions of the study, the data needs to be integrated. The integration will strengthen each approach and make the conclusion of the study more comprehensive.

Since in this study the intention is not to embed one set of data onto the other, the researcher analysed both sets of data concurrently. Both sets of data were examined and links between the two sets of data were identified. There was no attempt to compare the data, instead the linkages which emerged served to endorse, support and triangulate the findings. The exploratory nature of the research study and the sequence in which the data were collected may have inadvertently favoured the dominance of the qualitative method. The researcher favoured the method of connecting the information generated rather than embedding one set of data onto the other or merging one set of data into another (Creswell & Plano Clark, 2007).

4.8.1 Data analysis structure

The wealth of data available necessitated a structured approached to the data analysis. The use of the mixed method also necessitated the use of the bi-directional table in order to reconcile and integrate the quantitative and qualitative data generated. The table facilitated the researcher's efforts in organising the effective management and use of all available data.

The researcher designed a bi-directional table to explain how the data generated from each collection tool were prepared, how the data were reviewed and then analysed. It also explained the bias which that data generation tool had e.g. qualitative or quantitative. The table also explains how the analysed data were represented. The notation explained how e.g. the quantitative data generated were supported or integrated for the data analysis chapter.

When one examines Table 4.8.1, in the notation column one sees that there is a description or comment which has notations which are in capital letters then a / (backward slash) followed by lower case letters e.g. *QUAL/quan*. This notation is the researcher's technique of explicitly identifying the type of data e.g *QUAL* indicates that the data have a qualitative leaning or bias. The *quan* indicates that quantitative data are available to support the available qualitative data.

Since the data analysis stages requires data reduction, the researcher acknowledged the guidance of Onwuegbuzie and Leech (2006) who maintain that when using mixed methods then the dimensionality of the qualitative data can be reduced via exploratory thematic analysis or writing memos and the quantitative data can be reduced via

descriptive statistics, exploratory factor analysis or cluster analysis. The data display involves describing the qualitative data pictorially by way of graphs, charts, lists etc. The quantitative data can be displayed by tables and graphs. The quantitative data e.g., the pre- and post- task could serve to support what the participants were saying in terms of their understanding of the lessons/content.

The data transformation stage involves the quantitative data being converted into narrative data that can be analysed qualitatively and/or qualitative data are converted into numerical codes that can be represented statistically. Data correlation involves quantitative data being linked with qualitised data or qualitative data being correlated with quantitised data. Data consolidation is that stage at which the quantitative and qualitative data are combined to create new or merged variables or data sets. The next stage, data comparison involves comparing data from the qualitative and quantitative data sources. In this research study it is that stage that linking of emergent themes occurred. The data integration is the final stage, whereby both quantitative and qualitative data are integrated into either a coherent whole or two separates.

4.8.2 Coding textual data

The transcripts of the focus group interviews, the daily reflections sheets and the participants' responses to questions 9, 16 and 17 were read several times. Similar responses were then grouped into categories. Once the categorisation process was completed, the researcher searched for themes which emerged from these categories. I looked at the categories again and eradicated or removed phrases, words or concepts which did not link well in that classification. The similarities catalysed the emergence of a theme. The themes had to connect and relate to the three critical questions. Themes which connected to the study were retained and those which did not have a bearing on the study were set aside after careful consideration.

4.8.3 Analysis of quantitative data

The responses to the questions on the questionnaire which necessitated an objective response were captured on the Science Planning and Scheduling System, and the data were analysed in the form of graphs and tables. The responses to questionnaire 2 were tallied and a table was generated. The graphs and tables which emerged from the collation of this data, allowed for narrativisation. The information generated served

as the link to the themes which emerged from the qualitative data. The approach of working concurrently with the data allowed for the categories and pattern to emerge almost simultaneously from the data. It also provided a holistic view of all the data available before I could deconstruct the data into smaller units for the purposes of analysis. The coding process assisted me to familiarise myself with the data in order to start making the links. This process also allowed me to collate findings and to make some conclusions for this research study. The use of Activity Theory also enabled the researcher to organise the data and analyse them from the perspective of how technology is used in the Mathematical Literacy classroom.

Table 4. 1*: Bi-directional table depicting data analysis plan. Adapted from Onwuegbuzie and Leech (2006, p.49)*

Data collecting method	Bias	Preparing data	Reviewing data	Analysing data	Representing data	Notation
1. Questionnaire 1 Q. 1-8, 10-15, 18-24	Quantitative	Coding data and assigning a numerical value to the questions with a quantitative bias.	Analysis: looking for trends and links	Use of statistical software to generate a table	Representing results as a graph, table or figure	QUAN/qual
1.Questionnaire 1 Q. 9, 16, 17 & 25 (own responses)	Qualitative	data- organising the texts thematically	Analysis of responses- organise the responses thematically	Coding the data and assigning tags/groups. Looking for related themes. Linking and integrating the emergent themes	Presenting findings by narrativising. Figures/visuals may be used to discuss the themes.	QUAL/Quan
2. Pre- and post-task	Quantitative	Marking of task and grouping the scores	Analysis of pre- and then post-task	Statistical analysis of tasks	Present pre- and post-task as a bar graph	QUAN/qual
3.Reflections sheet	Qualitative	Data organising – placing the texts thematically	Analysis of feedback- thematic looking for themes	Coding the data and assigning tags/groups. Looking for related themes.	Presenting findings by narrativising. Figures/visuals may be used to discuss the themes.	QUAL/Quan
4.Focus group interviews	Qualitative	data- organising the texts thematically. Reading through the transcripts and coding them.	Analysis of responses- looking for themes which emerge	Coding the data and assigning tags/groups. Looking for related themes.	Presenting findings by narrativising. Figures/visuals may be used to discuss the themes.	QUAL/qual
5.Questionnaire 2	Quantitative	Coding data and assigning a numerical value to the questions with a quantitative bias.	Analysis: looking for trends and links	Use of statistical software to generate a table	Representing results as a graph, table or figure	QUAN/qual

4.9 Ethical considerations

Research is guided by a set of principles and rules. The purpose of following the protocol of research ethics is to prevent abuse, marginalisation or exploitation of institutions, participants, respondents and systems by the researcher for his/her expediency. The researcher must work within the ethical guidelines that serve as the code of conduct for any research study to be conducted. Respondents and participants must be treated sensitively and in a humane way. In the interpretative paradigm, a researcher is inclined to use data collection tools which necessitate face-to-face interaction with the participants therefore sensitivity should be the hallmark of research studies. The aspect of the vulnerability of a participant needs to be considered (McMillian & Schumacher,1993).

Zohrabi (2013) stressed that the principles governing ethical research are validity, the matter of trustworthiness, usefulness and reliability which the researcher as well as the different stakeholders place into it. The researcher considered the issues concerning ethical clearance, informed consent and the validity and reliability of the data generated.

4.9.1 Ethical clearance

In order to conduct this research study, the researcher applied for permission to the University of KwaZulu-Natal via a research proposal. After some adjustments were made to the research proposal, ethical clearance was granted.

4.9.2 Informed consent

Research must be conducted in a responsible manner. Research ethics dictates that the researcher follows all the protocols. Cohen, Manion and Morrison (2011) state that it is necessary to obtain consent of institutions and organisations who provide the field for the research study to be conducted. It is also necessary to obtain the consent of the subjects who are to assist in the research project. The investigation must be done professionally, and all the data collected must be handled in a scientific manner. It is imperative that the confidentiality of the participants is not breached and that the participants incur no harm, physically or emotionally. The researcher requested permission in writing from the school principal of Sunshine High School. Permission

was granted and this letter was forwarded to the university. The researcher also consulted with the departmental head of Mathematics, Sciences and Technology at the school to ensure that the data generation programme did not hamper the curriculum delivery programme at the school. The resident Mathematical Literacy teacher of the grade 10 Mathematical class which was used, was also consulted.

In order to ensure the well-being of the participants, they were informed at the outset of the nature of the study. Their level of participation in the data generation process was explained. A letter was forwarded via the participants to their parents/guardians informing them of the intention to collect data and I requested for consent from the parent/guardian of those participants who were willing to be part of the research study (see Appendix B).

The sequence in which the data generation phases would occur was explained to those participants who had returned the consent and indemnity forms to me. The researcher also sought permission from the prospective participants via a consent form (see Appendix C). They were reassured that they could withdraw from the research study at any time and were also reassured that strict confidentiality will be maintained throughout the research study.

The participants were informed that the evidence collected in the research study would be recorded as accurately as possible and will be analysed. It was explained that all evidence that was gathered could be perused by them at any given time. If they felt that any misrepresentation had occurred, then they had that opportunity to correct the data. The participants were also assured of their anonymity throughout the study and even after the research study had been concluded. The questionnaires, reflections sheets and pre- and post-task activities did not call for the participants' names to be recorded on the document. A teacher who served as a counsellor at Sunshine High School was present during the focus group interviews. The focus group interviews were transcribed as they were recorded but the names were edited after the participants signed to say that the transcriptions were a correct reflection of the interview process.

Pillay (2014) warns of the difference in power between the participant and the researcher. If the participant is a learner, then one needs to be mindful of the dangers of exploitation and fraternisation. Since my participants are learners, a work schedule of the lessons to be conducted was forwarded to the departmental head of Mathematics, Sciences and Technology. As the researcher and the learners became available to conduct the lessons and the focus group interviews, the departmental head was informed so that the researcher's interaction with the participants could be monitored and accounted for.

4.9.3 Validity and reliability of the data

Validity evolves around the meaningfulness of research components. When researchers measure activities, they are concerned with whether they are measuring what it is that they intended to measure. Fraenkel and Wallen (2003) conceded that it is crucial that data generation instruments be validated before they are used. They argue further that the data collected must also be validated. Amongst other techniques that are offered to validate the tools and the data, triangulation features foremost.

In order to strengthen the validity of the data generation tools used in this research study, the researcher discussed the data generation methods at a cohort held at the university. After some discussion and after the researcher was able to motivate for her choice of data generation methods, she felt confident enough to proceed with the use of the tools. There were many academics and students present at this meeting and the comments were well received. Lynch (1996) states that is very difficult for the researcher to conduct a study single-handedly. It is suggested that by sharing ideas with different students, learners, teachers and instructors during the research study, the research findings and interpretations may be strengthened because diverse ideas and views can be beneficial and useful. This can boost the validity of the research.

As already mentioned, the validity of transcripts of the focus group interviews was confirmed with the participants which supported the plausibility and truthfulness of the information. Gathering data through one technique could make the study questionable, biased and weak. The fact that a variety of data generation methods were used served to strengthen the validity of the data evaluation and the findings

(Merriam, 1998). The mixed method approach also helped the researcher to corroborate the findings to this research study.

The researcher was able to support the quantitative evaluations with qualitative evaluations and vice versa. The position adopted here was endorsed by Ponce and Pagán-Maldonado (2015) wherein they succinctly explain that in mixed methods the term of inference validity is used. Inference validity describes the effectiveness of the researcher to approach and capture the complexity of the research problem using quantitative and qualitative approaches. They argue that it is indeed effective when the researcher combines or integrates qualitative and quantitative data. The researcher is then better positioned to draw valid inferences.

4.9.4 Researcher bias

In as much as one is mindful of the ethical considerations which guide the researcher, there is that risk that one's own values, beliefs and worldview may inadvertently affect or influence the research process. The researcher has attempted to remain as impartial as possible throughout the research study. The rules of the research process were followed, and the data were handled as scientifically as possible. The evaluation of the data and presentation of the findings were conducted as accurately and as honestly as possible.

4.12 A summary of the chapter

Chapter four outlined the methods that were utilised in this research study. The use of the mixed method approach within an interpretivist paradigm was also rationalised in this chapter. Chapter four described the various data generation methods employed and the methodology reinforcing the rationale for these choices, was clarified. An explanation followed on how the data, which were collected during the data generation stages, was analysed. The ethical issues surrounding this research study were explored.

CHAPTER 5: PRESENTATION OF THE DATA

5.1 Introduction

This chapter depicts the processes involved in analysing the data generated from the data generation processes in this research study. It examined the analysed data and presented it in anticipation of the emerging themes. The negotiation of the data presented in this chapter was generated in response to the research questions as outlined in the previous four chapters**.** In analysing the data in relation to these research questions, Activity Theory underpinned this research study. This chapter describes in detail how each data generation tool was analysed in order to answer the critical questions. Table 5.1 illustrates how the data were evaluated and which data generation tools assisted the researcher in answering the critical research questions.

Table 5.1: *Linking the critical questions to the data generation tools*.

Critical questions	Research tools used
What technology is currently being used in the teaching of space, shape and measurement in Mathematical Literacy and how effective is its use?	Questionnaire 1 Questionnaire 2 Focus group interviews
Does the use of technology when teaching shape and space in Mathematical Literacy influence the teaching process?	Pre-task and post-task Focus group interviews Reflections sheets Questionnaire 1 Questionnaire 2
Why technology should/should not be used in teaching shape and space to grade 10 Mathematical Literacy learners?	Questionnaire 1 Focus Group Interviews Questionnaire 2

By examining each set of data, the researcher attempted to establish common themes which could further justify the engagement with literature and the theoretical framework selected. Where common elements did not emerge, then the analysis focussed on establishing reasons for the differences. This process illuminated a

detailed response to the exploration of whether the integration of technology into the teaching of Mathematical Literacy does impact the teaching process.

5.2 Results of questionnaire 1

The first questionnaire was divided into three distinct sections, namely biographical information, personal experiences and lastly, the social life and the use of technology. The tenets of the theoretical framework used in this research design, Activity Theory, are encapsulated in this questionnaire as it examined all the facets of the participants' lives. It attempts to interpret and account for the environment, the history of the participants, the participants' culture as well as what their motivations are (Bloomfield & Nguyen, 2015). The design of the questionnaire spoke to the chosen theoretical framework.

There were 31 questionnaires that were completed and returned. To capture the essence of the responses in the questionnaire, the researcher examined all the objective type responses of the voluntary participants. The data were collected and captured on tables. Using tables to display the data proved appropriate because it allowed for the data to be presented as clearly and as scientifically as possible. The data derived from the subjective questions viz questions 16 and 17 were narrativised. In the presentation of the data generated, some responses required more explanation and a greater degree of detail therefore the data were highlighted, explained and discussed with the help of graphs.

The biographical information consisted of four objective type questions, so the responses were simple to capture. There was no significant disparity in the number of participants from either gender. The male participants constituted 54.8 % of the total percentage of participants and 45.2% of the participants were females. The participants who were in the over 16 years of age category constituted 19.4% of the total percentage of participants. This meant that for some reason these participants were not situated in the academic year in which they should have been. The data generated from the responses to the biographical information questions of the participants are presented in Table 5.2.

Table 5.2*: Analysis of biographical information*

Biographic data						
Questions	Responses					
	15	16	17	18		
1.How old are you?	9	16	2	4		
	M	F				
2.Gender	17	14				
	English and isiZulu	isiZulu and Sesotho	English	isiZulu	isiZulu and Setswana	English and isiZulu and isiXhosa
3.Languages spoken at home	8	1	10	7	1	4
	Y	N				
4.Have you ever repeated a grade in High School?	9	22				

Based on the data generated, 67.7 % of the participants indicated that they spoke an African language at home. This is their mother-tongue. This information is of vital importance since Sunshine High School is an English medium school which offers English at home language level only.

A percentage of the participants had at some point in their academic career, repeated a grade. This study aims to measure what influence the use of technology had on the participants during the teaching process so, it would prove interesting to see what impact was made given that at least 30% of the participants have suffered some academic challenge or setback.

The next part of the questionnaire analysed the personal experiences of the participants in the field of education. The information generated from this section, served as a compass to give direction to the study. The answers elicited linked to that component of the activity system which focusses on the community. The aspect of the

community refers to all stakeholders involved in the education process (Verenikina, 2010).

In question 5 the researcher sought to gauge the participants' history at the school. The data that was analysed revealed that 90% of the participants had commenced their secondary school education at this school. The data generated from question 5 further supports the Activity Theory model where the "subject" (the person being studied) is considered through the community in which he/she is situated. It becomes necessary to understand the location and the milieu in which the participant is situated (Hashim & Jones, 2007). Question 6 served as a triangulation for question 5. 83.8% of the participants claimed that they had never been to any other secondary school. One gets the sense that the participants are established and comfortable at Sunshine High School. The statistics generated for question 6 corroborated the responses from question 5.

After the questions were asked about the participants' general schooling career, the questions became more specific and homed in on issues surrounding Mathematical Literacy. Of the total percentage of participants, 67.7% of them conceded that they had already decided in their grade 9 year that they would be choosing Mathematical Literacy as a subject in their grade 10 year. When it came to deciding between Mathematics and Mathematical Literacy, 74.2 % of the participants conceded that they had made their own decision concerning the choice of Mathematical Literacy as a subject in the FET phase. Only 9.7% of the participants were influenced by their parents into choosing Mathematical Literacy, whilst 16.1 % of the participants agreed that they had difficulties with Mathematics in grade 9 and this influenced their choice in grade 10.

When asked if they struggled with the concepts in any section in the Mathematical Literacy syllabus, the responses were varied. The participants could name as many as 3 sections which they found challenging. Hence, question 9 did not require the tallies to be reconciled. The sections on tariffs and volume were cited as the most problematic by the participants. By using some open-ended questions which required the participant to provide their own responses, it helped to draw specific data from the participants. This connected two issues, namely, obviating a one size fit all data

generation tool and secondly it aided in strengthening the mixed method approach used in this research study (Small, 2011).

Table 5.3: *Analysis of personal experiences of participants-questions 5-8*

Personal Experiences: Educational					
Questions	Responses				
	2014	2015	2016	2017	
5a When did you enrol at the present School (Year)?	6	23	2	0	
	8	9	10	11	
5b Which grade were you in when you enrolled at this school?	28	3			
	Y	N			
6. Did you attend any other Secondary School?	5	26			
	9	10	11	12	
7. When did you decide to do Maths Lit?	21	10			
	Self	Parent	Teacher	Maths Challenge	Other
8. What prompted you to do Maths Lit?	23	3		5	

Question 10 asked the participants whether they would revert to studying Mathematics if they had a choice.

The number of participants who indicated that they would revert to studying Mathematics as a school subject if they had a choice as opposed to studying Mathematical Literacy offered an insightful perspective to the researcher in that 38.7% of the participants expressed willingness to revert to Mathematics. This indicated the 38.7% of the participants were confident about their ability to handle Mathematics at

school level. Previously it was noted that 74.2% of the participants claimed doing Mathematical Literacy as a school subject was a self-made choice.

Table 5.4 depicts the analysis to the questions 9 to 15 When asked how they would rate the way that they learn at school, 74.2% of the participants ticked the "*satisfactory"* box. The follow up questions asked how they would rate their competence in Mathematical Literacy. Based on the data generated, 87.1% of the participants rated themselves as satisfactory or weak at Mathematical Literacy. Question 13 was linked to the two previous questions, in that the question asked the participants about their performance in the 2017 June Examinations. Based on the data generated, 21 participants responded by ticking the "*satisfactory*" box while 10 participants responded by ticking "*good*". No participant ticked the box that was labelled "*very good*".

Question 14 asked the participants whether their academic needs were being catered for at Sunshine High School. The participants could answer in the affirmative or the negative and they were expected to motivate for their choice. Based on the data generated, 14 participants felt that their academic needs were being met at this school whilst 17 participants of the 31 respondents, believed that their academic needs were not being catered for at this institution. When asked if their teacher is helpful when they experience challenges in the Mathematical Literacy classroom a resounding 80.6% of the participants claimed that their Mathematical Literacy teacher is helpful to them.

In question 15, the participants expand on their choice by providing their own responses. The responses were varied and polarised. Many explained that the Mathematical Literacy teacher was helpful and committed to them. Some expressed the sentiment that he was unhelpful and uncaring toward their Mathematical Literacy needs. The responses to question 16 were just as divergent as the responses to question 15. When asked how the teacher assisted them with the challenges they experienced in Mathematical Literacy, many responded that he was committed to doing the exercises and the corrections thereof. Livingstone and Blum-Ross (2017) cautioned that research conducted with children as the participants, respondents or the informants of the study, brings new opportunities and risks to the researcher. One needs to bear in mind that this question of the teacher's role in supporting the

participants is a contentious one. The participants' vulnerability as learners may have influenced the diverse responses.

Table 5.4: *Analysis of personal experiences of participants –questions 9-15*

Questions	*Responses*					
	Tariffs	Income & Expend	Volume	Data Handling	VAT/TAX	Shapes
9. Do you struggle with any section of Maths Literacy at School?	12	3	10	5	12	0
	Y	N				
10. If you had a choice, would you revert to learning Mathematics?	12	19				
14. Do you feel that your academic needs are being catered for at school?	14	17				
15. Do you think that your teacher is helpful to you in dealing with your Maths Lit Challenges?	25	6				
	Very Good	Good	Satisfactory	Weak		
11. How would you rate the way you learn at this school?	1	7	23			
12. How do you rate yourself in Maths Lit?	0	4	14	13		
13. How did you perform in Maths Lit in your 2017 June Exam?		10	21			

In question 17 the respondents were encouraged to suggest some methods that should be included in the Mathematical Literacy classes which they felt could help them understand the concepts more effectively. Some of the responses that were directed to the teacher called for stricter classroom control, repetition of classwork exercises, that more examples of the work should be done in class and that the work should not be rushed. Responses that were directed to the participants called for conscientious completion of homework given in the Mathematical Literacy class. This response lent credibility to the balanced responses that a researcher can extract when collecting data from children. The participants were mindful that they needed to be co-operative for effective learning to occur. Lloyd-Smith and Tarr (2000) argue that it is vital to listen and consult with children when researching in education and explained that the reality experienced by learners cannot be totally comprehended by inference and assumption. In response to question 17, the participants were objective in their response when they alluded to the fact that by the learners' cooperation in the Mathematical Literacy class, effective learning could occur.

Many of the responses called for the use of technology to be incorporated into the Mathematical Literacy lessons. Participants felt that if the lessons can be taught with the integrated use of technology then they would be able to cope with Mathematics instead of just doing Mathematical Literacy. Some mention was made of actual examples of technology such as white-boards, computers etc. The questionnaire was tailored such that the answer to a part of the first critical question, namely what technology is currently being used at this school when teaching Mathematical Literacy, could be answered from the responses analysed from question 18. Although this question could be answered immediately, the nature of a research study demands some degree of triangulation. These responses will also be compared to the data analysed from the focus group interviews and questionnaire 2 as indicated in Table 5.1.

The response to the question of which participant has access to a computer and internet whilst doing Mathematical Literacy at school gives one the impression that the participants were from two different classes. They were from one class with the same Mathematical Literacy teacher. One must bear in mind that the participants completed the questionnaire as one of the first tasks. Perhaps they were unclear

about this question which asked specifically about the availability of a computer and internet facilities for their use in the classroom itself.

The next section of the questionnaire questioned the participants' use of technology in their social life. Question 19 enquired about who offered them assistance with their schoolwork outside of school. This question was intended to examine if the participants have an academic support system outside of school. The responses from this question could validate or negate the activity system. The subject needs to mediate with the tools, the object and with the community so that meaning or sense can be made of the concepts. Only after meaning has been extracted, can one claim that the desired outcome has been achieved (Hardman, 2005). The finding of this question is best portrayed by way of a graph as depicted in figure 5.2.

Table 5.5: *Analysis of social life and use of technology-questions 19-23*

Questions	Responses				
	Parent	Guardian	Friend	Relative	Other
19. Who assists you with schoolwork outside School?	13	1	14	5	8
	English	Afrikaans	Isizulu	isiXhosa	Other
20. Which language do you usually get academic assistance in?	12	0	19		
21. Which Language do you think in?	13		18		1
22. Which Language would you prefer to communicate in the Maths Lit class?	19		12		
	Y	N			
23. Do you have access to a computer and internet when doing Mathematical Literacy homework?	3	28			

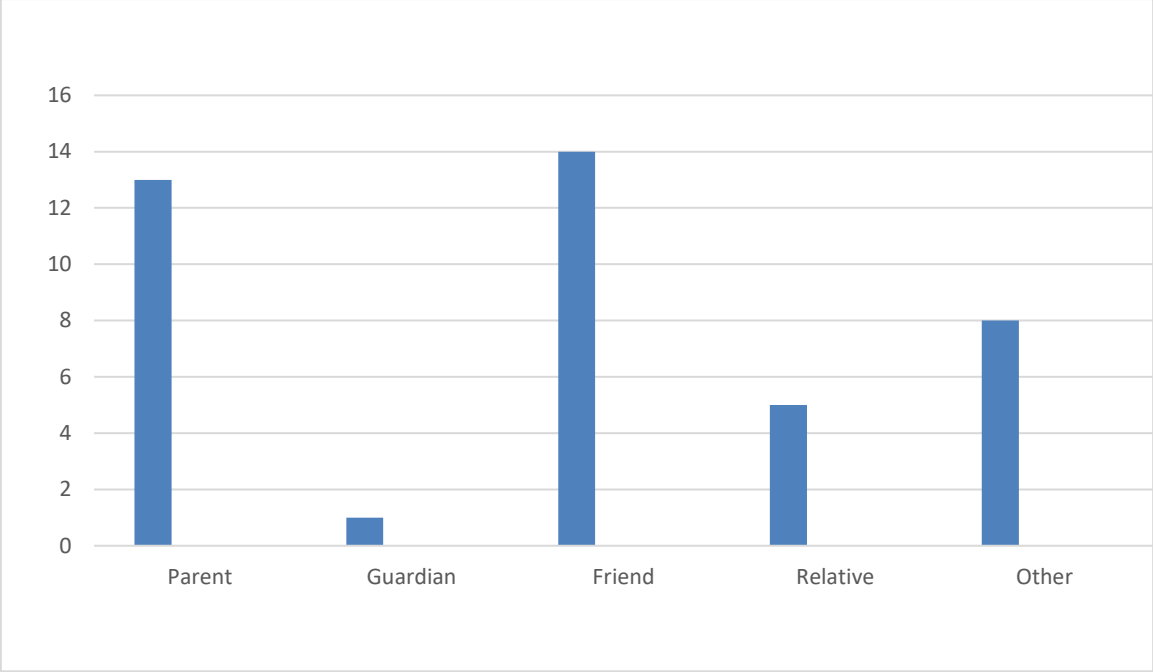


Figure 5.1: People who assisted the participants with schoolwork outside of school.

The heartening factor is that all participants indicated that they sought assistance with their schoolwork. The positive aspect is that 45.1% of the participants sought help from the parent or guardian and 45.1% sought help from a friend. Figure 5.1 captures the responses from the participants accurately.

Question 20 has a direct link to question 19. Question 20 probed the issue of seeking assistance. The question asked in which language the participants sought help. 61.3% of the participants declared that they were assisted in isiZulu from whom the person they sought help. The language issue had once again surfaced in the data analysis stage. The remaining participants (39.7%) secured help in the medium of English. Question 21 has a direct bearing on question 20.

Question 21 enquired from the participants in which language their thought processes were mediated. The responses were limited to English and isiZulu. 41.9% of the participants indicated that they think in English whilst 58.1% indicated that their thought processes occur in isiZulu. It is the third time in this questionnaire that the issue of language surfaced. When asked which language the participants would like to communicate in in the Mathematical Literacy class, the results were contradictory to the analysis of question 21. In question 22, most participants indicated that they preferred to communicate in the medium of English. Based on the data generated,

61.3% of the participants favoured English whilst 39.7% of them indicated isiZulu as a preferred medium of communication.

Question 23 probed the issue of the use of technology amongst the participants whilst doing Mathematical Literacy homework. Only 3 of the 31 participants indicated that they use a computer and the internet to assist them in their Mathematical Literacy homework. 90% of the learners indicated that they did not use technology when doing their homework.

When asked what they would like to do after they complete high school, 25.8% of the participants indicated they wanted to enter the work field and 22.6% of them wanted to proceed to tertiary education. Based on the data generated, 32.3% of the participants wanted to work and study on a part time basis and 16.1% indicated that they would like to start a business. Only 3.2% of the participants are still unsure of their future plans.

The final question in the questionnaire enquired whether the participants believed that Mathematical Literacy will be of assistance to them should they proceed to tertiary studies. Based on the data generated, 58.1% of the participants believe that studying Mathematical Literacy will be of assistance to them at tertiary level whilst 41.9% believe that it will be of no help to them.

Table 5.6: *Analysis of social life and use of technology-questions 24-25*

Questions	Responses				
	Work	Study at a tertiary institution	Work and study part-time	Start a business	Unsure
24. What do you want to do after you finish high school?	8	7	10	5	1
	Y	N			
25. Do you think studying Maths Lit will assist you in your tertiary studies?	18	13			

5.3 Results of questionnaire 2

The second questionnaire was used as a rounding up tool. This was completed by the participants at the end of the data generation phase. The questionnaire consists of twenty statements which the participants had to respond to in varying degrees of agreement or disagreement. These statements were concerned with the use of technology in the learning process.

A total of 31 participants completed questionnaire 2 and the collated information is displayed in Table 5.7.

Table 5.7*: The analysis of questionnaire 2*

		STRONGLY DISAGREE	DISAGREE	NOT SURE	AGREE	STRONGLY AGREE
Question Numbers	Statements	1	2	3	4	5
1	I know how to use a computer/laptop/ tablet/iPad.		3	2	16	10
2	The technology used in the teaching process helped me understand shape and space better.				9	22
3	The technology used in the teaching process helped me understand difficult concepts that I learnt in class.				7	24
4	I used the technology used in the teaching process outside regular class time.	3	3	9	6	10
5	I think I can learn more in my next Mathematical Literacy lessons if it includes the use of technology.				4	27
6	Using the computer/technology and its online features helped me understand the lesson better.				10	21
7	The use of the technology encouraged me to learn independently.				9	22
8	The technology was difficult to use.	19	10	2		
9	I prefer doing Mathematical Literacy without the use of technology.	12	18	1		

Question Numbers	Statements	STRONGLY DISAGREE 1	DISAGREE 2	NOT SURE 3	AGREE 4	STRONGLY AGREE 5
10	I do not have easy access to a computer after school hours.		5	2	14	10
11	The technology did not help me in my Mathematical Literacy lesson.	12	18	1		
12	Technology should not be used to teach Mathematical Literacy.	13	18			
13	The teacher only uses the board to teach concepts.			1	12	18
14	I enjoyed being able to see on the computer and videos what was explained to us on the board.				15	16
15	The videos made the concepts more visual.				10	21
16	I enjoyed completing my homework and assignments using technology.				11	10
17	I looked forward to attending the Mathematical Literacy lessons using the technology.				15	16
18	I don't need the teacher anymore. I can learn Mathematical Literacy concepts by using technology only.	13	18			
19	I am satisfied with how I am able to apply what I have learnt.			9	17	5
20	I believe I will be satisfied with my final mark in this section.			10	18	3

The numbers represent responses ranging from one (strongly disagree) to five (strongly agree)

It was evident from the responses in question 1 that 83.9% of the participants are competent with handling technology (tech-savvy). By the overwhelming responses in the affirmative of participants being able to use a computer, laptop, tablet or iPad, one

is reminded of Plowman and McPake's (2013) article wherein it is stated that there exists a natural bond between children and technology.

The researcher's primary concern was to understand the impact that technology-based teaching and learning had on the participants whilst teaching shape and space. The resounding 100% responses claimed that the use of technology in the teaching process helped the participants to understand the concepts of shape and space better. The 100% positive responses to questions 3 served as triangulation to question 2. The participants claimed that the use of technology in the teaching process also helped them to understand the difficult concepts of shape and space.

Question 5 asked whether the participants felt that they could learn more in their future Mathematical Literacy lessons if technology was included in the lessons. 87.1% of the participants agreed very strongly with this statement whilst 12.9% of the participants agreed with the statement. This implies that 100% of the participants agreed with this statement. Question 6 probed the issue of technological integration with lessons a little further. The researcher enquired whether the technology-based teaching was at all helpful to the participants in understanding the lessons taught to them. The online features referred to the YouTube videos whilst the integration of technology referred to the PowerPoint presentations and the worksheets used. An analysis of the responses indicated that.67.7% of the participants agreed very strongly with this statement whilst 32.3% of the participants agreed with this assertion. This translates to 100% of the participants concurring with the assertion suggested by the researcher.

Over 70% of the participants agreed very strongly that the use of technology in the classroom situation encouraged them to work independently. The encouraging feature of the responses to this statement is that no participant disagreed with this statement. To triangulate the responses by the participants, statement 8 intimated that the technology used during the lessons were difficult to use. 93.5% of the participants disagreed with this statement. The 2 learners who were unsure whether the technology was difficult to use or not, reflected a mere 6.5% of the total number of participants.

Based on the data generated, 96.8% of the participants indicated that they would prefer to do Mathematical Literacy with the use of technology. Only 1 participant was unsure about his/her sentiment about this statement. Statement 10 enquires about the accessibility of a computer to the participants after school hours. The responses to this statement are varied. These responses are also triangulated by the responses in the focus group interviews. 77.4 % of the participants indicated that they did not have easy access to a computer after school hours. 6.5% of the participants were unsure of the accessibility of a computer to them whilst 16.1% of the participants disagreed with this statement. One realises that an exorbitant number of participants do not have direct access to a computer after school hours.

Statement 11 enquires whether the use of technology during the lessons was of assistance to the participants. This statement is a direct means of triangulating the responses to statements 2 and 3. Statement 11 says that technology did not help the participants during the Mathematical Literacy lessons, and 38.7% of the participants felt strongly against this statement whilst 58.1% of the participants disagreed with this statement. One participant was unsure about how he/she felt about this statement.

When the researcher suggested that technology should not be used to teach Mathematical Literacy, 41.9% of the participants disagreed strongly with that statement. Based on the data generated, 58.1% of the participants disagreed with this statement. 100% of the participants felt that technology should be used to teach Mathematical Literacy.

When asked how teaching occurred currently in their Mathematical Literacy classroom, the participants were unanimous that the teacher uses the chalkboard as the principal means of teaching.

When the participants were asked to respond to statement 14, about whether they enjoyed being able to see on the computer and videos what was explained to them on the board, a total of 51.6% of the participants agreed very strongly with the statement. 48.4% of the participants agreed with this statement. There were no responses that disagreed with this statement.

This research study focussed on exploring what technology is currently being used in the teaching of space, shape and measurement in Mathematical Literacy and how

effective is its use. When the researcher suggested that the videos make the concept in the Mathematical Literacy class more visual, 67.7% of the participants agreed very strongly with the statement and 32.3% of the participants agreed with the statement. This implies that 100% of the participants concurred with this statement.

In statement 16, an overwhelming 100% agreed that they enjoyed completing the homework and assignments using technology and 32.3% of the participants agreed very strongly with the statement. The participants' responses to statement 17 suggested that they all enjoyed attending the Mathematical Literacy lessons when technology was used. 51.6% of the participants agreed very strongly that they enjoyed the lesson when the use of technology was integrated into the teaching process.

Statement 18 suggested to the participants' that they do not need the teacher anymore because they could learn Mathematical Literacy using technology. There was unanimous disagreement to this statement whereby, 41.9% of the participants felt strongly against this statement. The participants responses reminded the researcher that technology cannot replace the teacher (Hoon, 2008).

The participants' response to statement 19 required them to assess their level of competence. It required the participants to respond to how they will be able to apply what it is that they have learnt in the Mathematical Literacy class whilst using technology. A total of 16.1% of the participants strongly agreed that they will be able to apply what they had learnt in the lessons which incorporated the use of technology and 61.3% of the participants agreed that they were satisfied that they will be able to apply what they have learnt. A total of 29% of the participants were not sure whether they would be able to apply the skills learnt during the Mathematical Literacy classes which incorporated technology into the lessons.

All 31 participants who responded to questionnaire 1 also responded to questionnaire 2. They were also the participants in the pre- and post-tasks and they were respondents in the reflections sheets. Thirteen of the participants also participated in the focus group interviews. This implies that the probing for data from this group of participants, was intensive.

5.4 Focus group interviews

Three focus group interviews were conducted at three stages of the data generation phase. One was conducted at the inception of the data generation stage. The second focus group interview was conducted halfway through the data generation stage. The third and final focus group interview was conducted after all the lessons were delivered. At every stage of the data generation, it was emphasised that the participants could exit the study even though they had handed in consent forms signed by themselves and their parents/guardians. The participation in the focus group interview was voluntary. The analysis of the data generated from the focus group interviews was done methodically. All the data were transcribed and transcriptions were verified by the participants before the analysis process commenced.

A teacher who also serves as a counsellor at Sunshine High School was present at all focus group interviews. The counsellor's role was to ensure that the learners were comfortable during the interview process and that they had indeed volunteered to be part of the research process.

The data were initially handled by removing all names of participants. The analysis of the data took on the form of allowing patterns to emerge. These patterns were grouped and gave rise to themes. Data which did not form part of a pattern were retained and reasons for the differences were tracked. The participants were asked the same questions at all three focus group interviews. In order to get the participants comfortable, the first question enquired how the participants felt about Mathematical Literacy as a school subject. The participants were eloquent in their responses and in attempting to give all the participants a voice, all 3 interviews were cited in the analysis. All the participants conceded that Mathematical Literacy is not a difficult subject and that they do have a good teacher. The participants were vocal in the fact that despite having a good teacher, they still experienced some difficulties in understanding the content.

Although this was the very first question about Mathematical Literacy, the respondents were vocal in the fact that the use of the chalkboard as the only teaching method, did not allow consolidation and recap of the concepts.

Noma responded:

> *"Hi. I don't have a problem with school, but I think the work we do in Maths Lit is work done on the chalkboard. If any child doesn't understand the first time, they can't get help again."*

Noma's response highlights the fact that if a concept is taught in a certain way, then learners who have not grasped the concept initially may struggle to master that concept. Noma's comments highlight the issue of repeating and consolidating of concepts in the Mathematical Literacy class. Goss, Sonnemann, and Griffiths, (2017) had similar findings which were very much aligned to what Noma claimed. They found that practice and consolidation played a central role to understanding concepts in the classroom. Teachers needed to learn how to create the right learning climate, and how to respond well when they feel that they are under pressure.

David expressed similar sentiments as Noma:

> David*: "… is very simple to understand and it all depends on the teacher who is teaching it. If the teachers use charts and things to show us rather than tell us."*

David's comment is indicative of the learners' need to have a more visual take on the concepts being taught. He also reminds us that the teaching process needs to be complemented by tools which strengthen the teaching of that concept (Shabiralyani, Hasan, Hamad, & Iqbal, 2015).

Tumo responded:

> *"I think it is a good subject and it is right for me, but it depends how the teacher is teaching the learners. He uses only one method. He tells us, he doesn't show us."*

One gets the sense that the participants are calling for a varied teaching strategy and that they would prefer if the lessons incorporated tools which complemented the teaching process. This sentiment was previously echoed by Eady and Lockyer (2013) where they express the view that when teachers use resources to teach, it helps to facilitate the learning process.

Zodwa expressed her feelings about Mathematical literacy as follows:

"*I feel good about Math lit. I don't think it is the teacher he is teaching very nice he is doing his job very well. Sometimes there are things I don't understand"*.

Zodwa made it abundantly clear that the competency of the teacher is not in question. She concedes that she sometimes struggles to understand some concepts. The question arises that if learners are struggling even with all reasonable steps being taken, how can teaching and learning occur differently to ensure a greater degree of comprehension occurring (One might even think that the issue of the language barrier may be hindering comprehension and understanding)? Similarly, Kasapoglu-Akyo (2010) found that English Second Language (ESL) learners believe that using technology, especially using educational technology tools helps them to improve both language and communication skills.

The next question elicited a variety of answers. It required the participants to explain how they normally cope when doing their Mathematical Literacy homework. Zinhle was candid in his response to the question on how he strategises when doing his homework.

Zinhle said:

"By looking through my math book and seeing if my answer is okay with the one the teacher teaches us. I wish I had a computer to download the videos and the things you are using."

Zinhle expressed the sentiment that using the computer and accessing information from the internet would facilitate his ability to do the homework. Marla expresses a similar sentiment. Similarly, Dogruera, Eyyamb and Menevisab (2011) stated in their research findings on the use of the internet for educational purposes that in general the majority of the participants believed they can use the internet as an educational tool and "the participants stated that they used e-dictionaries, e-encyclopedias and translation tools to help them write their homework and do their projects" (p. 611).

Marla said:

"Sometimes I use the internet if I don't understand it…".

Marla gave the impression that the internet is not easily and readily accessible. The choice of the word *"sometimes"* created this impression.

Although the technology itself does not teach, Zinhle and Arlene commented that it is how the technology is integrated into the lesson that helps the learning process (Canough, 2013). Arlene agreed that even in accessing technological assistance, they still needed the assistance of the Mathematical Literacy teacher.

Arlene said:

"My math literacy homework is quite easy for me although I do have an app on my phone. It helps me with things I don't understand. If I don't understand by using the app I come to sir and ask him, or I ask my mum. If sir can use the app in class and then explain to me, I am sure it will be better". I downloaded it. But I need a teacher to help me to apply what the lessons on the app is covering otherwise it doesn't make complete sense to me".

Arlene's views are a direct link to the theoretical framework and the existing literature on the role of all the stakeholders in the learning and teaching process. Ghavifekr, and Rosdy (2015) were abundantly clear that the use of technology in the classroom cannot replace the teacher. They claimed that technology is used as an instructional or communication tool in the teaching process. Activity Theory emphasises the partnership between the subject, the rules, the community, the tools and signs and the division of labour, before any meaning can be negotiated to bring about an outcome (Bloomfield & Nguyen, 2015). Arlene justifies the use of technology outside of the classroom milieu as it has been established by the responses so far that technology is not being integrated into the Mathematical Literacy lessons at Sunshine High School.

Tumo explained how he coped with doing his homework.

Tumo said:

"I have a programme that plays on DSTV for schoolwork, so I normally watch it. I can incorporate and see how they do the maths. Sometimes they tell us we have to do on our own and they pause, and they come back and see if it is correct or wrong".

Tumo's views resonate with an important dimension. The learners in the classroom are regarded as digital natives and as such they are comfortable with technology because of their constant exposure to it. They can enhance and supplement the information at their convenience without the help of a teacher (Prensky, 2005) but the accessibility of technological devices in this community is limited. We gleaned this from the data obtained in questionnaire 1, question 23.

When the participants were asked what some of the challenges are that they are experiencing in the Mathematical Literacy class, Amahle's responses provided the challenge and the solution to this challenge.

Amahle said:

"… the learners are making noise when you tell them to keep quiet. They just tell you some other things. I don't understand the work…No. I think if the teacher uses the PowerPoint and videos like now, then the children will listen to him".

This comment by Amahle suggested that if the teaching tools and methods are varied, then the learners may offer a greater degree of attention to the lesson. This suggestion by Amahle correlates what Bush, Joubert, Kiggundu and van Rooyen (2009) highlighted when they spoke of the link between sound classroom practice and sufficient and suitable learning material. Poor discipline in the classroom can be a hindrance to the learning and teaching process.

Noma was frank in talking about her challenge. "

Noma said:

"I battle with the shapes that have too many parts to it. A house has a triangle and rectangle… I get so confused."

June piped in and said:

"I get confused with what area means and what surface area means."

Some participants cited other sections in Mathematical Literacy which posed a challenge to them, for example tariffs. One is reminded by Kaptelinin and Nardi (2006) that the use of tools cannot be separated from expressing and teaching concepts in Mathematics. The role of the world in which the learner finds himself is mediated by

the tools used in the teaching and learning process. For concepts to be fully understood the use of tools is imperative. This is the fundamental principle of Activity Theory.

Tumo suggested that to overcome the issue of the challenges faced in the Mathematical Literacy class:

> *"… we should watch more videos for maths because it is very difficult. If we want, we can watch the video of a section again in case we didn't understand it the first time. I do struggle with the work. Maybe I would pass if I can learn better."*

Tumo's response reminded the researcher of the fact that 29% of these participants have indeed repeated a grade at high school level. Question 4 of questionnaire 1 in the biographical information section, asks the participants if they had ever repeated a grade at high school level. Tumo reminded us that people vary in the manner in which they learn and absorb what they have been taught. Allcock and Hulme (2010) concur with Tumo's claim in their call for a personalised approach to teaching and learning. The teaching and learning process should be tailored to individual needs which is the inclusive approach to education.

Aisami (2015) maintains that 65% of the world's population are visual learners therefore they need to see what they are learning. When these learners are matched with teaching methods that complement their learning styles their absorption and retention is significantly enhanced. One needs to connect the learning enhancer to the learning style of the learner.

In so far as learners experiencing challenges in the classroom milieu and against the backdrop of school, they would be in the best position to explain their level of discomfort as well as to provide the adults around them with reasonable, plausible and workable alternatives. When the learners were asked what they think can be done to assist with their academic challenges in Mathematical Literacy, the responses were varied yet articulate.

Mphethu said for his academic challenges in Mathematical Literacy to be obviated, he suggested that the teacher uses:

"… examples and other means of showing us what he means".

Marla maintained that:

"I passed and comparing last year to this year it is way different because you explained to us and you used to come by us and help us. He is there by the board."

Marla's contention is that she enjoyed a poor level of interaction with the teacher. One also gets the sense of desperation by the learners to pass. The learners have called for more interaction with the teacher and a variation in the teaching method. Baderaddin and Mohammad (2015) support the assertion that learners can master the curriculum if they are taught with different strategies or a variety of methods.

Sanele felt that:

"Worksheets and examples that we can see will help me. If the shape is on a projector and the teacher shows us how to break it up, then we can see the parts of that shape and it will make sense. I think maybe stay in after school and tell sir the problems we have and maybe if he could try and explain them more or better. Then we can start learning very well and in the weekend some of us go to our friend's house instead we can come to school and learn more other subjects that might improve our schoolwork and our marks".

Sanele conceded that for the academic challenges to be minimised that he may have to attend extra classes. Again, one finds that the focus was on the improvement of results. Sanele's view is that this group of Mathematical Literacy learners share a common problem and that tools and strategies are required for transformation to occur. This assertion by Sanele is indeed a tenet of Activity Theory. Santhi's (2011) findings support and contradict Sanele's claim that he needs extra classes in order to improve his Mathematical Literacy results. Santhi (2011) found that extra classes could have a positive impact on learners if the learning process were facilitated and if it engaged and motivated learners and if it maximised their learning potential. He cautioned that too many extra classes can lead to stress amongst learners and this could have a negative impact on their physical and mental development.

The researcher also doubled as the teacher to collect the data. It therefore seemed rational to ask the participants what could be done to improve the teaching methods in order to help them learn more effectively,

Noma stated that:

"It will help if we can use textbooks and worksheets. Then if the lesson is mixed with videos, PowerPoint etc. we can actually see what the teacher means."

Wayne felt that the concepts were not difficult when he was taught by the researcher.

Wayne said:

"It is not that hard. Some of the work is easy. Mam you are teaching us well."

This method included the engagement with technology when presenting the lessons. The concepts taught were followed up with an application task per lesson. The application task was intended to consolidate what was taught. Noma and Wayne concurred that the use of technology integrated into the lessons, will make it easy for them to learn. Their opinions remind one of the descriptions of the collaborative classroom wherein Clapp and Swenson (2013) advocate the implementation of technology in the classroom and about changing how teachers teach and learners learn.

David explained that he would benefit if:

"The teacher must not rush with the work. He must take time to explain to us properly and he can show us by using practical examples. He must make the lessons real."

It is noted that the participants felt that they be shown how to handle the concept and not told how to do it. These sentiments by David resonate with the notions of Activity Theory. It is the engagement of the subject (learners) with the instruments (technology) that are used to teach shape and space. The object is the application of the shape and space aspect of Mathematical Literacy. The community is represented by the Mathematical Literacy teacher.

When asked how your school/teacher has assisted you in coping with Mathematical Literacy, the responses varied.

Noma stated:
"Sir is very good but the class is badly behaved, maybe they will listen if he adds other things to the lessons. If he teaches and then asks us to work using the computer or if he shows us videos."

Sanele agreed with Noma when he said:
"He needs to do something to get the children's attention. Maybe change the method."

The participants were quite emphatic that a review of teaching methods and a variety of visual techniques may help discipline in the classroom and improve the results. Shinn (1997) in an Agricultural Science study found that using an array of techniques and tool advances the teaching and learning processes.

Sanele felt that:
"Worksheets and examples that we can see will help me. If the shape is on a projector and the teacher shows us how to break it up, then we can see the parts of that shape and it will make sense."

Sanele's comment added another dimension to the learning and teaching discussion. He stated that together with technology-based teaching, the teacher should scaffold the teaching process wherein one concept can be taught and then another built up on that as the lessons progressed. Sanele's comment is aligned with the use of PowerPoint presentations. The use of PowerPoint presentations allows for concepts to be built up as the lessons progress.

The participants were asked what textbook/website/tool they find most helpful when studying Mathematical Literacy. David responded that he found a particular website learner friendly. He stated that he could understand the solutions that they provided on this website for the tasks they presented.

Whilst Jones (2003) felt that the use of the internet in the teaching and learning of Mathematics was still in its infancy at that time, Kissane (2009) recorded an increase in what the internet had to offer learners in terms of a teaching and learning tool. Fabian, Topping and Barron (2018) found that learners had a more positive view of technology and they found the integration of the internet in the learning and teaching processes fun, engaging and useful. The use of the internet as a tool in the classroom has evolved since Jones (2003) claimed that the use of the internet was in its infancy has since changed. It is therefore understandable that the millennials request for encouragement for the integration of the internet and technology in the teaching and learning processes.

Tumo explained that:

"*We don't get to use a computer at school unless we study CAT. It will help if we can use the internet at school."*

Tumo's claim lays bare the fact that even when resources are available at a school, the gatekeeping process restricts its accessibility to all learners. Learners who study Computer Applications Technology and Information Technology, are the learners who have access to the computer and the internet at school level.

Sanele captured the sentiments of the participants about their academic needs when he stated:

"...instead we can come to school and learn more other subjects that might improve our schoolwork and our marks."

Sanele's comments are a reminder that the definitive need of the learner is to flourish academically. The need to do well is inarguably the goal of most learners.

Tumo said:

"Sometimes they tell us we have to do on our own and they pause and they come back and see if it is correct or wrong."

Tumo's comment was on the use of videos in the classroom. He was able to define an advantage of using technology-based teaching without it being pointed out to him. Tumo conceded that the use of technology can assist as a catch-up for the learners

who require more time, or it can assist learners who need a second take on the lessons when they want to consolidate the concept being discussed. Tumo was one of the participants who was not afraid to express his opinion regarding issues which he found burdensome in the classroom as long as he was in a group setting. His contributions during the focus group interviews, made the researcher feel that the choice of a focus group interview was the most appropriate and beneficial to this study. Tumo was aware of the language barrier experienced by many mother-tongue isiZulu learners in an English medium school.

Tumo remarked:

"*although I am in the English school but some of us mam, we usually understand English but some work we don't understand and the teacher has to explain to you in Zulu so there is my problem mam"*

This vital contribution by Tumo reminded the researcher that the issue of language is a sensitive one and is discussed in greater detail in the next chapter.

The issue of passing/failing a grade or a subject is also a very sensitive and a contentious one. Marlene mentions this issue and she attributes the high failure rate at Sunshine High School to the teaching methods employed in the classroom.

Marlene said:

" Too many children fail at our school. The teaching methods must change."

The transcriptions of all three focus group interviews are available for perusal. It is not possible to report on all the data generated in the form of comments from the participants. The researcher selected and analysed the comments which fell in the ambit of the themes which were generated when all the data were accumulated.

5.5 Pre and post- task assessment

The scores of the pre-task and the post-task were self-explanatory as depicted in Figure 5.2. Of the 31 participants who answered both tasks, the scores differed significantly. In the post-task, all the participants scored over 30%. The median score for the pre-task was 10% whilst in the post-task the median was recorded as 52%. The

significant improvement in the scores can be attributed to the fact that the participants were taught using different teaching tools.

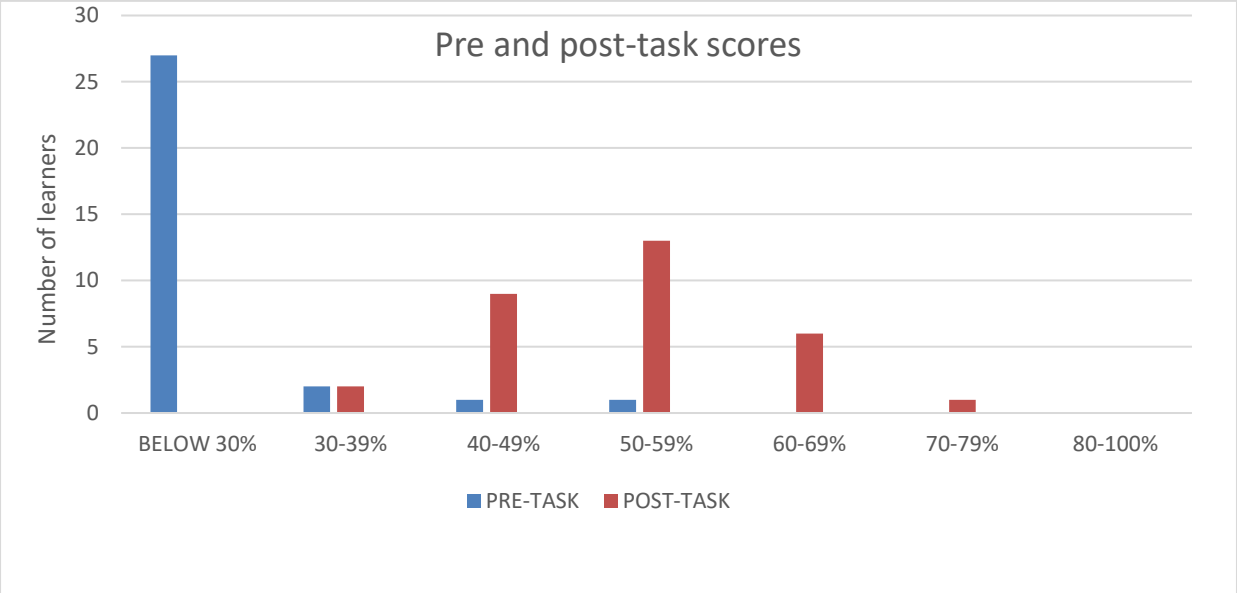


Figure 5.2 The pre-and post-task analysis.

5.6 Reflections sheet

The daily reflections sheets served as instruments to give a voice to every participant. The participants recorded their sentiments about the lessons. The reflections sheets encouraged the participants to describe the lesson, convey how they felt about the lesson and it asked the participant for suggestions to improve the teaching methods employed. The vast amount of data generated allowed the researcher to undertake deep analysis. The learners were encouraged to fill in their reflections per lesson, however when the participants expressed unwillingness to fill it out, no pressure was exerted to make the participant comply. It must be stated that this data generation tool generated a great deal of data. Each participant was allocated a number and the feedback was recorded as RS+no. (reflection sheet + the number assigned to the participant).

The teaching method employed was an integration of the concepts of shape and space at grade 10 level with technological resources which were easily accessible. The concepts were taught by the researcher and supported by the technological resources. The YouTube video or the power-point presentations served to strengthen the teaching process. These tools mediated the teaching and the learning process. The

use of worksheets also helped to consolidate the concepts being taught. One is reminded of Hardman's (2005) confidence that Activity Theory allows one to understand learning as an intricate product of tool mediated interactions.

> RS 01: It was a good lesson and I feel that I learnt a lot today. Just continue with this teaching method, it really gives me a better understanding.

> RS 02: Mam taught us first and then she showed us a video. She gave us a page and told us to answer. It is easy … By using videos that get our attention, we can benefit.

By the participants' admission, the use of technology, was able to sustain the attention of the learner during the teaching process. The participants were quick to allude to how this integrated teaching method could be of "benefit" and "give a better understanding" of the content of shape and space. The focus of the participants seemed to be on academic achievement. This has a great bearing on the fact that the participants also made this intimation in the first questionnaire. The analysis of Question 4 of questionnaire one found that 71% of our participants have at some point repeated a grade. The "benefit" that the participants alluded to could be academic excellent in the subject Mathematical Literacy or that they could be placed at an advantageous position to pass the academic year. This is an obvious response by the participants, and it is supported by the view of Maddock and Maroun (2018) in their description of the genuine feeling of hopelessness that pervades the classrooms in the South African milieu.

> RS 03: It was a good lesson; I learnt many things that I didn't know how to do. I feel like I am passing grade 10

The sentiment in reflection 3 reflects similar sentiments as does reflection 2. The need to pass the grade is the focal point for the participants. However, the participant in RS 02 elaborated by saying that he/she learnt "things that I didn't know how to do".

One is reminded of the findings by Maphosa, et al. (2012) that:

> “teachers are primarily accountable to the learners. The main curriculum transactions take place between the teachers and the learners. Therefore, the teacher has to be answerable to the learners on the way they learn in classrooms. Teachers are responsible for meeting learners’ various and diverse learning needs” (p. 546).

The article states that teachers are responsible for shaping the academic future of the learner therefore accountability should be the hallmark of the teaching profession.

RS 04: We watched the videos on how to work out perimeter and the educator explained. I’m excited and enjoy what I’m learning.

RS 05: The teacher showed us a video clip. Then she explained it better. Then we did a worksheet. Today’s lesson was very good and was very understandable. It dealt with perimeter and area.

RS 06: Today we watched a video then mam explained to us about perimeter and area. She gave us a worksheet to do and those who did not

RS 07: …videos were shown… it was wonderful

RS 08: It was good. The lesson is helping me in my subject…I feel happy about the work that was taught today.

Reflections 4 to 8 were indicative of the levels of enjoyment that the participants experienced whilst being taught shape and space by integrating the use of technology into the content. The participants commented that they *"enjoyed"* the lessons and that it was *"wonderful".* They also commented that the work was *"understandable"* and that they felt *"happy".* Aronstam and Braund (2016) found that many schools rely on a standardised, transmission-style pedagogy that contradicts a culture that promotes learners' ownership, curiosity and enjoyment in the classroom. South African teachers need to integrate play and spirit into existing and new curricula in order to make learning more engaging, appealing meaningful, and democratic.

RS 09 To use the technology as a key to our good work.

RS 10: Very good and exciting.

RS 11: I feel happy because I learnt something…. Its better this way

RS 12: I felt like I wasn't going to understand but the teacher explained it and the way we were taught today was not hard to understand. I could see how the area is different from surface area.

The participants explicitly echoed the sentiment that the use of the technology in the teaching process was *"exciting"* and a *"key"* to a better academic future. The trajectory of the feedback from the participants shifted from whether technology should be used in learning to how it can improve learning. The sentiment of having access to high-quality educational experiences seemed to be the call by the participants and this call is supported by the United States Department of Education: Office of Educational Technology (2017).

There were many noteworthy comments that the participants mentioned in the reflections sheets. For the purposes of this study, I selected the feedback which assisted in answering the critical questions of this study.

5.7 A summary of the chapter

This chapter depicted the collation of all the data collected during the data generation process in this research study. The use of tables, figures and diagrams facilitated the process of presenting the data. Chapter five presented the data collated for questionnaires 1 and 2, the focus group interviews, the reflections sheets and the pre- and post- tasks. This chapter served as a precursor to the discussions of chapter six. The discussions which emerged through the data presentation, will be analysed and interpreted in the following chapter.

CHAPTER SIX: ANALYSIS AND INTERPRETATION OF THE FINDINGS

6.1 Introduction

Tuckett (2005) describes thematic synthesis and outlines several steps for the process and outcome of this approach Thematic synthesis has three stages: the coding of text; the development of descriptive themes, and the generation of analytical themes. While the development of descriptive themes rests close to the primary studies, the analytical themes represent a stage of interpretation whereby the researcher goes beyond the primary studies and generates new interpretive constructs, explanations or hypotheses.

The process commences when the researcher begins to observe, and look for, patterns of meaning and issues of potential interest in the data. This process may begin during data generation. It concludes with the reporting of the content and meaning of patterns (themes) in the data. Analysis encompasses a continual moving back and forward between the entire data set, the coded extracts of data that you are analysing, and the analysis of the data that you are producing.

Writing is an integral part of analysis. It is not something that takes place at the end as with statistical analyses. Jotting down of ideas and potential coding schemes can continue right through the entire coding/analysis process. (Ryan & Bernard, 2000). There is no prescribed manner to proceed with the reading of the data for thematic analysis, although a more inductive approach would be enhanced by not engaging with literature in the early stages of analysis.

Whilst the previous chapter focussed on presenting the data, underpinning it with theoretical framework, it also supported and situated the data presentation within the wealth of literature available from similar studies. This chapter focusses on aggregating the analysis and interpretation process into the relevant themes. Relevant patterns and generalisations which emerge may be extrapolated in similar studies. The analysis and interpretation of the data that follows is based on the interactions with the participants. The pre and post-task, focus group interviews, reflections sheets and two sets of questionnaires were the tools that catalysed the data generation process. The purpose of multiple method data generation served the researcher as a means for triangulation. It also served to gain greater depth and understanding of the

phenomenon being studied. Perhaps the greatest benefits of the detailed data generation techniques are that the critical questions were answered succinctly, and some themes emerged without much searching. A comprehensive and extensive image emerged simply and easily because the data were collected at various junctures of this study. In analysing the data, one would find a degree of overlap because a specific piece of data could link to many of the themes which emerged.

The researcher's primary goal was to answer the research questions. Sometimes in trying to answer a question, more questions may be generated. An interesting anomaly emerged in this research study. It was simply not a factor that the researcher could have predicted. When the participants completed questionnaire 1, not a single learner reported to have had challenges with the concepts in shape and space, yet all the learners performed poorly in the pre-task activity. Perhaps the researcher's experience as a Mathematical Literacy teacher offered an insight into sections which are poorly answered during assessments hence the decision to engage with an exploration study into how the use of technology-based teaching methods impacts the teaching of shape and space in the Mathematical Literacy class.

6.2 Integrating technology effectively into the teaching and learning process

The first critical question interrogated what technology was being used in the teaching of shape and space in the grade 10 Mathematical Literacy class. This question went on to interrogate the effectiveness of the use of technology in the teaching and learning process. Effective integration of technology in education is broadly speaking, the expected curriculum-driven establishment of technology, tools and skills into the *hands-on* users to promote learning. Integration of technology implies the use of technology to meet any specified educational goal (Soden, 2019).

The questionnaires, the focus group interviews, and the reflections sheets revealed that the use of technology and technological tools which are available at Sunshine High School was not incorporated in the grade 10 Mathematical Literacy class at Sunshine High School. It was mentioned in section 1.5 that the school has 25 tablets, an interactive whiteboard, a docking station and a data projector. These items were sponsored to the school. The participants made no mention of these tools being used

in the teaching and learning process at school. Visual tools are definitely used by teachers at Sunshine High School with the intention of making the content more concrete e.g. drawing of a diagram on the chalkboard, using gesturing (Naidoo, 2012). This research study focussed specifically on the use of technology in teaching and learning i.e. the deliberate act of integrating technology and technological tools and resources to make the content more accessible and understandable to the learners instead of just using the routine of 'chalk and talk'. I feel that if the tools and resources are available then one needs to investigate why they are not being utilised. I am confident that there are some very valid reasons for the available technology not being utilised at Sunshine High School in the Mathematical Literacy class.

As already mentioned in chapter five, the participants were unanimous in their responses that the teacher uses the chalkboard as the principal agency of teaching. The participants were quite vocal about their partiality to a teaching method which integrated the use of technology into the teaching and learning process. They have indicated a bias to visual and audio presentations being done simultaneously.

One cannot examine the effectiveness of the technology integrated lessons being used at Sunshine High School when teaching shape and space since no available technology was integrated into the lessons or used by the teacher to teach. This conclusion has been drawn as per the data generated from the interviews with the learners. If technology is not being utilised in and integrated into the Mathematical Literacy lessons at Sunshine High School then one cannot conclude that learning and teaching is not taking place at the school. Instead of speculating on the reasons for the absence of technology and technological tools in the Mathematical Literacy classroom, one needs to enquire why the available technology and technological tools are not being used in the teaching and learning process at Sunshine High School.

One is aware that the learners in the modern-day classroom, are empowered and are eager to express their desires in terms of their academic goals. The learners of the 21st century, are termed the millennial generation. As already discussed in chapter two, the expectations of the millennial generation are not aligned to what is presented to them in the classroom. Studies suggest that 96% of the millennial generation subscribe to at least one social network (Childs, Gingrich, & Piller, 2010). The millennials' approach to education, their demands of curricula, as well as how

knowledge is transferred is different to the previous generations. Millennials expect technology to play a large role in the learning process by expecting vast areas of informational sources to be incorporated into the actual delivery of knowledge through multimedia modes with an emphasis on entertainment during the learning process (Chelliah & Clarke, 2011).

Engeström and Glăveanu (2012) in an interview expressed this sentiment that "expansive learning is learning what is not yet there, that is, learning to master a new way of working while designing and implementing that new way of working." (p. 512), similarly the participants in this study called for the reconfiguration of the teaching and learning process. They requested for a teaching and learning scenario that integrates the technology and the technological facilities available at school with the curriculum.

Engeström's (1999) basic principles as suggested in the Activity Theory and Maurizio and Pisanu's (2013) findings when exploring how learners learn more effectively, have much in common. They suggested that people learn more effectively when the content taught arises from a point that they already know. They also suggested that people learn better when they engage with other people e.g. the teacher or fellow learners. The next suggestion is perhaps the suggestion which encapsulates the call of the learners and the fundamentals of the Activity Theory. It is suggested that people learn more effectively when the cognitive levels and needs of all are considered and the information is described and presented in different ways. The different way or method in this study was the integration of technology and technological tools in the teaching and learning process. It is further suggested that cognitive tools are designed, integrated and adapted to make the application of knowledge easier. It was stated that learners learn better when they receive regular feedback on their tasks or assessments. The participants' calls for their academic challenges in Mathematical Literacy to be obviated is justified in view of what the literature is telling us. The participants suggested that the teacher uses other means of showing them what is it that they mean when they are being taught a concept. The participants called for lesson deliveries to be varied and that it should incorporate the use of videos and Powerpoint presentations. The evidence of these assertions has been provided in the data presentation chapter. Perhaps the learners mention these two tools/techniques since these tools/techniques were used to teach the lessons on shape and space. Perhaps if the researcher integrated other devices, tools or techniques in the lessons,

then the learners may have asked for those facilities to be integrated into the lessons. However, the participants were vocal about their need to be able to see what the teacher means when he/she is explaining the concepts in the classroom.

The participants reflected the view that the integration of technology into the lesson/s would make learning easier for them. These sentiments initiated the theme of İntegrating technology effectively into the teaching and learning process. Piaget (1970) maintained that learners initially develop ideas concretely and later progress to abstractions. He suggested that learners be taught with more tangible visualisations for them to learn an abstract idea.

6.2.1 How can technology be effectively integrated into the teaching and learning process?

A crucial observation in this research study is that although not a single learner mentioned that they experienced difficulties with the concepts of shape and space, they performed poorly in the pre-task. The post-task which was conducted after all lessons had been done, showed a marked improvement in the learner performance. The one thing that was done differently was that available technology and technological tools were integrated into the six lessons. The lessons accommodated for a self-paced approach where learners worked at their pace to gain proficiency in a concept. The videos could be replayed for a learner if he/she required any information to be repeated as he/she attempted the consolidation tasks. The PowerPoint presentations could be re-projected to those learners who needed assistance if they struggled to complete the consolidation tasks. The technological tools and resources used in the lessons served to offer consistency in the delivery of the lessons. If the learner did not fully grasp a concept, method or a calculation, then parts of the lesson could be replicated, for example, replaying a video or by presenting the PowerPoint presentation again to the learner. This assisted the learners in such a way that should the teacher re-teach aspects of a lessons, it may not contain the same turn of phrases, diction and tone. Very often in a revised explanation of a concept, synonyms are used to help clarify understanding but when the learner is not learning in his/her mother tongue then this clarification process may result in greater confusion for the learner. Of the 31 participants of this research study only 10 of them are mother tongue English

speakers, yet Sunshine High School is an English medium school. The use of technology helped to standardise the teaching and learning process.

According to Roschelle et al. (2000) integrating technology into the classroom can improve Mathematics teaching. They maintained that teachers could use technology to advance the teaching and learning of Mathematics instead of memorising facts and performing repetitive calculations. The focus should be on developing ideas, exploring consequences, justifying solutions, and understanding connections. In a research study to explore the relationship between Mathematical Literacy and technology use, it was discovered that the “greatest inequities did not lie in how often computers were used, but in how they were used" (Wenglinsky, 1998, p. 3). One of the key findings was that a teacher's professional growth in the use of technology to teach higher order thinking skills was positively interrelated with learners’ academic achievement in Mathematics. Although this study concentrated on exploring how the integration of technology in the Mathematical Literacy classroom impacts the teaching and learning of shape and space, perhaps one may hereafter explore how integrating technology in the teaching and learning curve impacts on teaching higher order thinking skills. I conclude that it is important for teachers to be proficient in the use of technology if it is to be an effective and a utility tool in the classroom.

It was highlighted in chapter two that many teachers struggled to engage the use of technology in the classroom. The reasons were also mentioned in chapter two. The sporadic curriculum changes that were ushered in with the advent of the South African democracy meant that many teachers were themselves struggling to keep abreast with the changes. Mathematical Literacy is a subject that was introduced in 2008. With its introduction came the many academic, political and social debates. The public engagement and spats on the introduction of Mathematical Literacy into the curriculum, did not serve as a reassurance mechanism for learners and teachers of Mathematical Literacy. If anything, the very public contentions generated a greater degree of vulnerability and stigma for the Mathematical Literacy learners (Bansilal, Webb, & James, 2015). This stigma may have inadvertently impacted negatively on the willingness of teacher involvement in the teaching of Mathematical Literacy.

Based on the feedback from the participants of this study, the need to integrate technology into the pedagogic situation emerged as a significant theme. Vrasidas and

Glass (2005) found that the effectiveness of integrating technology into lessons relied on a few cardinal principles. The proficiency of the teacher in using technology featured as the most important catalyst in driving the integration process forward. The available technology and tools must be compatible with the pedagogy and with the concepts that need to be illuminated. Integration cannot occur for integration itself. It needs to promote the learning and teaching process. The social and organisational setting of the school are factors which can promote or impede the integration of technology into the teaching and learning curve. The resources, both technological and human, as well as support for the facilities are important in the successful and effective integration of technology into the classroom.

To integrate the use of technology effectively in the classroom, one admits that intensive planning and organisation must occur. This planning would require and command a great deal of time. Sound choices must be made by the teacher in choosing the most ideal tool or technology as an aid to convey the concept to the learner.

The learner does not enter the classroom as a blank slate. One should recognise the digital native and his/her prior learning as he/she enters the classroom. The teacher could also engage the experience of the learner and seek his assistance in sourcing the best technological resource to teach a concept or a lesson. Vrasidas and McIsaac (2001) maintain that by using technology in the classroom, teachers can increase literacy and understanding in any subject. They argued further that the use of audio and video components motivate the learners to participate in the classroom and this helps raise their level of understanding. One is reminded of the components of the Activity Theory and how these components facilitate collaboration in a learning system. Hoon (2008) believes that teachers need to be actively involved in teaching and learning across the curriculum. For this to occur, a teacher education programme plays an essential role in equipping the teacher with a solid understanding of the various tools, technology and media available for use in the classroom context. While technology can be a powerful means to advance learning, the teacher remains the critical factor to learner success, and must be informed of learners' development to mediate directly with them.

Although the participants did not suggest how technology could be effectively integrated into the teaching and learning process, they believed that technology should be integrated into the pedagogy. The comments that were received during the rollout of the lessons are indicative of the participants' attitude towards technology integrated teaching. The comments echoed by the participants during the data generation phase, have already been presented in the previous chapter. However, the sentiments of the participants reflected positively how they experienced the technology-based lessons conducted by the researcher. The responses of *"feeling happy about the work"* and *"getting to know more detail"* were indicative of the participants' optimism, confidence and positivity regarding the concepts that were taught.

One should remember that the lessons taught during the data generation phase were integrated with the use of technology. The inputs from the reflections sheets provided proof that the participants favoured the lessons which integrated the technology-based approach when teaching shape and space.

Comments made by participants during the final focus group interview concur with the attitudes reflected in the reflections sheets. Some of the sentiments conveyed by the participants expressed trepidation and apprehension that their Mathematical Literacy lessons had reverted to the 'chalk and talk' approach. A participant drew a distinction between how lessons were during the researcher's tenure as the teacher and the status quo. Responses to the question of how the teaching methods employed by the resident Mathematical Literacy teacher differed from the method used by the researcher were specific. These responses were quoted and mentioned in the previous chapter.

6.2.2 The barriers to integrating technology into the teaching and learning process

Of the 31 learners who participated in this research study, 77,4% of then indicated that they have no access to computers outside of school. Whilst some of them did have access to a computer and the internet, it must be remembered that most learners were not engaging with technology and technological tools to complete their Mathematical Literacy homework. This highlights a barrier which learners at Sunshine High School experience. They probably do not see it as a hurdle in their education but such a barrier is indeed an obstacle to effective learning.

Although one is aware that technology and technological tools are not restricted to the use of computers, the internet, the white board etc. in the pedagogic situation, should a teacher at Sunshine High School need to use a computer for a lesson, arrangements must be made with the management of the school to secure the use of the venue. Should a teacher wish to conduct a lesson which integrates the use of electronically available technology at Sunshine High School, this will also have to negotiated and prearranged. This creates an impediment to the teaching and learning landscape.

The barriers which emerged in planning the data generation stages of this research, although incidental, is a very real reminder that the challenges which arise in the pedagogic situation must be examined and solved. The barriers to integrating technology in the teaching and learning of shape and space in the Mathematical Literacy classroom must be understood so that these barriers can be qualified and understood.

The logistics that are prevalent at Sunshine High School reminds one of Hardman's (2005) expression that in post-apartheid South Africa, the challenge arose in meeting the disparate learning needs of a diverse body of learners. In an attempt to level the metaphoric playing fields and the unequal terrain, it was suggested that tools be developed to bridge the proverbial gap amongst learners. However, one needs to be conscious of the fact that the external barriers were influenced by the economic, political and the academic situation in the fledgling democracy. Sunshine High School is an example of a public school which struggles financially in the democratic South Africa. It labours to service an impoverished community but the assistance of the feeding scheme funded by the Department of Basic Education supports the functioning of the school.

There are also internal barriers which were reflected by the participants during the data generation stage of this study. They also indicated that the integration of technology into the lesson/s would make learning better for them. These sentiments which were reflected, initiated the theme of İntegrating technology effectively into the teaching and learning process. Piaget (1970) maintained that because learners initially develop ideas concretely and later progress to abstractions, that they should be taught with more tangible visualisations for them to learn an abstract idea.

The participants pointed out in the focus group interviews that the computer laboratory at Sunshine High School is accessible only to the learners who study CAT as a school subject. They also expressed a keenness to be able to use the computers and to have access to the internet at school. This is an indicator that there are barriers to accessing technology and technological tools at Sunshine High School. One can deduce that there may exist an array of barriers which are experienced here by the learners and the teachers.

6.2.2.1 External barriers

The fact that sponsored technological resources are available at Sunshine High School but that they are unused in the Mathematical Literacy classroom, makes one wonder why such an anomaly would occur. The barriers to the integration of technology which manifest in any school situation needs to be investigated.

The external barriers or challenges which affect the engagement with technology in the classroom could range from the disparity in facilities available at a school to the different teacher training facilities and methods employed over the years.

Access to technology, training the teacher to use technology and supporting the teachers when they attempt to integrate technology into the teaching process poses a major barrier or challenge to integrating technology into the teaching and learning process in South Africa. Warschauer, Zheng, Niiya, Cotten, and Farkas (2014) remind us that this anomaly is not peculiar to South Africa. They cited the lack of accessibility to technology and the lack of consistent support for teachers who are attempting to integrate the use of technology in the pedagogic milieu. It was also found that the dynamic nature of technology necessitated ongoing training of teachers as newer tools and devices become available. Training, retraining and upgrading of teachers to be able to integrate the latest technology may prove to be very expensive and time consuming. Acquiring equipment is also an expensive feat and maintaining and upgrading it may also be beyond the economic viability of a school. Data are very expensive in South Africa so underprivileged schools may not be able to afford linking equipment to the internet. Security of the equipment is a real problem in South Africa. Using technology and integrating its use with the content is excellent but Ramorola

(2010) questioned the practicality of this endeavour. Sunshine High School experiences similar barriers.

Sunshine High School is situated in the Pinetown district in KwaZulu Natal. Cluster groups of teachers exist but its purpose is to ensure standardisation of tasks and assessments per subject. Orientation workshops are held annually to reorientate the teachers to the prescripts of a given subject for the academic year. Its function does not extend to serve or to assist teachers to master the skill of integrating technology into the lessons. The dearth of reskilling and retraining workshops of teaching personnel is a formidable barrier to implementing technology-based lessons in the classroom.

The Department of Basic Education (DoE, 2003c) has expressed a commitment to ensure that all South African learners will be given help to develop skills and knowledge so that they can achieve their personal goals and they can participate in the global community by 2013, however this has completely eluded us. The resurgence of this commitment came with the call for the Fourth Industrial Revolution (4IR) in South Africa. Gastrow (2018) stated the aims for the rollout of the 4IR as envisaged by the Department of Basic Education. The commitment was to prepare learners for the world of work, then the capacity for post-school education needed to be strengthened at school level and at the classroom level. With the current South African unemployment rate at approximately 30%, it is imperative that the Department of Basic Education embraces and understands what skills sets potential employers are looking for. This will influence the design of the curriculum, the teaching and learning styles as well as the kinds of tools used in the classrooms. The 4IR plans specify that the curriculum must respond to changing technologies at school level. This catalysed the call for fresh and flexible modalities to ensure lifelong learning for all participants in the education fraternity. The model that was presented for 4IR is aligned to Activity Theory. It encourages self-learning, peer-learning and customised learning.

The subject of self-learning and customised learning surfaced when some participants in this research study indicated that when they did not understand a concept, they used an app. If they struggled with the app then they sought assistance from a parent. The sentiments were that the Mathematical Literacy teacher should be equipped to use the app in the classroom and explain the subject matter to the learners. The

opinion was that the teacher would be more effective if the use of the app were combined with explanations at the classroom level. The participants elaborated that the use of the app combined with the assistance from the teacher would also consolidate the learning process. Bojuwoye, Moletsane, Stofile, Moolla, and Sylvester, (2014) showed evidence of many classroom practices representing support for meeting the academic, social and emotional needs of learners thereby helping them to succeed in schools. Their study predicted that if support systems are nurtured and encouraged by school authorities and the Department of Education officials at district, provincial and national level, then the learners will flourish academically. The use of repetition, memorisation and routine learning techniques were discouraged, instead the call was made for greater inclusion of technology and technologically compatible devices which can be connected to the internet, facilitated by a hands-on teacher.

The request made by the participants of this research study for access to technology-based teaching and learning at school is aligned to the SA-EU Strategic Partnership Dialogue conference which was held in Pretoria in December 2018.

6.2.2.2 Internal barriers

The internal barriers according to Cloete, (2017) are just as central to the impediments to the effective integration of technology in the classroom. In the South African climate Ramorola (2010) cited some of the challenges which the teaching fraternity encountered when attempting to integrate technology with pedagogy. Funds are not allocated for the purchasing and maintaining of technology and equipment. School staff must look for patrons and raise funds to equip their schools with technology and related equipment. The reality that older teachers did not have computers during their teaching training years meant that many teachers have reskilled and upgraded their skills on their own, but many remained untrained. The lack of support from all the relevant stakeholders in education does not help promote or encourage the integration of technology in the classroom. Perhaps the fact that learners were not at the same level as teachers and that some learners were more tech-savvy than the teacher posed a sense of intimidation to the teachers.

As explained in the previous chapter, a participant claimed that learners at Sunshine High School had no access to a computer whilst at school. The claim was

substantiated when it was stated that only the learners who studied CAT (Computer Applications Technology) at school had access to the computer laboratory and its facilities. This claim encapsulated the notion that technology in the form of computers was only available to the Computer Applications Technology (CAT) and Information Technology (IT) teachers and learners at school. This phenomenon poses a problem to the effective deployment of resources to benefit the larger school population. Chürr (2015) warns us that unequal access to facilities by learners in the schooling system could be detrimental to the overall growth of a nation.

Occasionally, we have the challenge of teachers who do not fully grasp the content which they need to teach, so how then can these teachers be expected to deliver lessons effectively or to prepare effectively for lessons. (Hughes, 2005)? There are instances where teachers may not be qualified in a given field but may be expected to teach a subject which he/she is not familiar with and may not be comfortable to teach it. These scenarios play out at schools especially when there is a teacher substituting for another. Integrating technology in the delivery of these lessons may serve as a crutch to the teacher and this will deliberately benefit the learners. Effective integration of the lessons using technology and technological resources will not be possible if the concepts are not fully understood by the teacher. Resistance by teachers to adopt new and fresh teaching methods or to be capacitated is also an example of an internal barrier (Johnson, Jacovina, Russell & Soto, 2016).

One must be mindful of the potential dangers which lurk around technology and everything that it encompasses. The challenge arises as to how to protect learners from these potential dangers at the classroom level.

6.3 Meeting the academic needs of the millennial learner

The second critical question in this research study examined whether the use of technology when teaching shape and space in Mathematical Literacy influenced the teaching and learning process. As was already explained in chapter five with the use of Figure 5.2, the pre- and post-task indicated a marked improvement in the participants' scores. This outcome is peculiar to this study and one cannot say that it can be extrapolated to other contexts. The danger in claiming that the use of

technology when teaching shape space and measurement to grade 10 Mathematical Literacy will indeed improve results, is that the sample used in this research study is too narrow and specific.

The millennial generation occupy the classroom and their defining characteristic is that they are driven by technology and by the need to use technology in all aspects of their daily lives. This drive that they possess should be used to influence strategies which can be used in the teaching and learning process to promote learning. I concur with Ghavifekr and Rosdy (2015) when they claim that approaches and strategies used a decade ago are not efficient in the 21st century classrooms. Teachers need a new sense of understanding of the millennial learners in order to accommodate their learning skills. The participants in this study also echoed the sentiment that the use of technology-based teaching methods would greatly assist them in the learning process.

My view is aligned to that of Monaco and Martin (2007) who believe that if the teacher understands the learners then they can assist them to develop learning skills didactically and clinically. Wilson and Gerber (2008) offer guidance and helps channels my thinking when I realise that they combined several of the generational characteristic in their study. They provide teaching strategies to meet the needs of millennial learners. I concur with their belief that today's millennial learner will "shortly be a colleague in the teaching profession" (p. 40). They also demonstrate the proposed teaching strategies which are derived from classroom experiences and from theoretical literature and recommend that in order to meet the needs of the millennial learner, the teacher should adapt to engage with them. Effective engagement with the learners will assist to foster a healthy didactical relationship.

Suggestions that the learners should be involved in the designing of the syllabus/curriculum to provide an enhanced clarity of subject/content and assignments, would be key to engaging with the millennial learner. Planning, and pre-planning of lessons are crucial to reducing stress in the classroom. A tenet of learning demands that the teacher considers the need of the learner to achieve his academic needs. Moulding and reinventing the teaching strategies to meet the needs of the millennial learner is the key to ensuring that the academic requirements are satisfied. Teachers should understand these features as they attempt to connect with their

millennial learners who strive to learn if the teaching strategies fit their needs (Wilson & Gerber, 2008).

The participants' need and the desire for academic improvement as expressed during the focus group interviews is commensurate with the sentiment shared by many school going learners. During this research study, the learners requested for a varied method of teaching by the teacher. I have already established that the millennial learner appreciates clarity, structure, collaboration and an enriched learning experience so it makes sense that technology-based teaching allows learners to integrate the various tools that they use in their everyday lives into the classroom such as, music, video clips and social media (Clayton-Pederson and O'Neill, 2005) The use of multimedia and group work contributes and allows learners to match their aptitudes and interest in technology to track projects that attracts them in a way that suits them best. The use of technology-based teaching methods offers some flexibility and diversity in presenting information to the learners, providing feedback to learners, and addressing different learning styles to the learners. It is suggested that teachers integrate numerous learning objectives into their curriculum. These objectives will address the learners' desire for group work, flexibility, and options in the classroom.

When the focus group was asked what is it that they believe that can help them advance the learning of shape and space, all the participants agreed that the use of videos, charts, worksheets and PowerPoint presentations amongst others, will assist them to understand concepts better.

The data analysed from the questionnaires concurred with the responses from the participants during the focus group interviews. In questionnaire 1 question 17 the participants declared that the use of the computer, the use of the internet and any visual material such as worksheets will make learning easier. The data analysed from questionnaire 2 questions 14 and 15 indicated the unanimity amongst all 31 participants that the use of the videos and PowerPoint presentations made the lessons enjoyable and made the concepts easier to understand. These responses indicate that meeting the academic needs of the millennial learner is achievable.

I concur with Oblinger and Oblinger, (2005) when they warn that technology alone will not meet the academic needs of the learners, but that technology will facilitate the strategies to meet the various needs of the learners in the classroom of today. The teachers must realise that the learners are so familiar with technology and upon engaging with these technological tools for their academic needs, it will assist them to become lifelong learners. Technology is widely available at many schools. The most important question is how best the technology can be integrated in the classroom rather than whether technology will be used in the classroom.

6.4 How can technology-based teaching methods be integrated into the pedagogy to support learners?

The researcher maintains that if the technology is integrated effectively into the pedagogy, it can assist the learners to learn effectively. The data which was presented in chapter five figure 5.2 indicated a significant increase in the post-task scores of the participants. These scores support the assertion of the researcher. Bester and Brand (2013), in a similar study found that there was a significant difference between the average achievements of the group of learners exposed to technology during a lesson compared to the group who were not exposed to technology and only received normal verbal instruction. A finding of this study indicated that the average achievement of those who received technology supported instruction was significantly higher. One of the findings was that technology plays a significant role in the achievement of learners in Geography, Mathematics, and English.

Now that one has evidence that technology-based lessons do have a positive impact on the learning process, one needs to examine how the technology can be integrated into the teaching process to assist the learners to grasp concepts more effectively and concisely. In order to discuss this aspect, one needs to examine what technology should be incorporated into the lessons at the classroom level. The question of whether technology is a tool or a method in the teaching process needs to be explored. Similarly, the need for complementary technology in the classroom needs to be examined.

6.4.1 What technology should be used in the teaching and learning of shape and space in Mathematical Literacy?

Technological tools have always taken pride of place in the Mathematics classroom. The use of the protractor, compass, calculator, overhead projector to name a few, have been used in the teaching of Mathematics. The Mathematical Literacy classroom has a different set of skills which need to be consolidated. The technology and the technological tools which need to be engaged with, can be content specific. It must be able to support the learners in exploring and identifying the concepts in the Mathematical Literacy classroom. Examples of these content specific tools and technology can be YouTube videos which teach a lesson, a Power-Point presentation which expounds a concept (Gadanidis & Geiger, 2010).

In the previous chapter, Tumo's explanations on how the YouTube videos benefited him whilst learning shape and space in the Mathematical Literacy class, was mentioned. He pointed out that technology-based teaching allows for the replay of the lessons, thus capturing the content succinctly with no margin for misunderstandings. It also facilitated the learning process because it allowed for the pause and play feature to be applied. Incidentally, Jia's (2019) claims coincides with the assertion made by Tumo regarding the use of YouTube videos in the educational setting.

The technology used in the Mathematical Literacy class can also be content neutral. According to the National Council of Teachers of Mathematics (2015), the engagement with content neutral concepts assists learners to communicate and collaborate with tools and with their peers. This can help enhance the sense making process which is integral to the learning curve.

When the participants' contributions, which were made during the focus group interviews on the issue of language was presented in the previous chapter, the researcher did allude to the fact that deliberations on this issue will be done in chapter six. The issue of language could pose as a barrier to effective learning, in the Mathematical Literacy class. The use of content neutral technology can be employed to improve communication and collaboration in the classroom space. The use of neutral technology serves to bridge the gap between the learners and this concept of working collaboratively is very much aligned to the tenets of Activity Theory (Hardman, 2005).

Technology can be integrated differently into the teaching milieu depending on the expertise of the teacher. This will be possible only if the technology is accessible to the teacher and the learner. The planned, well executed use of technology in the teaching and learning domain, assists the learner to engage with the content and gives power to the learner over the learning process. This implies that the technology employed should encourage learner-centred participation. The use of subject specific, neutral content, accessible and familiar technology should be integrated into the Mathematical Literacy lessons (Sianjina, 2000).

In chapter five mention is made of David who spoke of using a website that assists him with his Mathematical Literacy work however, he concurs with Sianjina (2000) when suggesting that we use the technology which is available and accessible. David also alluded to the high cost of data and suggested that the internet be made available for learners at school.

A participant admitted that the use of technology-based teaching methods sustained the attention of the learner during the teaching process. The participant alluded to the fact that a technology integrated teaching method could be of “benefit” to the learners in the Mathematical Literacy class.

Embracing and understanding how the concepts of shape and space operate, requires one to be able to visualise shapes and figure out how these shapes occupy space in real-life situations. If a learner is unable to “see” how a rectangle can contextually become a gate i.e., if he/she is unable to comprehend the transformation from a two-dimensional image to a three-dimensional shape, then he/she will not be able to work on the concept of depth. A figure which is imprinted on a worksheet can be transformed into a three-dimensional shape using technology and technological tools. The strategic representation of a shape in three-dimensional form will assist the learner to grasp the features of a shape and this will help make learning meaningful and realistic.

The use of videos presentations portraying shape and space content serve to make the images real, relevant and meaningful. The use of technology and technological tools which allows for the projection of visual images remove the burden from the learner of having to create a picture of the concepts in his/her mind and it helps him/her to bring to life the concepts that are being taught.

I believe that there are various teaching methods and teaching resources available to assist teachers and learners to consolidate concepts in shape and space in Mathematical Literacy. However, I believe that the use of visuals via technology and technological tools which are already available , is one of the most standardised and effective ways of teaching concepts in shape and space. If a video needs to be replayed at the convenience of the learner for the purpose of consolidation, then one knows that the video is available for replay. This also ensures that no confusion will arise because no new words and phrases are being added to the explanation.

This study is by no means the design of technology-based teaching for teaching shape and space in the grade 10 Mathematical Literacy class. This exploratory study integrated just a few tools into the lessons. Perhaps future studies may examine which technology or technological tools can best complement the teaching of a given topic or concept.

6.4.2 Technology: a tool or a method in the pedagogy?

Graven and Venkat (2007) as well as Spangenberg, (2012) concede that Mathematics requires that learners be able to think in terms of symbolic representations or abstract conceptualisation. Integrating technology in the classroom particularly in the Mathematical Literacy classroom is a very virtuous goal given that some Mathematical Literacy learners struggle to understand Mathematical concepts that are abstract and that are symbolically represented.

A book, a calculator or a piece of chalk can be regarded as a tool but when these tools are incorporated into the teaching process then they promote and advance the teaching process. Similarly, any tool is only as good as the teaching methods being used with it. The integration of an available technological tool which fosters the teaching and learning process, is regarded as a method in the pedagogic practices. Effort and money should be invested into helping teachers perfect teaching methods in general so that whatever tool they have at their disposal will be used to its full potential (Yildirim, 2000). In question 12 of questionnaire 2, the participants unanimously agreed that technology should be integrated into the Mathematical Literacy lessons. In question 11 of questionnaire 2, the participants were also

unanimous in their agreement that during the research study, the technology integrated lessons were academically very helpful to them.

6.4.3 The need for complementary technology

The contemporary classrooms must change to reflect what goes on around outside. They must be able to bridge the gap between classrooms and real-world settings such as changing workplace demands. So, when the participants called for the use of complementary technology in the teaching process, one realises that they are aware that the benefits of using technology in the classroom extend beyond the academic. Mphethu called upon the teacher to use *"other means"* to complement the teaching process. Amahle concurred with Mphethu's comments but she extends her claim that the use of complementary technology will indeed improve discipline in the classroom. Their claim that there is greater focus by the learners during the lessons when technology is integrated into the lessons, suggests that if technology is used complementary to the lessons, then learner discipline will improve in the classroom.

In their research studies Bester and Brand (2017) found that there were significant differences between the average attention of a group of learners exposed to technology during a lesson compared to a group not exposed to technology. The information in chapter five which presented data from the reflections sheets, indicated the participants' claims that the use of technology-based teaching, greatly benefitted them.

The feedback from reflections sheet 2 echoed similar sentiments as Amahle. The term complementary technology suggests that like all tools they do not replace good education, they enhance it. Technology is not here to replace a teacher but to enhance the teacher's capabilities. When it is used properly, a teacher learns new ways of teaching, and it not only improves the delivery of instruction but improves the teacher as a learner too. A good teacher of the 21st century has the most important trait of being a lifelong learner (Shah, 2013).

6.5 Varied learning styles

The traditional classroom favoured the 'chalk and talk' approach but as already stated, the millennial learner preferred the use of visuals which stimulate the learning process. One is aware that all people learn differently. Some people have a bias to auditory

learning whilst some may prefer to learn visually. There is also a group of people who have a strong bias to the reading/writing modality. The kinesthetic learner prefers to learn by being actively involved in the learning process and makes use of all his/her senses in the learning process. One person can also display several different learning styles. In an ideal classroom it is incumbent on the teacher to use teaching styles that favour the learning styles of his/her learners in order to promote effective teaching and learning, however the incongruous classroom dynamics in South African public schools make this very difficult.

Technology-based teaching is a teaching technique which can help the teacher and the learner to reach a position of middle-ground in terms of accommodating for the varied learning styles. If technology-based teaching is well planned and structured then visual, auditory, kinesthetic and learners who have a reading/writing bias can be accommodated. The participants in this study were vocal about the methods they preferred in the learning and teaching environment.

Smaldino, Lowther and Russell, (2008) and Lytras, Gasevic, Ordonez de Pablos and Huang, (2008) warned that the millennial learner has been brought up with technology so without audio and visual information being used simultaneously in a presentation the learners may not learn effectively. Current learners are accustomed to absorbing information from the screen rather than from the printed page, and they find teachers who use technology to be more reliable and knowledgeable than those who do not. Since learners are used to ongoing stimulation outside the school context by way of their cell phones, tablets, iPads etc., the question which arises is whether the classroom environment will also succeed in stimulating the interest of the learner. A variety of learning styles needs to be presented in a classroom. According to Shah, Ahmed, Shenoy and Srikant (2013) learners prefer multimodal and the kinesthetic method of learning regardless of geographical locations. Kinesthetic is a learning style which occurs when learners carry out physical activities rather than by sitting and listening to a lecture. This method encourages collaboration in the learning process. Since Activity Theory can explain the nature of collaborative activities and indicate how people can socially participate while interacting with technology, this framework is ideally situated in this research study.

It is the teachers and the learners' responsibility to identify the dominant learning style of the learner. It is also the responsibility of the teacher and the learner to remain mindful of learners' learning style partialities in order to improve learning. Once a teacher is able to assess and understand how to reach all learners by understanding how to present information in multiple modes, then the learners can perform optimally both in and out of the classroom. One must be aware of the learners' partiality to a learning style, then only can one assist them in determining their preferences.

The participants in this study also alluded to a preference to a learning style. Mphethu call for the teacher to use examples and other means of depicting what he intends for the learners to know is synchronous with the comment made in reflections sheet one. Both sentiments are aligned in their stance that the use of technology-based tools in the classroom can assist them to perform better academically. The fundamental principle of Activity Theory is based on the fact that the use of tools is imperative.

Tumo reminded us that people vary in the way they learn and absorb what they have been taught. Similarly, Allcock and Hulme (2010) discussed the shift towards a personalised approach to teaching and learning. The teaching and learning process is tailored to learn and teach to individual needs. This is the inclusive approach to incorporate learning styles for the different personality traits, environments and varied strengths and weaknesses. Activity Theory firmly underpins this philosophy. When the *object* component of the structure of the human Activity Theory is depicted as an oval space, it aims to indicate the potential within the activity system is characterised. It can be characterised by movement, possible contradictions, tensions and potential for change. *Objects* also indicate the stage at which sense and meaning are derived from a process. Knowing and understanding the learners' preferences will improve the motivation to learn and to provide opportunities to approach learning appropriately (Bloomfield & Nguyen, 2015).

As stated in chapter five, Sanele's comment added another dimension to the learning and teaching discussion. He stated that together with technology-based teaching, the teacher should scaffold the teaching process such that one concept can be taught and then another concept can be built up on the original concept as the lessons progressed. Sanele's comment is aligned with the use of PowerPoint presentations. The use of PowerPoint presentations allows for concepts to be built up as the lessons

progress. The worksheets which contained the application task per lesson, also served the consolidate knowledge of the concept before the next lesson was taught.

Both Sanele and the feedback provided in reflections sheet 11 harmonise with Aisami's (2015) claim that 65% of the world's population are visual learners therefore they need to see what they are learning. Baderaddin and Mohammad's (2015) research studies support the idea that learners can master the curriculum if they are taught with different strategies or different methods that completes what they lack in classroom instructions. Technology-based teaching offers this promise to learners since the use of technology can fill in the gaps in their knowledge which the teacher may inadvertently omit.

6.6 Why should technology be used when teaching shape and space?

The third critical question which this research study endeavours to answer, examined why technology should/should not be used when teaching shape and space to grade 10 learners in the Mathematical Literacy class. From all the discussions which have surfaced thus far, one can emphatically say that that technology should be incorporated in the teaching of shape and space in the grade 10 Mathematical Literacy class.

As already discussed in chapter two, the concepts that are expected to be learnt and applied in the grade 10 Mathematical Literacy class regarding shape and space, can be challenging to the learner, therefore a greater degree of assistance is required for the learner to master these concepts.

Space and shape in Mathematical Literacy is the study of shapes where the learners learn to know, explore, and conquer, to live, breathe, and move with more understanding in the space in which they live. This understanding can only be achieved if the learners are able to understand the properties of objects and their relative positions. Learners must learn to navigate through space and through constructions and shapes. An understanding of the relationship between shapes and images is required (Ojose, 2011).

Roschelle et al. (2000), found that when technology makes abstract ideas tangible, teachers can more easily help the learners to connect abstract concepts to real life settings. Tumo suggested during the focus group interview that Mathematical Literacy learners should watch more videos. He qualified his suggestions by advising that the videos can be viewed repetitively by the learners as the need arises. This would consolidate concepts and make learning more effective. This would ensure that the consolidation of concepts taught in the classroom become more standardised. Tumo's sentiment and the descriptions offered in reflections sheet 5 is proof that technology-based teaching has a positive academic role in the life of the learner. It helps to consolidate the abstract features of lessons and make it more concrete. Common misunderstandings in the handling of shape and space can be eradicated. The use of technology-based teaching provides additional opportunities for learners to see and interact with mathematical concepts. Groff and Mouza (2008) speak about a sense of pride and empowerment which becomes characteristic of the participants when they can shift their thinking from concrete examples to abstract thinking. This sense of pride is noted in the details of reflections sheet 5.

6.6.1 The effect of language on learning concepts

In questionnaire 1, three questions pertaining to the issue of language were presented to the participants. The analysis revealed that 63.3% of the participants received assistance with their academic work in the medium of English. Although 58,1% of the participants agreed that they think in the medium of isiZulu, only 38.7% of them stated that they prefer to communicate in the medium of isiZulu in the Mathematical Literacy class. The bias towards English as the language of learning and teaching was obvious from the responses. This is also a very interesting anomaly which needs to be examined through a global lens.

Probyn's research study (2006) was based in the South African milieu specifically in the grade 8 Science class. She talks about the use of code switching to help second language learners to cope with learning in an English medium school however the article extends its recommendations that traditional teacher-centred practice be abandoned in favour of learner-centred approaches to facilitate the learning process amongst second language English learners. The article recommended the use of concrete examples and the use of resources that can be used interactively. It also

calls on all teachers' need to understand the role of language in learning. Tumo expressed similar sentiments as expressed in the research study by Probyn (2006). Probyn (2006) cautions that these recommendations are not to be confined to Science teachers. This knowledge is needed to develop more effective teaching across all learning areas and to seriously address the question of equity and access to the curriculum for most of the learners in South Africa.

The reality is that not all English medium schools have teachers who can code-switch for the learners especially if it requires the use of fine and specific terminology when teaching the content.

One may ask why the participants who think primarily in the medium of isiZulu, count as a 61.3% majority in indicating a preference to be taught in the medium of English. It may seem to display as a contradiction given that English is a former colonial language. In the South African setting, English has expanded its position as the language of access and power since the democratic elections of 1994, and African languages effectively are confined to functions of general communication in the home only. English remains the dominant language in South Africa. The language of learning and teaching frequently creates a barrier to learning when it is not the learners' home language. Riasati, Allahyar and Tan (2012) concluded that technology is being increasingly employed in instruction to enhance teaching and learning. He elaborated that there is a marked improvement in academic performance amongst learners when technology-based teaching occurs. Tumo and Marlene commented on the difficulties expressed when they work with shape and space. The issues of the language barrier and the desire to succeed at schools were encapsulated in their comments.

6.6.2 Integrating technology into the lessons stimulates learner engagement

During the lessons conducted at Sunshine High School, the learner engagement in the lessons was commendable. The learners were eager to attend the lesson even though the lessons were conducted during their "free" periods and after school hours. They displayed enthusiasm during the lessons and they attended all six lessons. Their eager responses may have been because the learners may have seen this as an opportunity to revise for the final examinations, but their interest at being taught with

the use of technological tools and projected images was conveyed by the learners during the focus group interviews.

Hamilton-Hankins (2017) found that technology-based teaching had a positive and desirable effect on the learners. It increased the academic performance of the learners as well as increased the collaboration among teachers and learners. The benefits of enhancing learner engagement in the classroom increases learner confidence. Similarly, the responses from the participants in this study depicted a scene wherein the lessons called for collaboration. The participants also claimed to be more confident with the content of shape and space when taught using technology-based methods.

The sentiment expressed in reflections sheet 11 is evidence that the participants were stimulated and happy to learn from a technology integrated lesson. This favourable outcome is summarised when Activity Theory represents the entire activity as the unit of analysis. The rules, the tools, the division of labour, the subject, the object and the community are neatly mediated to offer the favourable outcome. Activity Theory regards technology as tools. These tools mediate social action, in other words, the tools will have an influence over the interaction between the subject and the object (Hashim & Jones, 2007).

Wayne admitted that there are academic challenges but he concedes that the use of technology facilitated the learning process. When the researcher suggested that the videos during the lessons made the concept in the Mathematical Literacy class more visual, 67.7% of the participants agreed very strongly with the statement and 32.3% of the participants agreed with the statement. This implies that 100% of the participants concurred with this statement. The similar responses from the reflections sheets, the questionnaires and the focus group interviews allow one the latitude to conclude that technology-based teaching serves as a stimulant to the learner and it encourages collaborative learning.

The researcher is of the view that the teacher must create an engaging learning environment for the learners. Likewise, Taylor and Parsons (2011) suggest that the teacher not only creates an engaging learning environment, but one where the learners are able to enjoy the feel of an able and safe environment. These strategies will help empower the learner. Learner empowerment will encourage learner engagement with the teacher and with colleagues. They will be able to challenge the

teacher, their colleagues and themselves as part of the learning process. Learner empowerment will give rise to the development of interpersonal skills. Interpersonal skills will then assist the learner to engage in discussion with the teacher and fellow learners respectfully and constructively. It will also equip the learner to master the subject content. This recommendation is aligned to Vygotsky's zone of proximal development (ZPD) Activity Theory focuses on the move from an individual subject's learning to that of a collective activity system. This is similar to ZPD where a learner learns through a process of collaboration.

6.6.3 Technology integration in the classroom as a preparation for the Fourth Industrial Revolution

Sunshine High School is an example of a public high school with computers, internet accessibility and a few other technological devices. One knows that these technological tools are not used per se in the Mathematical Literacy lessons at the school however, of the 31 learners who participated in this research study, 26 learners indicated that they know how to use a computer/laptop/tablet/iPad. This is encouraging because the learners are self-empowered with technological skills. This augurs well for them because these skills are handy for the world of work. It also serves as testimony that learners' prior learning must be recognised. The learners' answers to the question of whether they engaged with technology and technological tools outside of the Mathematical Literacy classroom in order to their schoolwork, were encouraging. More than 50% of the learners indicated that they utilise the technology used in the teaching process outside regular class time.

One needs to check if technology-based teaching takes place in other learning areas at Sunshine High School. One needs to also check on the willingness of the teachers to engage with technology-based teaching. These questions are for another research study. In this study I have already recorded the keenness of the participants to engage with technology whilst learning.

This exploratory study offers value because one uses it as a gauge to measure whether this school is in line with the current trajectory that education has taken in South Africa. The Department of Basic Education has been called upon by the current president of South Africa, Mr Cyril Ramphosa, to embrace the advent of the Fourth

Industrial Revolution (4IR). The merits and the timing of the Fourth Industrial Revolution may be debatable however the intentions are noble.

The goal is to ensure an inclusive digital economy and society. Gillwald, (2019) warns of the existing disparity in the society in readiness for the Fourth Industrial Revolution. As an educationist in South Africa, one needs to ask how prepared we are for the Fourth Industrial Revolution. We need to examine whether the schooling system is ready to help the learners meet the target of being able to embrace the technological changes which 4IR rolls out. It is a worrying factor that the national education goals are not commensurate with and has not filtered down to what needs to happen at the classroom level. The positive spinoff is that although technology and technological tools are not used in the teaching of Mathematical Literacy at Sunshine High School, many of the learners have the capacity to work with a computer/tablet/iPad for the purposes of schoolwork.

The learners' meaningful engagement with technology and technological tools outside of the classroom is an advantage, but one needs to be cognisant that the nucleus of this study is technology-based teaching and its impact on teaching and learning shape and space in the Mathematical Literacy lessons. One needs to ask whether we are doing our bit by using the available technology discerningly in order to help create a brighter future for South African learners who run the risk of leaving high school without mathematical skills. One needs to understand the learners need assistance to reach their full potential in order to function meaningfully in their communities.

Although the Department of Basic Education has succeeded in implementing Mathematical Literacy and Technical Mathematics as school subjects in South African schools, the challenge remains that society has recognised the stereotype that Mathematics are for the few. The reality is that Mathematics and mathematical skills are deeply entrenched in the modern workplace and in everyday life. We need to communicate the belief that mathematical skills are for everyone. If teachers exude confidence about the content through the content delivery, then learners will feel more confident and enthusiastic about the content. Planned integration of tools and resources into the lessons can enhance the quality of the delivery of the lessons. Once learner self-confidence has been built then learners are empowered with the key component to effective learning in Mathematical Literacy (Gouthro & Griffore, 2004).

Learner self-confidence is the cornerstone to mastering cognitive skills. The cognitive skills for example critical thinking, problem solving, and creativity are presently covered by the South African curriculum, however, digital tools can boost and extend critical thinking simultaneously providing learners with exposure to digital technology. The benefits of integrating technology into the curriculum, according to McNulty (2018) include personalised and expanded learning, increases engagement and collaborative learning.

Tumo's suggestion of being able to use technology to improve his results in Mathematical Literacy connects with the concept of personalised learning where the learner can progress at an individual pace. There is no pressure to keep up with the class. The use of technology enables the teacher to pace the learning according to the needs of the learners. It also allows some learners to move ahead whilst others can continue to develop the cognitive skills needed.

The concept of expanded learning is intertwined with what David explained in the focus group interview. David explained that he uses a website that assists him to understand concepts with which he would otherwise struggle. He added that this website also offers the solutions to the practice examples.

Expanded learning offers the learners additional learning opportunities and this learning extends beyond the confines of a classroom. The use of technology to consolidate or improve knowledge is extended to learners of all ability levels. A great benefit to technology-based teaching is increased learner engagement. The learner is able to engage critically with the teacher, whilst engaging with other learners and the content. The increased engagement has a domino effect which results in more collaboration with the teacher and learners whilst engaging with the content. Collaborative learning affords learners vital prospects to critically appraise each other's contributions and to communicate with each other in order to solve problems through teamwork.

Since South African's schools are so results driven, assessment for learning is probably one of the most positive aspects that technology-based teaching can offer the teacher. In this research study, the marked improvement in the learners' pre- and post-tasks, is indicative of the fact that the use of technology makes it easier for the

teacher to assess and reassess in order to gauge whether the necessary skills are being imbibed by the learner.

Although I am convinced that technology-based teaching can help the learners and the teachers in the classroom, I am not convinced that the learners will be capacitated with the technological skills to function effectively at the workplace upon leaving school.

6.6.4 How technology integration impacts the many facets of education

The issues of improved language skills, improved communication, improved discipline, fun learning and self-paced learning are some of the aspects which were noted in Sunshine High School's Mathematical Literacy grade 10 class because of technology-based teaching

The improved scores in the post-task, which was completed by the participants, is evidence of the improved skill of understanding what the task expected of them. The learners coped better at completing the task. They did not ask for help or for clarifications. They had a clearer understanding of the instructions and the terminology in the tasks. The learners also seemed to handle the daily consolidation tasks with greater ease as the lessons advanced. The completed daily reflections sheets also indicated a willingness to express their experiences in the Mathematical Literacy classroom. The depth of the reflections on the reflections sheets increased.

The participants became more confident as the lessons progressed. They were not afraid to ask for a video to be replayed or for an example from the consolidation task to be explained. The learners were also vocal that they enjoyed the lessons and they were keen to share their feelings in the classroom and during the focus group interviews.

Amahle alluded to the fact that if the teaching in Mathematics Literacy class is technology-based then it can also assist with discipline and classroom control. She mentioned that the classroom control was better during the six technology-based lessons than during the normal Mathematical Literacy classes.

Amahle's sentiment is congruous with Sithole (2017) who mentioned that discipline, effective learning and collaboration are some key elements to creating a conducive

learning environment Amhle's assertion implies that the use of technology-based education in the classroom, assists in creating an environment that is conducive for learning to occur. Noma and Amahle's comments in the focus group interviews also resonate with the issue of discipline in the classroom. They concur that if the use of technology is integrated into the lesson then there may be a greater degree of discipline in the classroom. Although Lavin, Korte and Davies's (2010), research findings do not concur exactly with the findings of this study that technology-based teaching improves the learners' results, their study offers a new perspective on the use of technology in the classroom. They found that whilst technological enhancement and integration in the classroom may not necessarily be suitable for all classroom situations and all subject matter, the results suggest that teachers who are comfortable using technology and find that it enhances their teaching experience should continue to incorporate it in their classes. Their finding that specifically impacts on this study is that technology is that tool, which when used appropriately, can have a positive impact on learners' behaviour and perceptions.

Amahle felt findings that technology is a tool which can be used to supplement the teachers' instruction in the classroom and if technology is used properly by the teacher then it can foster more interest in learning on the part of learners and teachers can use it in the instruction of their respective subjects. The contribution by the participant in reflections sheet 12 indicates and supports findings that the technology-based lessons do indeed assist in the learning process. This participant was able to differentiate between the area and surface area because the teacher taught and integrated the lessons with use of technology.

Sunshine High School accommodates learners of varied ability levels. It is a school that is culturally and racially diverse and most learners are not mother-tongue English learners. Technology-based teaching has been recognised as providing a means of assisting schools to realise their goal of promoting equal access to education regardless of their cultural, racial and socio-economic backgrounds, as well as their strengths and weaknesses in any area into an integrated school (Jhurree, 2005).

6.7 A summary of the chapter

This chapter analysed and interpreted the data which was presented in chapter five. The data were examined with a view of developing patterns and making generalisations to the larger population of similar studies. The data which were presented, was aggregated intentionally to extract the common themes. The varied data generation tools helped elicit a vast body of rich data. The mixed -method approach favoured the triangulation process. The data generated from the questionnaires and the pre- and post-task scores were triangulated by the focus group interviews and the reflections sheets. The expectation was that similarities and differences in responses would emerge. The data were able to reflect the voice of the participants, effectively and concisely.

The participants were all Mathematical Literacy learners in a grade 10 class. Whilst they performed poorly in the pre-task based on shape and space, they were keen to be part of the research project. They acknowledged that no technology was integrated in the teaching and learning process in their Mathematical Literacy classroom by their resident Mathematical Literacy teacher, yet they were keen to participate in technology-based lessons.

The themes which emerged from the data were discussed in this chapter. The themes answered the three critical questions and they resonated with the reviewed literature and the tenets of the theoretical framework guiding this research study.

The participants called for the use of technology-based teaching therefore the integration of technology effectively into the teaching and learning process, was expounded. How technology can be effectively integrated into the classroom was discussed. The domino effect of such a discussion led one to examine the barriers to integrating technology into the teaching and learning space. The participants expressed the need to pass Mathematical Literacy and this gave rise to the theme of meeting the academic needs of the participants.

Since the participants repeatedly asked for technology-based teaching methods, the issue of how technology can be integrated into the pedagogy to support learners was examined. This discussion examined what technology should be used when teaching Mathematical Literacy. There was some discussion around the technology being a

method or a tool. This research study also examined the need for technology which complements the lessons.

The participants also expressed the desire to have a variety of teaching styles used in the classroom. This inspired the researcher to consider a discussion which focussed on the varied learning styles amongst learners. Stemming from the call from the participants to use Power-Point presentations and YouTube videos in the Mathematical Literacy lessons, the discussion around why technology should be used when teaching shape and space in the grade 10 Mathematical Literacy class was conducted. Many of the learners at Sunshine High School are not mother-tongue English speakers, therefore the effect of language on learning concepts was discussed. The aspects of how technology-based teaching can reduce the language barrier in the classroom was reviewed. This study also examined how the integration of technology into the lessons can stimulate the learner whilst helping to create an environment that is conducive to learning

The participants also spoke about their plans post grade 12 so it was incumbent on the researcher to examine whether the current status at Sunshine High School was in line with national call embracing the Fourth Industrial Revolution. Lastly, this chapter discussed how technology integration impacts the many facets of education.

Each of the themes were analysed in relation to the literature review and the theoretical framework that has been used in this study. Chapter seven attempts to provide a description of some of the insights.

CHAPTER 7: EMERGING INSIGHTS

7.1 Introduction

Chapter five presented the findings as each set of data were analysed, underpinning it with what current literature says on those issues. Activity Theory supported and reinforced the themes which emerged from the data analysis process. In chapter six the analysed data were grouped by aggregation and then intertwined in order to allow the emerging themes to be discussed. Through this arrangement the three critical questions were addressed.

The themes which emerged were discussed in chapter six. These themes allowed for the generation of new ideas and gave rise to suggestions and proposals. The themes which emerged were:

7.1.1 Integrating technology effectively into the teaching and learning process

Under this theme, the question of how technology can be effectively integrated into the teaching and learning process was examined. The barriers to integrating technology into the teaching and learning process were expounded.

7.1.2 Meeting the academic needs of the millennial learner

The research participants expressed their need as to how they would like to have the lessons taught to them. The participants were in favour of technology-based lessons. They acknowledged that they are able to access educational sites from their cellphones or from a friend's/relative's cellphone. It is evident that the current generation of learners are technologically competent.

7.1.3 How can technology-based teaching methods be integrated into the pedagogy to support learners?

This theme examined what technology should be used in the teaching and learning of Mathematical Literacy. The concept of whether technology is a tool or a method in the pedagogy was discussed. The need for complementary technology in the classroom was examined thereafter.

7.1.4 How learners love to learn

The varied learning styles as specified by the participants were deliberated. The data that was collated revealed that this group of learners love to learn visually. They expressed the sentiment that visual learning was more meaningful to them. Using technology to learn is more than just learning from those within your zone (ZPD). It is about using the world as your global village and relating to it accordingly to make sense of the task at hand. Learners do not favour the 'chalk and talk' approach used by the teacher. They preferred the use of various stimuli in order to learn effectively.

7.1.5 Why should technology be used when teaching shape and space?

The research exploration revealed that integrating technology into the lessons has an impact on how concepts are learnt and it helps reduce the language barrier for the participants who are not mother-tongue English learners. This study revealed that the IsiZulu mother-tongue learners struggled with the language used in their classrooms. They also struggled with the fact that English is used as the language of learning and teaching with no code switching by the teachers. The learners were vocal about the fact that they would rather have been shown how to tackle the task in the Mathematical Literacy class rather than being told how to do the task.

The integration of technology into the lessons assisted the learners to grasp the concepts more effectively. My observation is that the technology-based lessons also assisted the mother-tongue English speaking learners to grasp the concepts of shape and space well. Although the mother-tongue English speaking learners did not cite language as a barrier to learning in the Mathematical Literacy class, they did say that they struggled to grasp the concepts. The use of visuals projections accompanied by the audio made the lessons simpler for the learners to understand the concepts of shape and space. This influenced how the learners were able to handle the consolidation tasks at the end of each lesson.

This theme also elucidated that integrating technology into the lessons stimulate learner engagement in the classroom. The learners were keen to work together and they supported each other. There were no objections raised in the classroom when a learner wanted to watch a video or part of a video again. Learners worked at their pace and if they could not complete the consolidation task during the lessons, they were

keen to complete it as homework. The learners were keen to support and encourage each other when the consolidation tasks were being marked.

The discussion also revealed that technology integration creates a realistic and well rounded environment which is conducive for learning. A discussion on how technology integration impacts the other aspects of education such as discipline, was also conducted.

7.2 Emerging insights

When the data generated in this research study was examined through the lens of the theoretical framework (Activity Theory) and the relevant literature, certain trends and insights emerged. I have analysed the experiences and the views of the learners throughout this research study but my perceptions and perspectives on the process need to be explained. Preparing the lessons and the execution of the lessons required intense planning. Although I knew exactly which aspects of shape and space I needed to cover over the six lessons, I had to be very selective of the technological resources that I used in the lessons. I was careful to engage with technological resources which were already available at the school. The design of the PowerPoint presentations had to capture as effectively as possible, the concepts of perimeter, area, volume and surface area. A considerable amount of time was used to select the most relevant YouTube videos which taught the concepts of perimeter, area, surface area and volume. Designing of the PowerPoint presentations required perseverance by the researcher.

Proper planning and attention to detail had to be done so that the lessons could be delivered without disruptions. Although the critical questions were answered in chapter six, a great deal of incidental information also surfaced. These incidental data have a contribution to make to educational practices and to the classroom scenario in the South African context. Its discussion may lend insight into other areas of education and thus promote discussion.

The researcher found that although the learners at Sunshine High School hail from poor socio-economic backgrounds, their operational knowledge of cell phones, laptops, iPads and how to access internet sites was evident from the information they shared with the researcher during the course of the study. I can therefore conclude

that the millennial learner's tech-savvy traits makes him/her comfortable to engage with social media and to interact with others using technology and social platforms. Perhaps a beneficial research study would be how social platforms can be engaged within the teaching and learning scenario.

In my opinion the integration of technology into the lessons could inadvertently serve as a preparation for the Fourth Industrial Revolution (4IR) which President Cyril Ramphosa called for in July 2019. The Fourth Industrial Revolution aims to revolutionise the way we live, work, study and socialise. I dare say that the integration of technology into lessons for the learners of Sunshine High School may be a natural process for them.

I will attempt to express the realisations that I have experienced during the data generation process at Sunshine High School under the following sub-headings.

7.2.1 Classroom control and discipline

When engaging with learners that are not the learners that you teach on a daily basis, the learners can be cooperative or uncooperative and difficult. I relied on the learners' goodwill to be disciplined in order to conduct the lessons. The learners intrigue and excitement at seeing the technological tools ready for use in the classroom, aided excellent learner discipline.

Effective classroom control and discipline is a prerequisite to ensure that effective teaching and learning occurs. Although this study had no intention of exploring this theme, the participants alluded to the fact that the integration of technology into the lessons conducted during the data generation phase improved the discipline in their classroom. Similarly, Bester and Brand (2013) found a positive correlation between learner engagement with technology and an improvement in the discipline in the classroom. Elstad and Christophersen (2017) offer a somewhat divergent view on this matter. They examined the operational challenges that teachers encountered when learners are situated in a technology rich classroom and how teacher control over the class was diminished in such a classroom. However, for the purposes of this research study, it can be concluded that the technology-based teaching approach benefitted the learners academically and it improved discipline.

The researcher did not encounter any challenges in respect of learner cooperation and learner discipline. I was impressed with the fact that the learners were able to effectively communicate their feelings about the lessons through the reflections sheets and at the focus group interviews. They were not awkward about expressing their uncertainty about aspects of the lessons. They were also generous with praise when they felt that they had learnt a concept or a technique relating to shape and space. The learners responded spontaneously when the consolidation tasks were reviewed after each lesson. They worked well with each other as well as with the researcher.

They were eager to continue with more technology-based lessons. This was noted by the fact that they invited the researcher to continue engaging with them with aspects of the Mathematical Literacy syllabus. The evidence of this is available in the transcripts of the focus group interviews.

The excellent attendance by the learners to all six lessons was commendable even though not all the lessons were conducted during normal teaching hours. This speaks well of learner discipline and commitment towards the learning and teaching process.

Many of the findings of this research study coincide with the finding of McLennan and Dale-Jones (2016) wherein they found that when “learners are more engaged – they enjoy the challenge of searching for information, learn well from videos and benefit from working collaboratively. Learners enjoy being at school, which translates into lowered absenteeism. If the school context provides for this, learners can use ICTs (Information and Communications Technology) to do their homework at school, an important benefit if home conditions are not conducive to doing schoolwork” (p. 56). The concept ICT is synonymous with technology-based teaching and blended learning.

7.2.2 Language barrier

Since language is the principal medium by which learning is negotiated, learners rely on hearing or reading about a concept in order to learn it. If a learner struggles to comprehend what he/she hears or reads, then meaning will not be formed. This research study was undertaken inter alia with the intention of exploring what impact/effect the use of technology-based teaching methods have when teaching shape and space in grade 10 Mathematics Literacy. During the focus group interview

with the participants, the challenges which they encountered, surfaced. The dominant struggle which the participants encountered, was the issue of language. Only 32,2% of the participants were mother-tongue English speaking learners yet 61.3% of the participants preferred to be taught in the medium of English. This foregrounds the sensitive issue of the language of learning and teaching. One cannot help but wonder why learners would choose to be taught in the medium of English even though they encountered challenges with the language issue at school. However when the researcher looked at other research studies in order to understand why the learners responded in this way, it became quite easy to understand the learners' choice for the medium of instruction.

Pillay and Zungu's (2010) study which focussed on high school learners' attitudes towards isiZulu in the greater Durban area, proved relevant for this research study. It found that although isiZulu has been accorded its rightful place in the constitution and it is available to the participants, they have shown a preference to engage in the medium of English. When isiZulu mother-tongue learners are in favour of using English as the language of learning and teaching, then one needs to examine why this is so. Mashiya (2011) found that learners in KwaZulu-Natal chose English over an African language as the language of learning and teaching. The research showed that most parents and learners opted for English because they believe that English will empower them. They viewed African languages as the language of communication and not of learning. Parents believed that if their children learnt in the medium of English then it has the potential of meeting the material needs of the child. According to the above-mentioned studies parents valorised the position of English in education, therefore it would stand to reason that the non-mother tongue English learners at Sunshine High School preferred to be taught in the medium of English.

7.2.3 The lack of and the under-utilisation of resources at public schools

The research study revealed that even though Sunshine High School has a computer laboratory, use of the computers and the internet was restricted to the learners who did Computer Applications Technology (CAT) as a subject. This is an example of how an available facility is under-utilised. The use of available facilities and resources at a school needs to be maximised so that many learners can benefit from its use. The

enhanced, integrated use of a facility such as a computer laboratory can yield greater productivity and improve results in a school such as Sunshine High School.

It is achievable and attainable to teach using a varied teaching style when the use of available facilities is optimised to benefit teachers and learners. The lessons taught by the researcher at Sunshine High School are proof that much can be done to ensure that the learning and teaching dynamics in the classroom can be transformed. The capacity of the leadership such as the school's governing body and the school management should be able to facilitate the compliance of learning institutions to the policies as outlined by the Department of Basic Education.

The call by the President of South Africa for the educational sectors to be 4IR compliant should be supported by the stakeholders in education. Sunshine High School is proof that the capacity of the leadership can elicit the funds necessary to bring about change. Money is not the only challenge in managing schools effectively; the capacity of the leadership to lead schools in the change process is by far the greatest challenge. The management's vision for the school needs to be in line with educational policy and it should be focussed on serving the needs of a dynamic community. Activity Theory depicts the strategic positioning of all the stakeholders in the didactic relationship.

Learners are resilient and determined. Trends have changed in society and many schools have embraced these changes. The use of computers linked to the internet and other devices such as interactive whiteboards are available in many public schools however, some public schools have not been able to embrace the changes and meet the demands of an evolving society (Ojo & Adu, 2018). In our democracy, education has been overhauled several times yet one observes that the schooling system and the classroom dynamics have remained largely unchanged. Stoffels (2008) examined why classroom practices are hard to change. It was found that against the background of the implementation of educational practices of the post-apartheid era, the human aspect of change as a personal transformation process was not so visible amongst teachers. There was a general concern for a quality education and for a new political and educational dispensation in South Africa. This is evidence that there is a reluctance on the part of teachers to implement educational changes which are geared towards teaching and learning for a change in a society in transition. There needs to

be more direct involvement in the form of ongoing reskilling of teachers and supervision by the Department of Basic Education in order to ensure that the schools are not reneging on their responsibility in serving the community effectively. It is the report by van der Berg, Taylor, Gustafsson, Spaull and Armstrong (2011) that claimed that low teacher effort is considered one of the most serious problems in the South African schooling system. The report goes on to explain that this challenge is even greater than weak teacher content knowledge and pedagogic skills to effectively teach the curriculum. This report however made many suggestions on how schools can be administered effectively which is aligned to the insights arrived at in this research study. It called for the development of the capacity within the teaching force, strengthening of relationships of accountability and support amongst stakeholders throughout the school system and it called for the sharpening of accountability through better information to parents and education departments.

It is agreed that facilities and resources need to be procured to make a school fully functional. In order to supplement the resources already provided by the Department of Basic Education, partnerships need to be established with the corporate sector as well as parents and well-wishers of the community in which the school is based. Upgrading, retraining and a general sense of capacitating and empowering all the stakeholders in education will yield enormous results (DoE, 2015).

7.2.4 Improving results

Throughout the research study, I felt the learners desperate need to succeed at school. The learners desire to pass may have been a reason that learners were keen to be part of this study. The learners' efficiency at completing the tasks were commendable . The collaborative effort enjoyed by the 31 learners during the lessons was admirable. Learners worked at their own pace but all were meaningfully engaged with the tasks at hand. Learners were not offended or upset if their colleagues requested a replay of a video or a re-explanation of a concept. The team spirit which prevailed in the classroom assisted greatly with the common goal of learning and consolidating the concepts of shape and space.

The keenness of the learners to receive feedback on their post-task was a clear indicator of their intention of improving their understanding of the concepts and ultimately to improve their results. I felt the willingness and the enthusiasm of the learners to try and grasp the concepts of shape and space as solidly as possible. In spite of the fact that I was not their resident Mathematical Literacy teacher and that they bore no obligation to me, the learners continued to interact informally with me even after the post-task exercise .

There is a huge and ongoing cry from all quarters of the South African society for improving education in our society. A nation's academic results are measured by test scores and by standardised tests. The National Senior Certificate examinations is one such standardised test which generally generates much criticism from many groups upon the release of results and it is understandable that efforts are being made by educationists to improve the academic results in South Africa.

According to the report by the Department of Basic Education (2019) three intervention processes were structured into the schools' curriculum delivery process in order to help improve the results in the 2018 NSC exams. The report states that support was provided to learners through direct instruction. This included vacation schools, weekend schools, exam schools and learner incubation camps. The second category in which support was provided to the learners has a direct bearing on this research study. The support took on the form of indirect instruction which included the use of Information and Communications Technologies such as internet broadcast lessons, telematics lessons, radio lessons, television broadcast lessons and a series of teacher training to improve content and methodology of teachers. The last category of support focused on the provision of additional learning and study material.

The improvement of results will help uplift a school, a community and a nation. It will also save the taxpayer funds which are used to accommodate learners who repeat grades in the schooling system. Klopfer, Osterweil, Groff and Haas, (2009) found that when there is engagement with technology-based teaching then results improve, and the domino effect is that this educational competence by the learners will help the economy to grow. Perhaps the most positive finding of this study is the point that technology-based teaching immerses the learners in a learning experience that allows

them to tackle a problem and emerge with the necessary skills as they pursue the solution.

7.3 Introducing divergent knowledge to the field: The amended Activity Theory model for the purpose of teaching and learning in the classroom

Technology has rooted itself in our everyday lives therefore if we embrace the facilities available to us, we will be able to utilise technology to improve learning and teaching and assist our learners to flourish academically.

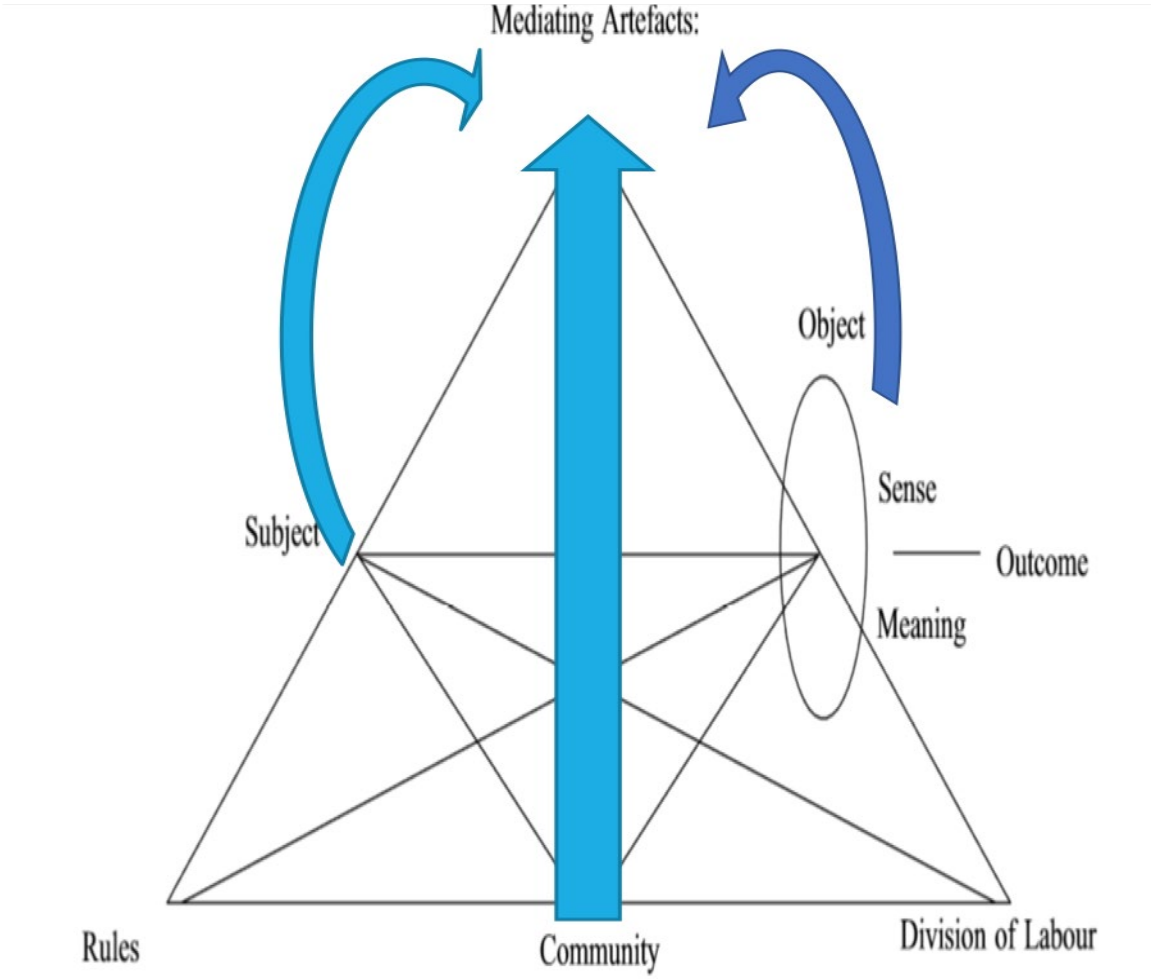


Figure 7.1: A proposed amendment to the activity system (Adapted from the collective activity system as illustrated by Engeström,1987, p.136).

As already explained in chapter three, the Activity Theory model as explained by Zurita and Nussbaum (2007) suggests that Engeström's Activity Theory model is explained

effectively in an Activity system. The evolution of the Engeström's model displays interrelatedness as well as connections between the various stakeholders and the numerous facets which form an essential part of education. Learners, teachers and parents are nucleic components of the educational didactic. These components are not products of a mechanical system. All three components are socially and culturally embedded and are regarded as "actors" in this model (Khiok-Seng, 2003).

Integral to Activity Theory are the contributions that each facet brings to complete the model effectively. Each facet has played a pivotal role in the activity system however, the human elements are in a state of dynamism therefore they can offer input and contributions to the changes and improvements they wish to see in the teaching and learning environment.

The researcher suggests and extends the idea that the following influencing factors be added to the already functional model. As seen in figure 7.1, it is suggested that the subject, community and the object offer input into determining the mediating artefacts which should be used in the teaching and learning process. The intention is to encourage collaboration and to harmonise the teaching and learning process. The nuclei components ideally should be the components who will know what is best and most effective in a didactic scenario. Figure 7.1 encapsulates the essential features of this amended model. If the subject, object and the community do not offer some input into what mediating artefacts should be included into the technology-based learning and teaching, then it would be difficult to encourage and promote technology integration in the classroom. Even if technology-based teaching and learning does become mandatory, without the contributions of the stakeholders of education, this would be an example of a pyrrhic victory for education (Mashau, Kone, & Mutshaeni, 2014).

Engagement with all the relevant stakeholders in education may nurture the education process. The community may serve as the "eyes" of the school and may be able to offer some degree of security and allegiance towards the institution. Community engagement may assist to keep the school's infrastructure and technological tools safe. The role of the community may also influence and help to provide the type of technological tools which are needed at a school through their fundraising and

networking efforts. Community involvement is essential to grow a community successfully and I believe that it takes a community to successfully raise a child.

Molnar (2016) in her interview with Bill Gates, found that he believes that the use of technology in the classroom should be personalised by the relevant stakeholders in education. He says that whilst technology is starting to improve education, the fact that the use of technology is not personalised or focussed enough to assist the teacher to figure out how to improve education. Capacitating teachers to engage with different tools may assist them to integrate technology effectively in the teaching and learning environment. It may assist the teacher to make sound choices when deciding which technological tool best enhances the teaching of a particular concept.

As mentioned earlier, technology-based teaching and learning is synonymous with blended learning and ICT. Activity Theory is the most ideal tool when innovation is introduced in an educational setting. Activity Theory assists the researcher to hypothesize about what functions and what does not when embracing an innovation. It further assists by helping the researcher to gauge what hinders change, at what level change is obstructed, and which factors generate these obstructions. Activity Theory provides the researcher with a platform to study how a practice or a system can be reconfigured by introducing innovation into the system (Hasan & Kazlauskas, 2014).

The role and contribution of learners is very important in the teaching didactic. The learner does not enter the teaching and learning environment as a blank slate. They are unique in learning styles and they inform the learning and teaching didactic. The prior learning and the knowledge which the learner brings into the classroom should be recognised. School-going children belong to the millennial generation. Their knowledge of computers, the internet and other technological tools must be valued and used in the classroom.

This suggested amendment to Activity Theory hones in on the contributions of the most important stakeholders in the teaching and learning space. I am not suggesting that there is no room for the contributions of other stakeholders who inform and support education. I feel that specific decisions governing the rollout of the syllabus must be

left to those who are at the heart of the educational engagement however, the process must be monitored and supported by other stakeholders in education.

7.4 The limitations of this study

This research study constituted a very small sample size of 31 participants and the findings of this study may not allow for generalisations. However, the intention of this study was to explore how technology-based teaching impacts the teaching and learning process, and not necessarily to arrive at generalisations. The data were generated at the latter part of October and progressed into November. This was close to the final examination and the participants may have been busy with their revision programmes. This study was conducted at a public/disadvantaged school, therefore the findings from this study may not be extrapolated to other better resourced and better located schools. I am a current employee of the school which serves as the data collection site, so the findings of the study may be biased. The findings from this study may not necessarily apply to other schools, especially schools which are already integrating technology and tools in the teaching and learning process.

The researcher used only a few technology-based tools. The question which remains is what about other types of technology-based tools which could have been included in this study.

It is a brilliant idea to use technology-based methods to teach and learn, but one needs to consider its practicality. Will all the classes have access to all the tools and facilities needed for lessons which are conducted simultaneously? The very real issue is that data is expensive in South Africa. How can poor schools afford to purchase data? South African schools have been targeted by criminals and there is added burden on the principals of schools to keep whatever technological tools and devices that they may have at school, safe. The other issue is can we protect our learners from potential dangers which lurk around on websites and cyberspace?

7.5 Some suggestions and a proposed new model for technology integrated teaching and learning

Learning and teaching techniques/methods should be varied in any classroom. One technique/method should support/consolidate the other. Since technology is accessible to the learners, why should we not interlink the technological experience of the learners with academic knowledge? Teachers should always be mindful that everything in the classroom has a cultural and social connotation. The way learners relate to each other and with the teacher will be mediated by tools and technology. The Department of Basic Education should consider establishing a unit that assists with teacher development. This unit can be structured such that teachers are assisted to familiarise themselves with the latest in technology and how the available technology can be integrated effectively at the classroom level. It may assist teachers to effectively integrate the technology into the teaching and learning process.

Situated at the centre of this study is the exploration of the effects that technology has on the teaching and learning process. This study examined very specifically the impact of technology-based teaching on the teaching and learning process when teaching shape and space to grade 10 Mathematical Literacy learners. Based on the findings of this research study, the researcher endeavours to offer a proposal on how technology should feature in the education system.

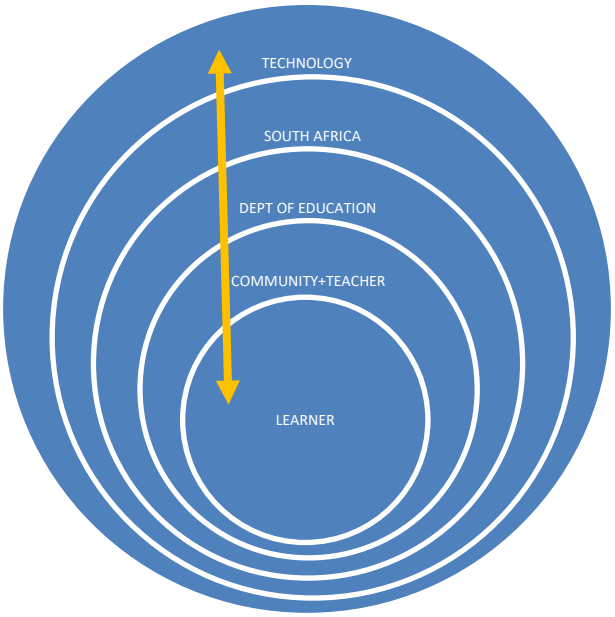


Figure 7.2 A proposed model for technology integrated learning and teaching in education.

The presence of technology is being experienced internationally and its influences are being felt on a global level (Naikoo, Thakur, Guroo, & Lone, 2018). It stands to reason that all facets of South African society may also be impacted by technology and technological tools. One realises that education needs to embrace the technological changes and the available technology. Technology should be used to enhance the teaching and learning process and to improve the quality of education. Since education is such a dynamic process, a further suggestion would be that all spheres and sectors of education should embrace technology-based mechanisms in the daily implementation and monitoring of educational tasks. A proposed model as depicted in figure 7.2 indicates the concentric approach to embracing technology in our current South African education climate. The concentric approach indicates that all components share the same centre. The learner is placed at the centre or the core of the design. The aspects which influence the learners' performance which enables readiness for the real-world, form the other circles. The ubiquitous nature of technology is depicted by the outer ring. The impact and influence of technology is experienced internationally, therefore South Africa is placed as the second inner circle. The role of the Department of Basic Education influences the role of the community and the teacher, who in turn will have an impact on the learner. The arrow which indicates movement from the innermost circle to the outermost circle and vice versa, depicts that reciprocity of the relationship in the didactic environment. If the country and the education system have been effective in preparing a learner for society, then every learner will be able to extend and apply knowledge to uplift the country. The symbiotic relationship of the learner and the education system will emerge.

The researcher suggests that when technology-based teaching and learning has been effectively executed, then one could examine other aspects in education which could be transformed to embrace the technological opportunities available. If teachers could monitor and assess the learners' tasks through electronic means, then there is the advantage of saving paper, thus rendering the didactic system environmentally friendly. The benefits of e-learning and e-marking should be a topic for another research study.

7.6 A summary of the chapter

This research study set out to explore the use of technology-based teaching methods when teaching shape and space in grade 10 Mathematics Literacy**.** The findings are from one case, but the deeply contextual data collected allows the researcher to make conclusions which may be valid across other similar studies. The findings indicate that the use of technology-based teaching as a teaching/learning tool does undeniably force a shift in the activity system. It transforms traditional behaviours and leads to contradictions in and between systems consequently, forcing changes in and between systems. The use of Activity Theory is a framework for tracing changes across an entire system, instead of merely tracing changes within the individual. Using Activity Theory as a theoretical framework, is still a comparatively new means for observing the integration of technology into the classroom. Activity Theory is not a traditional theory which inspires the construction of predictive models, instead it offers a channel for researchers to locate themselves in a real-life problem and identify key issues which need to be addressed. It supports the researcher in the research process by assisting him/her to ask the right questions.

The model as represented in Figure 7.2 creates the awareness that in fact our planet is a global village. The technological evolutions which bombard society affects all countries similarly. This perennial model is applicable to all facets of the South African community. It is not restricted to the school milieu. However, this study was situated in the school system, therefore it is how we respond as a teacher, a school, a community, a Department of Education or a nation that will ultimately determine whether we find ourselves as trailblazers or whether we lag behind as a society. Once we are able to embrace and integrate technological changes discerningly, we will be able to place ourselves and our country on the cusp of an educational revolution. The final word in this study is that technology should supplement the teaching and learning process, not substitute it. Engaging with technology which is fit for purpose will be the arsenal that can spur the education sector to greater heights.

References

Abidin, Z., Mathrani, A., Parsons, D., & Suriadi, S. (2015). *Opportunities and challenges of mobile learning for promoting mathematical literacy*. Paper presented at the Australasian Conference on Information Systems, Adelaide.

Aisami, R. S. (2015). Learning styles and visual literacy for learning and performance *Procedia - Social and Behavioral Sciences, 176*(1*),* 538 – 545. doi: 10.1016/j.sbspro.2015.01.508

Alber, R. (2018). Embracing the Whole Child. *Edutopia.* San Francisco, CA: Jossey-Bass.

Allcock, S. J., & Hulme, J. A. (2010). Learning Styles in the Classroom: Educational Benefit or Planning Exercise? *Psychology Teaching Review, 16*(2), 67-79.

Amalki, S. (2016). Integrating Quantitative and Qualitative Data in Mixed Methods Research-Challenges and Benefits. *Journal of Education and Learning, 5*(3), 288-296.

Aronstam, S., & Braund, M. (2016). Play in Grade R classrooms: Diverse teacher perceptions and practices. *South African Journal of Childhood Education 5*(3), 1-10.

Askew, M. (2002). Making Connections: Effective teaching of numeracy. Retrieved from www.beam.co.uk/pdfs/resoz.pdff.15February2018

Baderaddin, M. Y., & Mohammad, A. A. (2015). How to Accommodate Different Learning Styles in the Same Classroom: Analysis of Theories and Methods of Learning Styles. *Canadian Social Science 11*(3), 26-33. doi:10.3968/6434

Bain, R. (1937). Technology and State government. *American Sociological Review, 2*(6), 860-874. doi:10.2307/2084365

Bakhurst, D. (2009). Reflections on activity theory. *Educational Review 61*(2), 197-210. Retrieved from doi:10.1080/00131910902846916

Bansilal, S., Webb, L., & James, A. (2015). Teacher training for mathematical literacy: A case study taking the past into the future *South African Journal of Education, 35*(1), 1-10.

Barnard, R. (2010). Activity Theory: A Framework for Analysing Intercultural Academic Activity. *An International Journal of Human Activity Theory, 3*(1), 25-37.

Bester, G., & Brand, L. (2013). The effect of technology on learner attention and achievement in the classroom. *South African Journal of Education, 33*(2), 1-15.

Bickham, M., Bradburn, F., Edwards, R., Fallon, J., Luke, J., Mossman., &Van Ness, L.A. (2008). *Learning in the 21st Century: Teaching Today's Students on Their Terms*. USA: Certiport.

Bloomfield, D. & Nguyen, H. T. M. (2015). Creating and sustaining professional learning partnerships: Activity Theory as an analytical tool. *Australian Journal of Teacher Education, 40*(11), 23-44.

Bojuwoye, O., Moletsane, M., Stofile, S., Moolla, N., & Sylvester, F. (2014). Learners' experiences of learning support in selected Western Cape schools. *South African Journal of Education; 34*(1), 1-15.

Booyse C., Grussendorff, S., Houston, J. I. A., Singh, R. I., Ntenza, S. P. & Hough, S.M. (2014). *What's in the CAPS package-Mathematical Literacy*. Pretoria: Umalusi Retrieved from https://www.umalusi.org.za/docs/reports/2014/mathematical_literacy.pdf.

Botha, J. J. (2011). *Exploring Mathematical Literacy: The relationship between teachers' knowledge and beliefs and their instructional practice.* (PhD in fulfilment for the requirements of the degree), University of Pretoria, Pretoria.

Bowie, L., & Frith, V. (2006). Concerns about the South African Mathematical Literacy curriculum arising from experience of materials development *Pythagoras* (64), 29-36

Burbules, N., & Callister, T. A. (2000). *Watch IT: The Promises and Risk of New Information Technologies for Education.* Boulder, CO: Westview Press.

Bush, T., Joubert, R., Kiggundu, E., & van Rooyen, J. (2010). Managing teaching and learning in South African schools. *International Journal of Educational Development, 30*(2), 162-168.

Buytenhuys, E., Graven, M., & Venkatakrishnan, H. (2006). Mathematical Literacy - a Lifeline for Many. *Learning and Teaching Mathematics, 5*(1), 31-35.

Bygate, M. (2001). Effects of task repetition on the structure and control of oral language. [In M. Bygate, P. Skehan and M. Swain (Eds)]. *Semantic Scholar*, 23-38. Retrieved from https://www.semanticscholar.org/paper/Effects-of-task-repetition-on-the-structure-and-of-Bygate/91c29da5b9ea0f82e9e0977a8fa682a7febfa163 doi:10.4324/9781315838267-

Campbell, T. (2014). Selected at seven: The relationship between teachers' judgments and assessments of pupils, and pupils' stream placements *Leading education and social research, 14*(1), 1-68. Retrieved from http://repec.ioe.ac.uk/REPEc/pdf/qsswp1410.pdf

Canough, J. (2013). *Effective Implementation of Technology.* (Submitted in partial fulfilment of the requirements for the degree M.S. Special Education Masters), St. John Fisher College- Ralph C. Wilson, Jr. School of Education, Fischer Digital Publications. Retrieved from http://fisherpub.sjfc.edu/cgi/viewcontent.cgi?article=1262&context=education_ETD_masters

Carrejo, D. J., & Marshall, J. (2007). What is Mathematical Modelling? Exploring Prospective Teachers' Use of Experiments to Connect Mathematics to the Study of Motion. *Mathematics Education Research Journal, 19*(1), 45-76. doi:10.1007/BF03217449

Carson, D., Gilmore, A., Perry, C., & Gronhaug, K. (2001). *Qualitative marketing research*. London: SAGE Publications.

Chelliah, J., & Clarke, E. (2011). Collaborative teaching and learning: Overcoming the digital on the divide? *On the Horizon, 19*(4), 276-285. doi:10.1108/10748121111179402

Childs, R. D., Gingrich, G., & Piller, M. (2010). The future workforce: Gen Y has arrived. *Public Manager, 38*(3), 32-34. doi:10.1109/EMR.2010.5559140

Chisholm, l., Volmink, J., Ndhlovu, T., Potenza, E., Mohamed, H., Muller, J., . . . Mphahele, L. (2000). *A South African Curriculum for the Twenty First Century: Report of the Review Committee on Curriculum 2005*. Retrieved from Pretoria: Government Printers: http://citeseerx.ist.psu.edu/viewdoc/download?

Christiansen, I. M. (2006). Mathematical Literacy as a school subject: Failing the progressive vision? *Pythagoras, 64*(1), 6-13.

Chürr, C. (2015). Realisation of a child's right to a basic education in the South African school system: Some lessons from Germany. *Potchefstroomse Elektroniese Regsblad, 18*(7). Retrieved from http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1727-37812015000700002 27October2019

Clapp, B., & Swenson, J. (2013). The Collaborative Classroom: New Technology Brings New Paradigm. *Atlantic Marketing Journal,* 2(3), 60-68.

Clark, R. (2012). Maths vs Maths Literacy: the continuing debate. *Mail and Guardian Online Network*. Retrieved from https://thoughtleader.co.za/readerblog/2012/01/09/maths-vs-maths-literacy-the-continuing-debate/

Clayton-Pedersen, A., & O'Neill, N. (2005). Curricula Designed to Meet 21 st-Century Expectations. *Educause*, 123-139. Retrieved from Educating the Net Generation website: http://www.educause.edu/Resources/EducatingtheNetGeneration/CurriculaDesign

Cloete, A. L. (2017). Technology and education: Challenges and opportunities. *HTS Teologiese Studies / Theological Studies, 73*(4), 1-7. doi:10.4102/hts. v73i4.4589

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education.* (7th ed.). New York: Routledge.

Coupland, M., & Crawford, K. (2006). *Many dimensions: the complex picture of student encounters with a computer algebra system.* Paper presented at the Education Research Group of Australasia Conference, Canberra, Australia.

Cravens, T. R. (2011). *Effective Technology Strategies Teachers Use in the Urban Middle Grades Mathematics Classroom.* (PhD Partial Fulfilment), Georgia State University, ScholarWorks@Georgia State University

Crawford, K., & Hasan, H. (2006). Demonstrations of the Activity Theory Framework for Research in Information Systems. *Australasian Journal of Information Systems, 13*(2), 49-68. doi:https://doi.org/10.3127/ajis.v13i2.40

Creamer, E. G. (2016). A Primer about Mixed Methods Research in an Educational Context. *International Journal of Learning, Teaching, and Educational Research, 15*(8), 1-13.

Creswell, J. W. (1998). *Research design: Qualitative and quantitative approaches*. Thousand Oaks: Sage Publications.

Creswell, J. W. (1999). *Mixed-method research: Introduction and application. In G. Cizek (Ed.), Handbook of educational policy*. San Diego, CA: Academic Press.

Creswell, J. W., Hanson, W. E., Plano Clark, V. L., & Morals, A. (2007). Qualitative research designs selection and implementation. *The Counseling Psychologist, 35*(2), 236-264.

Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research* CA: Sage.

Czerniewicz, L., Ravjee, N., & Mlitwa, N. (2006). Information and Communication Technologies (ICTs) and South African Higher Education: Mapping the Landscape. Pretoria: Council on Higher Education.

Daniels, H., Edwards, A., Engeström, Y., Gallagher, T., & Ludvigsen, S. R. (2010). *Activity Theory in Practice promoting learning across boundaries and agencies* London: Routledge.

De Lisle, J. (2011). The Benefits and Challenges of Mixing Methods and Methodologies: Lessons learnt from implementing Qualitatively led mixed methods research design in Trinidad and Tobago. *Caribbean Curriculum, 18*(1), 87-120.

Denscombe, M. (2008). Communities of Practice: A Research Paradigm for the Mixed Methods Approach. *Journal of Mixed Methods Research, 2*(3), 270-283.

Department of Education. (2003a). National Curriculum Statements Grades 10 - 12 (General) Mathematics. Pretoria: Department of Education.

Department of Education. (2003b). *National Curriculum Statement Grades 10-12 (General): Mathematical Literacy*. Pretoria: Department of Education.

Department of Education. (2003c)., *Draft White Paper on e-Education: Transforming Learning and Teaching through Information and Communication Technologies (ICTs)*. South Africa: Cape: Formerset printers Retrieved from www.gov.za. Department of Education. (2015). *National Senior Certificate Examination: School Subject Report*. Pretoria Retrieved from https://www.education.gov.za/Portals/0/Documents/Reports/School%20Subject%20report%202015%20Final.pdf?ver=2016-02-03-134622-000.

Department of Education. (2014). *National Curriculum Statement Grades 10-12 (CAPS): Technical Mathematics*. Pretoria: Department of Education.

Department of Education. (2015). *Action Plan to 2019. Towards the Realisation of Schooling 2030. Taking forward South Africa's National Development Plan 2030*. Pretoria: DBE. Retrieved from http://www.governmentpublications.lib.uct.ac.za/news/action-plan-2019-towards-realisation-schooling-2030-taking-forward-south-africa's-national.

Department of Education. (2019). *Report on the National Senior Certificate Examination: Advancing the potential of education*. Retrieved from Pretoria: https://www.education.gov.za/Portals/0/Documents/Reports/NSC%202018%20Examination%20Report%20WEB.pdf?ver=2019-01-03-085338-000

Devlin, T. J., Feldhaus, C. R., & Bentrem, K. M. (2013). The Evolving Classroom: A Study of Traditional and Technology- Based Instruction in a STEM Classroom. *Journal of Technology Education, 25*(1), 3-20.

Dogruera, N., Eyyamb, R., & Menevisab, I. (2011). The use of the internet for educational purposes. *Procedia - Social and Behavioral Sciences, 28*(1), 606-611. doi: 10.1016/j.sbspro.2011.11.115

Duhaney, D. C. (2000). Technology and the Educational Process: Transforming Classroom Practices. *International Journal of Instructional Media, 27*(1), 67-72.

Eady, M. J., & Lockyer, L. (2013). "Tools for learning: technology and teaching strategies". *Learning to Teach in the Primary School*, 71-94. Retrieved from http://ro.uow.edu.au

Education, U. S. D. o. (2017). *Reimagining the Role of Technology in Education: 2017 National Education Technology Plan Update*. United States Retrieved from http://tech.ed.gov.

Edwards, A., & Protheroe, L. (2003). Learning to See in Classrooms: What are student teachers learning about teaching and learning while learning to teach in schools? *British Educational Research Journal, 29*(2), 227-242.

Ellis, V., Edwards, A., & Smagorinsky, P. (2010). *Cultural Historical Perspectives on Teacher Education and Development: Learning Teaching*. London: Routledge.

Elstad, E., & Christophersen, K. (2017). Teachers‟ Self-Efficacy at Maintaining Order and Discipline in Technology-Rich Classrooms with Relation to Strain Factors. *International Journal of Learning, Teaching and Educational Research, 16*(1), 103-119.

Engeström, Y. (1987). "*Learning by Expanding: An Activity Theoretical Approach to Development Research*". Paper presented at the Orienta-Konsultit, Helsinki.

Engeström, Y. (1999). *Activity theory and individual and social transformation in: Y. Engeström, R. Miettinen, and R-L. Puaaki (Eds) Perspectives on Activity Theory*. Cambridge: Cambridge University Press.

Engeström, Y. (2001). Expansive Leaning at Work: towards an activity theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133-156.

Engeström, Y. (2016). *Activity Theory in Education Research and Practice*. Rotterdam, Sense Publishers.

Engeström, Y., & Glăveanu, V. (2012). On Third Generation Activity Theory: Interview with Yrjö Engeström. *Europe's Journal of Psychology, 8(1),* (4515-518). doi:10.5964/ejop. v8i4.555

Engeström, Y., & Miettinen, R. (1999). Activity theory: A well-kept secret. *In Perspectives on Activity Theory*. Retrieved from https://psycnet.apa.org/record/1999-02157-000

Engeström, Y., Miettinen, R., & Punamäki, R. L. (1999). *Perspectives on activity theory.*: Cambridge University Press.

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, 5(5).* doi:10.11648/j.ajtas.20160501.11

Fabian, K., Topping, K. J., & Barron, I. G. (2018). Using mobile technologies for mathematics: effects on student attitudes and achievement. *Educational Technology Research and Development, 66*(5), 1119-1139. doi: https://doi.org/10.1007/s11423-018-9580-3

Fauzana, R., Dahlan, J. A., & Jupri, D. (2019). *Mathematical Literacy Ability of Students for The Content of Space and Shape*. Paper presented at the 1st International Seminar STEMEIF (Science, Technology, Engineering and Mathematics Learning International Forum), Purwokerto.

Flanagan, J. L. (2008). "Technology: The Positive and Negative Effects on Student Achievement". *Education and Human Development Master's Theses. 254*. Retrieved from www.google.co.za website: http://digitalcommons.brockport.eduehd.theses/254

Flick, U. (2006). *An Introduction to Qualitative Research (3rd ed.)*. London: Sage Publications.

Fraenkel, J. R., & Wallen, N. E. (2003). *How to design and evaluate research in education* (5th ed.). New York: McGraw-Hill.

Freudenthal, H. (1991). *Revisiting Mathematics Education: China Lectures* Paper presented at the Dordrecht, The Netherlands: Kluwer.

Gadanidis, G., & Geiger, V. (2010). A social perspective on technology enhanced mathematical learning—from collaboration to performance. *ZDM, 42*(1), 91-104.

Gastrow, M. (2018 10 - 12 December). *4IR Conference Policy Framework Report.* Paper presented at the Policy Options framework for the Fourth Industrial Revolution In South Africa SA-EU Strategic Partnership Dialogue Conference: Disruptive technologies and public policy in the age of the Fourth Industrial Revolution, CSIR International Convention Centre, Pretoria.

Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and Learning with Technology: Effectiveness of ICT Integration in Schools. *ERIC, 1*(2), 175-191.

Giessen-Hood, C. (1999). *Teachers' Attitude Towards the Implementation of Outcomes Based Education (OBE) in South Africa.* (in partial fulfilment of the requirements for the degree of Master of Education), University of the Witwatersrand, Johannesburg.

Gifford, B. R., & Enyedy, N. D. (1999). *Activity centred design: towards a theoretical framework for CSCL*. Paper presented at the Proceedings of the Computer Support for Collaborative Learning (CSCL) Conference, Stanford University, Palo Alto, CA.

Gillwald, A. (2019, 26 August 2019). South Africa is caught in the global hype of the Fourth Industrial Revolution. *Mail and Guardian*. Retrieved from https://mg.co.za/article/2019-08-26-south-africa-is-caught-in-the-global-hype-of-the-fourth-industrial-revolution

Gina, N. C., & Kubayi, M. C. (2014). *Government and telecommunication companies on broadband connectivity for schools* Parliamentary Monitoring Group. Retrieved from www.gov.za.

Goss, P., Sonnemann, J., & Griffiths, K. (2017). *Engaging students: creating classrooms that improve learning.* . Retrieved from https://grattan.edu.au/report/engaging-students-creating-classrooms-that-improve-learning/

Gouthro, M., & Griffore, J. (2004). *The Report of the Expert Panel on Student Success in Ontario*. Retrieved from http://www.edu.gov.on.ca/eng/document/reports/numeracy/numeracyreport.pdf

Grant, C. (2014). Leading for social justice in South African schools: Where have all the activists gone? In I. Bogotch, & C. M. Shields (Eds.), International Handbook of Educational Leadership and Social (In)Justice (Vol. 1, pp. 521-539). Dordrecht, Netherlands: Springer.

Graven, M., & Venkat, H. (2007). Emerging pedagogic agendas in the teaching of Mathematical Literacy. *African Journal of Research in Mathematics, Science and Technology Education, 11*(2), 67-84.

Graven, M., & Venkatakrishnan, H. (2006). Emerging Successes and Tensions in the Implementation of Mathematical Literacy. *Learning and Teaching Mathematics* (4), 5-9.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed method evaluation designs. Educational Evaluation and Policy Analysis. (11), 255-274.

Grigoryan, T., & Babayan, N. (2018). Activity Theory in studying innovations: The interconnected phases of Activity System. *Humanities and Social Sciences Review, 7*(1), 331-336.

Groff, J., & Mouza, C. (.2008)). A framework for addressing challenges to classroom technology use. *AACE Journal, 16*(1), 21-46.

Grösser, M. (2007). Effective teaching: linking teaching to learning functions. *South African Journal of Education, 27*(1), 37-52.

Gumpel, T. P., & Golan, H. (2000). Teaching game-playing social skills using a self monitoring treatment package. *Psychology in the Schools, 37*(1), 253-261.

Hamilton-Hankins, O. J. (2017). *The Impact of Technology Integration on the Engagement Levels of Ten Second Grade Students in an English Language Arts Classroom. (Doctoral dissertation).* (Degree of Doctor of Education in Curriculum and Instruction), University of South Carolina, South Carolina. Retrieved from https://scholarcommons.sc.edu/etd/4343

Hardman, J. (2005). Activity theory as a potential framework for technology research in an equal terrain. *SAJHE, 19*(2), 378-392.

Hartley, J. (2013). Some thoughts on Likert-type scales. *International Journal of Clinical and Health Psychology 13*(1), 83-88.

Hasan, H., & Kazlauskas, A. (2014). Activity Theory: who is doing what, why and how. In H. H. (Ed.), *Being Practical with Theory: A Window into Business Research* (pp. 9-14). Wollongong, Australia: Theori.

Hashim, N. H., & Jones, M. L. (2007, 3-5 September 2007). *Activity theory: a framework for qualitative analysis.* Paper presented at the 4th International Qualitative Research Convention (QRC), Hilton, Malaysia.

Hayes, P. (1992). "De-Jargonizing" Research Communication *Sage Journals*. Retrieved from doi:https://doi.org/10.1177/10547738920010030

Hennessy, S., Ruthven, K., & Brindley, S. U. E. (2005). Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution, and change. *Journal of Curriculum Studies, 37*(2), 155-192. doi:10.1080/0022027032000276961

Herold, B. (2017). Technology Counts 2017: Classroom Tech: Where Schools Stand. *Education Week,* pp. 5-6, 8-11. Retrieved from https://core.ac.uk/download/pdf/51288541.pdf

Higgins, S., Xiao, Z., & Katsipataki, M. (2012). *The Impact of Digital Technology on Learning: A Summary for the Education Endowment Foundation* Retrieved from Durham University: www.educationendowmentfoundation.org.uk

Hoon, S. A. (2008). *The Technological Teacher: How Educational Technology is Changing the Role of the Teachers in the High School Classroom.* (Masters of Arts Partial Fulfillment of the requirements of the degree of Masters of Arts), Georgetown University, Washington DC.

Hughes, J. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal of technology and teacher education, 13*(2), 277-302.

Humerinta-Peltomaki, L., & Nummela, N. (2006). Mixed methods in international business research: A value - added perspective. *Management International Review, 46*(1), 439-459.

Jhuree, V. (2005). Technology integration in education in developing countries: Guidelines to policy makers. *International Education Journal, 6*(4), 467-483.

Jia, S. (2019). *Literature Review of YouTube in Teaching Activities.* Paper presented at the Twenty-Third Pacific Asia Conference on Information Systems, China.

Johnson, A. M., Jacovina, M. E., Russell, D. E., & Soto, C. M. (2016). Challenges and solutions when using technologies in the classroom. *Adaptive educational technologies for literacy instruction*, 13-29.

Johnson, R. B., & Onwuegbuzie, A., J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher, 33*(7), 14-26.

Johnson, R. B., Onwuegbuzie, A., J., & Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. Journal of Mixed Methods Research. *Journal of Mixed Methods Research 1*(2), 112-133.

Jojo, Z. (2019). Mathematics Education System in South Africa [Online First]. Retrieved from https://www.intechopen.com/online-first/mathematics-education-system-in-south-africa doi:10.5772/intechopen.85325

Jonassen, D. H. (1996). *Computers in the classroom. Mindtools for critical thinking*. Englewood Cliffs, NJ.: Prentice-Hall.

Jonassen, D. H. (2006). *Modelling with Technology: Mindtools for Conceptual Change (3rd rev.)*. Columbus: OH: Pearson/Prentice Hall.

Jones, K. (2003). Using the internet in the teaching and learning of mathematics: a research bibliography *MicroMath, 19*(2), 43-44.

Jones, R. (1995). Why do qualitative research? BMJ, 311. Retrieved from http://www.bmj.com/content/311/6996/2

Julie, C. (2006). Mathematical Literacy: Myths, further inclusions and exclusions *Pythagoras, 64*, 62-69

Kafyulilo, A., Fisser, P., & Voogt, J. (2016). Factors affecting teachers' continuation of technology use in teaching. *Educ Inf. Technol, 2016*(21), 1535-1554.

Kaptelinin, V. (1992). *Human Computer Interaction in Context: The Activity Theory Perspective*. Paper presented at the: East-West International Conference on Human-Computer Interaction: Proceedings of the EWHCI92, St Petersburg.

Kaptelinin, V., & Nardi, B. A. (2006). *Acting with technology: Activity theory and interaction design.*: MIT press.

Kasapoglu-Akyol, P. (2010). Using Educational Technology tools to improve language and communication skills of ESL students *Novitas-ROYAL (Research on Youth and Language), 4*(2), 225-241.

Khiok-Seng, Q. (2003). *Activity theory for mathematics learning in and out of the classroom?* Paper presented at the ERAS Conference, Singapore.

King, I. C. (2003). Examining middle school inclusion classrooms through the lens of learner-centred principles . *Theory into Practice, 42*(2), 151-158.

Klopfer, E., Osterweil, E., Groff, J., & Haas, H. (Producer). (2009). Using the Technology of Today, in the Classroom Today: The Instructional Power of Digital Gaming and Social Networking and How Teachers Can Leverage It. *The Education Arcade Massachusetts Institute of Technology*. Retrieved from https://www.researchgate.net/publication/263125941_Using_the_Technology_of_Today_in_the_Classroom_Today_The_Instructional_Power_of_Digital_Gaming_and_Social_Networking_and_How_Teachers_Can_Leverage_It

Kissane, B. (2009). *What does the Internet offer for students?* Paper presented at the Mathematics: It's Mine: Proceedings of the 22nd Biennial Conference of the Australian Association of Mathematics Teachers, Adelaide.

Lancaster, L. C., & Stillman, D. (2009). *When Generations Collide*. New York: HarperCollins.

Lavin, A. M., Korte, L., & Davies, T. L. (2010). The impact of classroom technology on student behavior *Journal of Technology Research 2*(1), 1-13.

Lekalakala, B. (2018, 13 July 2018). South African schools' toilet facilities: A shame and a disgrace *Mail and Guardian*.

Leont'ev, A. N. (1981). *Problems of the Development of the Mind. (Trans. M. Kopylova).* (Vol. 21). Moscow.

Liamputtong, P. (2007). *Researching the Vulnerable: A Guide to Sensitive Research Methods*. London: SAGE Publications.

Liamputtong, P. (2010). Cross-Cultural research and qualitative inquiry. *Turkish Online Journal of Qualitative Inquiry, 1*(1), 16-29.

Liaw, S. S., Huang, H. M., & Chen, G. D. (2007). Surveying instructor and learner attitudes toward e-learning. *Computers & Education, 49*(4), 1066-080.

Lieberman, A., & Miller, I. (2004). Teacher leadership. *Jossey-Bass*. Retrieved from https://link.springer.com/chapter/10.1007/978-0-387-73317-3_17

Litoselliti, L. (2003). *Using focus groups in research.* New York: MPG Books.

Litowitz, L. S. (2009). Addressing Mathematics Literacy through Technology, Innovation, Design, and Engineering. *Technology Teacher, 69*(1), 19-22.

Livingtone, S., & Blum-Ross, A. (2017). *Researching children and childhood in the digital age* (3rd ed.). London Routledge

Lloyd-Smith, M., & Tarr, J. (2000). *Researching children's perspectives: a sociological dimension* (A. Lewis & G. Lindsay Eds.). Buckingham: Open University Press.

Loc, N. P., & Hao, M. H. (2016). Teaching Mathematics Based On "Mathematization" Of Theory of Realistic Mathematics Education: A Study of the Linear Function Y=Ax+B *The International Journal Of Engineering And Science (IJES), 5*(6), 20-23.

Long, M., & Blackwell, W. (2015). *Second language acquisition and task- based language Teaching.* UK: West Sussex.

Lynch, B. K. (1996). *Language program evaluation: Theory and practice.* Cambridge: CUP.

Lynch, M. (2016, 15 October 2015). The Dark Side of Educational Technology. *The Edvocate*.

Lytras, M. D., Gasevic, D., Ordonez de Pablos, P., & Huang, W. (2008). *Technology Enhanced Learning: Best Practices*. New York: IGI Publishing.

Maddock, L., & Maroun, W. (2018). Exploring the present state of South African Education: Challenges and recommendations. *South African Journal of Higher Education 32*(2), 192-214. doi:http://dx.doi.org/10.20853/32-2-1641

Major, T. E., & Mangope, B. (2012). The Constructivist Theory in Mathematics: The Case of Botswana Primary Schools. *International Review of Social Sciences and Humanities, 3*(2), 139-147.

Maphosa, C., Mutekwe, E., Machingambi, S., Wadesango, N., & Ndofirepi, A. (2012). Teacher Accountability in South African Public Schools: A Call for Professionalism from Teachers. *Anthropologist, 14*(6), 545-553.

Marcus, A. (2003). Universal, ubiquitous, user-interface design for the disabled and elderly. *Interactions,10(2),* 23-27.

Mashau, L., Kone, L. R., & Mutshaeni, H. N. (2014). Improving Participation in Quality Education in South Africa: Who are the stakeholders? *Internal Journal of Educational Sciences, 7*(3), 559-567. doi:10.1080/09751122.2014.11890217

Mashiya, N. (2011). IsiZulu and English in KwaZulu-Natal rural schools: how teachers fear failure and opt for English. *South African Journal of Childhood Education 1*(1), 19-31.

Mathematics, N. C. o. T. o. (2015). Strategic Use of Technology in Teaching and Learning Mathematics Retrieved from https://www.nctm.org/Standards-and-Positions/Position-Statements/Strategic-Use-of-Technology-in-Teaching-and-Learning-Mathematics/

Maurizio, G., & Pisanu, F. (2013). *Integrating technology and teaching with Learning Solutions*. Paper presented at the ATEE-SIREM, Winter Conference Proceedings. Learning & Teaching with Media & Technology, Genoa, Italy.

Mbatsha, Z. (2013). *Learners' Perceptions of Mathematical Literacy in the Further Education and Training (FET) Band in Three Selected High Schools.* (Masters in Education), University of Fort Hare, Retrieved from https://pdfs.semanticscholar.org/5ca0/c8aae4b2e5d573531153c22dfe48b07560e8.pdf?_ga=2.163131452.1811220437.1576951295-366829971.1554934373

Mclachlan, J. (2018) *Gr R teachers' understanding and implementation of the mathematical content knowledge of space and shape.* (Master's degree Partial fulfilment), University of Pretoria, Pretoria.

McLennan, A., & Dale-Jones, B. (2016). *Teachers, Parents and school leaders working together to improve learners' education: Deep dive report*. Retrieved from http://tshikululu.org.za/wp-content/uploads/2017/09/Tshikululu_FirstRandFoundation-_Teacher_Parent_Leadership_Report.pdf

McCrone, S. S., & Dossey, J. A. (2007). Mathematical Literacy--It's Become Fundamental. *Principal Leadership, 7*(5), 32-37.

McKim, C. A. (2017). The Value of Mixed Methods Research: A Mixed Methods Study. *Journal of Mixed Methods Research, 11*(2), 202-222.

McMillan, J. H., & Schumacher, S. (1993). *Research in Education: A Conceptual Introduction (3rd ed.)*. New York: Harper Collins.

McNulty, N. (2018). Are South African schools ready for the 4th Industrial Revolution? *Niall McNulty: Learning, Publishing & Tech Stuff* Retrieved from https://www.niallmcnulty.com/2018/07/are-south-african-schools-ready-for-the-4th-industrial-revolution/

Merriam, S. B. (1998). *Qualitative research and case study applications in education.* San Francisco: Jossey-Bass.

Merriam Webster's collegiate dictionary (10th ed.). (1993). Springfield, MA: Merriam-Webster.

Miettinen, R. (2003). *Transcending traditional school learning: Teachers' work and networks of learning in Perspectives on Activity Theory.* Cambridge, UK: Cambridge University Press.

Minty, R. (2011). *Infusing Information and Communication Technologies (ICTs) into the teaching and learning of Mathematical Literacy.* (Masters in Education), University of Johannesburg, Johannesburg.

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record 108*(6), 1017–1054.

Mitsi, P., & Papasyrou, G. (2017). Implementation of "Activity Theory" in the framework of differentiated teaching: A Case Study. *International Journal of Teaching and Education, 2*.

Molnar, M. (Producer). (2016, 21 April). EDWEEK Market Brief. *Bill Gates: Ed Tech Has Underachieved, But Better Days Are Ahead*. Retrieved from https://marketbrief.edweek.org/marketplace-k-12/bill-gates/

Monaco, M., & Martin, M. (2007). The millennial student: A new generation of learners. *Athletic Training Education Journal, 1*(2), 42-46.

Morelock, J. S. (2015). Effective Technology Implementation in Schools: Differing Perceptions of Teachers, Administrators, and Technology Staff. Retrieved from https://pdxscholar.library.pdx.edu/open_access_etds/2626

Mothofela, R. M. (2017). *Teach and Assess: A Strategy for Effective Teaching and Learning in Economic and Management Sciences* (Philosophiae Doctor in Education), University of the Free State, Bloemfontein.

Mottiar, S., & Bond, P. (2011). *Social Protest in South Africa* Retrieved from Durban-UKZN: http://ccs.ukzn.ac.za/files/Social%20Protest%20in%20South%20Africa%20sept2011.pdf

Mouton, N., Louw, G. P., & Strydom, G. L. November 2012). A Historical Analysis of The Post Apartheid Dispensation Education in South Africa (1994-2011). *International Business & Economics Research Journal, 11*(11), 1-12.

Mthethwa, T. M. (2007). *Teachers' views on the role of context in Mathematical Literacy.* (in partial fulfilment of the requirements for the degree of Master of Science), University of the Witwatersrand, Johannesburg. (0617649w)

Mupa, P., & Chinooneka, T. I. (2015). Factors contributing to ineffective teaching and learning in primary schools: Why are schools in decadence? *Journal of Education and Practice. 6*(19), 126-132.

Muthusamy, N. (2015). *Teachers' Experiences with overcrowded classrooms in a mainstream school.* (Degree of Master of Education), University of KwaZulu Natal, Durban.

Naidoo, J. (2012). Teacher reflection: The use of visual tools in mathematics classrooms. *Pythagoras,33*(1),1-9. http://dx.doi.org/10.4102/pythagoras.v33i1.54

Naidoo, J. (2014). *Exploring the use of Activity Theory as a Framework for the teaching and Learning of Mathematics*. Paper presented at the 20th Annual National Congress of the Association for Mathematics of South Africa, Diamnetveld, Kimberley.

Naikoo, A. A., Thakur, S. S., Guroo, T. A., & Lone, A. A. (2018). Development of Society under the Modern Technology - A Review. *Scholedge International Journal of Business Policy & Governance, 5*(1), 1-8. doi:10.19085/journal. sijbpg050101

Nel, B. (2012). Transformation of teacher identity through a Mathematical Literacy re-skilling programme. *South African Journal of Education, 32*, 144-154.

Ng, E. S. W., & Johnson, J. M. (2015). Millennials: Who are they, how are they different, and why should we care? *Research Gate*. Retrieved from https://www.researchgate.net/publication/282368010_Millennials_Who_are_they_how_are_they_different_and_why_should_we_care/citations doi:10.4337/9781783476589

Nonaka, I., & Takeuchi, H. (1995). *The Knowledge-Creating Company: how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Nunez, I. (2009, June). *Activity theory in mathematics education.* Paper presented at the Proceedings of the British Society for Research into Learning Mathematics.

Numeracy Lifelong Confidence with Mathematics - Framework for Action 2007-2010. (2007). *Curriculum and Leadership Journal,5(40).* Retrieved from: www.curriculum.edu.au/leader/numeracy_framework-for_action.21757.html.

Oblinger, D., & Oblinger, J. (2005). Is it age or IT: First steps to understanding the net generation. *Educating the Net*, 12-31.

OECD. (2000). Measuring Student Knowledge and Skills. The PISA 2000 assessment of reading, mathematical and scientific literacy. *Paris: OECD*.

OECD. (2003). Pisa 2003 Assessment Framework-Mathematics Reading, Science and Problem Solving Knowledge and Skills. *OECD publishing*.

OECD. (2012). Pisa 2012 Assessment and Analytical Framework-Mathematics Reading, Science and Problem Solving and Financial Literacy. *OECD publishing*.

Ogunkola, B. J. (2012). Improving Science, Technology and Mathematics Students' Achievement: Imperatives for Teacher Preparation in the Caribbean Colleges and Universities. *European Journal of Educational Research. 1(4),* 367-378.

Ojo, O.A., & Adu, E.O. (2018). The effectiveness of Information and Communication Technologies (ICTs) in teaching and learning in high schools in Eastern Cape Province. *South African Journal of Education*, *38(2),* 1-11.

Ojose, B. (2011). Mathematics Literacy: Are We Able to Put the Mathematics We Learn into Everyday Use? *Journal of Mathematics Education. 4*(1), 89-100.

Onwuegbuzie, A., J., & Collins, K. M. (2007). A Typology of Mixed Methods Sampling Designs in Social Science Research. *The Qualitative Report, 12*(2), 281-316.

Onwuegbuzie, A., J., & Leech, N. I. (2004). Enhancing the Interpretation of Significant Findings: The Role of Mixed Methods Research. *The Qualitative Report, 9*(4), 770-792.

Onwuegbuzie, A. J., & Leech, N. L. (2006). Linking Research Questions to Mixed Methods Data Analysis Procedures. *The Qualitative Report, 11*(3), 474-498.

Papanastasiou, E. C., & Ferdig, R. E. (2006). Computer Use and Mathematical Literacy: An Analysis of Existing and Potential Relationships. *Jl. of Computers in Mathematics and Science Teaching, 25*(4), 361-371.

Patton, M. Q. (2002). *Qualitative research and evaluation methods.* London: Sage Publications.

Peshkin, A. (1993). The goodness of qualitative research. *Educational research, 22*(2), 23-29.

Phurutse, M. C. (2005). *Factors Affecting Teaching and Learning in South African Public Schools*. Cape Town: HSRC Press

Piaget, J. (1970). *Structuralism*. New York: Basic Books.

Pillay, J. (2014). Ethical considerations in educational research involving children: Implications for educational researchers in South Africa. *South African Journal of Childhood Education, 4*(2), 194-212.

Pillay, R., & Zungu, P. J. (2010). High school learners' attitudes towards isiZulu in the Greater Durban Area. *Indilinga -African journal of indigenous knowledge sysytems, 13*(2), 109-125. doi:10.1080/10228195.2010.492230

PISA. (2015). *Assessment and Analytical Framework: Science, Reading, Mathematics and Financial Literacy and Collaborative problem solving*. Retrieved from https://www.oecd.org/publications/pisa-2015-assessment-and-analytical-framework

Plowman, L., & McPake, J. (2013). Seven myths about young children and technology. *Childhood Education, 89*(1), 27-33. doi: http://www.tandfonline.com/toc/uced20/89/1

Ponce, O. A., & Pagán-Maldonado, N. (2015). Mixed Methods Research in Education: Capturing the Complexity of the Profession. *International Journal of Educational Excellence, 1*(1), 111-135.

Prensky, M. (2005). Complexity matters. *Educational Technology, 45*(4), 1-15.

Primary Framework for literacy and mathematics: Primary National Strategy. (2006). UK.

Probyn, M. (2006). Language and Learning Science in South Africa. *Language and Education, 20*(5), 391-414. doi:10.2167/le554.0

Queensland Studies Authority (QSA). (2009). QCE literacy and numeracy requirements. Retrieved from Queensland Studies Authority. Retrieved from http://www.qcaa.qld.edu.au.

Ramirez, J. L., Juárez, M., & Remesal, A. (2012). Activity Theory and e-Course Design: An Experience in Discrete Mathematics for Computer Science. *University and Knowledge Society Journal, 9*(1), 320-329.

Ramorola, M. Z. (2010). *A study of effective technology integration into teaching and learning: A case study* (Doctor of Education), University of South Africa, Pretoria.

Rana, M. D., & Muhammad, I. L. (2013). Focus Group Interview as a Tool for Qualitative Research: An Analysis *Pakistan Journal of Social Sciences (PJSS), 33*(1), 191-198.

Riasati, M. J., Allahyar, N., & Tan, K. (2012). Technology in Language Education: Benefits and Barrier. *Journal of Education and Practice 3*(5), 25-30.

Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children, 10*(2), 76-101.

Roschelle, J., Tatar, D., Shechtman, N., Hegedus, S., Hopkins, B., Knudsen, J., & Stroter, A. (2007). *Can a Technologically enhanced Curriculum Improve Student Learning of Important Mathematics?* Retrieved from http://www.sri.com/publications/index/html

Roth, W. M. (2012). Cultural-Historical Activity Theory: Vygotsky's Forgotten and Suppressed Legacy and Its Implication for Mathematics Education. *Mathematics Education Research Journal, 24*, 87-104.

Ryan, G. W., & Bernard, H. R. (2000). *Handbook of Qualitative Research (2nd ed)*. CA: Sage.: Thousand Oaks.

Safdar, A., Yousuf, A., Parveen, Q., & Behlol, M. G. (2011). Effectiveness of Information and Communication Technology (ICT) in Teaching MAthematics at Secondary Level. *International Journal of Academic Research, 3*(5), 67-72.

Sannino, A., Daniels, H., & Gutierrez, K. D. (2009). *Learning and expanding with activity theory.* New York: Cambridge University Press.

Santhi, N. (2011). Are extra classes the success behind high performance and marks? *Educational Research and Reviews, 6*(18), 935-942. doi:10.5897/ERR10.224

Scanlon, E., & Issroff, K. (2005). Activity Theory and Higher Education: evaluating learning technologies. *Journal of Computer Assisted Learning, 21*(1), 430-439.

Schuck, S. (2016). Enhancing Teacher Education in Primary Mathematics with Mobile Technologies. *Australian Journal of Teacher Education, 41*(3), 126-139.

Shabiralyani, G., Hasan, K. S., Hamad, N., & Iqbal, N. (2015). Impact of Visual Aids in Enhancing the Learning Process Case Research: District Dera Ghazi Khan. *Journal of Education and Practice 6*(19), 226-233.

Shah, K., Ahmed, J., Shenoy, N., & N, S. (2013). How different are students and their learning styles? *International Journal of Research in Medical Sciences, 1*(3), 212-215. doi:10.5455/2320-6012.ijrms20130808

Shah, S. A. (2013). Making the Teacher Relevant and Effective in a Technology-Led Teaching and Learning Environment. *Procedia - Social and Behavioral Sciences 103*(1), 612 – 620

Shahneaz, M. A., Akhter,S.,Yasmin, N. (2014). The impact of Teacher and Technology in Classroom. *Journal of Educationa and Practice, 5*(27), pp. 79-83.

Shinn, Y. H. (1997). Teaching strategies, their use and effectiveness as perceived by teachers of agriculture: A national study. *Retrospective Theses and Dissertations., 12244*. Retrieved from doi:https://lib.dr.iastate.edu/rtd/12244

Shulman, L. S. (1986). Those who understand: Knowledge Growth in Teaching *American Educational Research Association, 15*(2), 4-14.

Sianjina, R. R. (2000). Educational technology and the diverse classroom. *Kappa Delta Pi Record, 37*(1), 26-29.

Sithole, N. (2017). *Promoting a positive learning environment: School setting investigation.* (Masters in Education), University of South Africa, Pretoria.

Skovsmose, O. (2004). Critical Mathematics Education for the Future *CME-future, 5*(1), 1-23. Retrieved from https://www.researchgate.net/publication/252205485_Critical_Mathematics_Education_for_the_Future

Smaldino, S. E., Lowther, D. L., & Russell, J. D. (2008). *Instructional Technology and Media for Learning (9th ed)*. Upper Saddle River: NJ: Pearson Publications.

Small, M. L. (2011). How to Conduct a Mixed Method Study: Recent Trends in a Rapidly Growing Literature. *The Annual Review of Sociology, 37*, 57-86. doi:10.1146/annurev.soc.012809.102657

Soden, B. (2019). What does successful technology integration look like in education? Retrieved from https://www.classcraft.com/blog/features/successful-technology-integration-in-education/

Spangenberg, E. D. (2012). Thinking styles of Mathematics and Mathematical Literacy learners: Implications for subject choice. *Pythagoras, 33*(3), 1-12.

Steen, L. A. (Ed.). (2001). Mathematics and Democracy: The case of qualitative literacy. *Princeton, N.J: National Council on Education and the Disciplines*.

Stoffels, N. (2008). *Educational Change in South Africa Reflections on Local Realities, Practices, and Reforms*. In W. Weber (Ed.), *Why do teachers do what they do? Teacher decision-making in the context of curriculum change in South Africa*. Retrieved from http://semanticscholar.org

Struwig, F. W., & Stead, G. B. (2013). *Research: planning, designing and reporting* (2nd ed.). Cape Town: Pearson.

Suryani, A., & Widyastuti, T. (2015). The Role of Teachers' Experiential Learning and Reflection for Enhancing their Autonomous Personal and Professional Development. *Jurnal Sosial Humaniora, 8*(1), 22.

Tashakkori, A., & Teddlie, C. (2003). *Handbook of Mixed Methods in Social & Behavioral Research*. Thousand Oaks: Sage.

Taylor, L., & Parsons, J. (2011). Improving Student Engagement. *Current Issues in Education, 14*(1), 1-33.

Terrell, S. R. (2012). Mixed-Methods Research Methodologies. *The Qualitative Report, 17*(1), 254-280.

The Oxford learners dictionary (3rd ed.). (2017). Oxford University Press.

Toomela, A. (2000). Activity theory is a dead end for cultural psychology. *Culture and Psychology, 6*(1). 353-365.

Toomela, A. (2008). Activity theory is a dead end for methodological thinking in cultural psychology too. *Culture and Psychology, 14*, 289-303.

Tshuma, N. (Ed.). (2016). Teaching and Learning with Technology: Reframing traditional understandings and practices. *Teaching and Learning with Technology*, 1-40.

Tsui, A., & Law, D. (2007). Learning as Boundary Crossing in School University Partnership, *Teaching and Teacher Education, 23*(8), 1289-1301.

Tuckett, A. G. (2005). Applying thematic analysis theory to practice: A researcher's experience. *Contemporary Nurse, 19*(1), 75-87. doi:10.5172/conu.19.1-2.75

Twenge, J. M., & Campbell, W. K. (2008). Increases in positive self-views among high school students: Birth-cohort changes in anticipated performance, self-satisfaction, self-liking, and self-competence. *Psychological Science, 19*(11), 1082–1086.

van Den Heuvel-Panhuizen, M. (2003.). The didactical use of models in realistic Mathematics Education: An example from a longitudinal trajectory on percentage. *Educational Studies in Mathematics 54*(1), 9–35.

van der Berg, S., Taylor, S., Gustafsson, M., Spaull, M., & Armstrong, P. (2011). *Improving Education Quality in South Africa*. Retrieved from https://resep.sun.ac.za/wp-content/uploads/2012/10/2011-Report-for-NPC.pdf

Venkat, H., & Adler, J. (2008). Expanding the foci of activity theory: accessing the broader contexts and experiences of mathematics education reform. *Educational Review, 60*(2), 127-140.

Verenikina, I. (2010). *Vygotsky in Twenty-First Century research.* Paper presented at the Proceeding of World Conference on Educational Multi-media, Hypermedia and Telecommunications., Chesapeake, VA.

Vithal, R., & Bishop, A. J. (2006). Mathematical Literacy: A new literacy or a new mathematics. *Pythagoras, 64*(1), 2-5.

Vogel, J. J., Greenwood-Ericksen, A., Cannon-Bowers, J., & Bowers, C. A. (2006). Journal of Research on Technology in Education. *39*(1), 105-118.

Volmink, J. (2015). *Quality Assurance of the 2015 National Senior Certificate (NSC) Examination and Assessment of the Department of Basic Education (DBE)*. Pretoria: Umalusi: Council for Quality Assurance in General and Further Education and Training.

Vrasidas, C., & McIsaac, M. S. (2001). Integrating Technology in Teaching and Teacher Education: Implications for Policy and Curriculum Reform. *Education Media International*, 127-132. doi:10.1080/09523980110041944

Vrasidas, C., & Glass, G. V. (2005). *Preparing teachers to teach with technology*. Connecticut: Information Age Publishing.

Vygotsky, L. S. (1978). *Mind in Society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wahab, S. A. (2012). Defining the Concepts of Technology and Technology Transfer: A literature Analysis. *International Business Research 5*(1), 61-71.

Warschauer, M., Zheng, B., Niiya, M., Cotten, S., & Farkas, G. (2014). Balancing the one-to-one equation: Equity and access in three laptop programs. *Equity & Excellence in Education, 47*(1), 46-62.

Wenglinsky, H. (1998). Does it compute? The relationship between educational technology and student achievement in mathematics. *Assessing Effects of Technology on Learning: Limitations of Today's Standardized Tests*. Retrieved from https://www.researchgate.net/publication/28799452_Assessing_Effects_of_Technology_on_Learning_Limitations_of_Today%27s_Standardized_Tests [accessedFeb 21 2019].

Wilson, M., & Gerber, L. (2008). How generational theory can improve teaching: 35 Strategies for working with the "millennials". *Currents in Teaching and Learning, 1*(1), 29-44.

Wilson, S. M., & Peterson, P. L. (2006). Theories of Learning and Teaching. What do they mean for Educators? *Best Practices*, 1-23. Retrieved from https://files.eric.ed.gov/fulltext/ED495823.pdf

Wilson, V. (2014). Examining teacher education through cultural-historical activity theory. *Teacher Education Advancement Network Journal (TEAN), 6*(1), 20-29. Retrieved from http://insight.cumbria.ac.uk

Yamazumi, K. (2006). Actvity Theory and the Transformation of Pedagogic Practice: International yearbook. *Educational Studies in Japan, 1*(1), 77-90.

Yildirim, S. (2000). Effects of an educational computing course on pre-service and in-service teachers: A discussion and analysis of attitudes and use. *Journal of Research on Computing in Education, 32*(4), 479-495.

Young, R. (2008). *Using Technology Tools in the Public School Classroom.* (Partial Fulfillment for the Master of Science Degree), University of Wisconsin-Stout, Wisconsin.

Yusuf, H. O. (2011). The effect of pre- reading activities on students' performance in reading comprehension in senior secondary schools. *International Research Journals., 2*(1), 1451-1455.

Zenda, R. (2017). Essential teaching methods to enhance learner academic achievement in physical sciences in rural secondary schools: A South African case study. *Information and Learning Science, 118*(3), 170-184. doi:doi:10.1108/ILS-03-2017-0014

Zohrabi, M. C. a. (2013). Mixed Method Research: Instruments, Validity, Reliability and Reporting Findings *Theory and Practice in Language Studies, 3*(2), 254-262. doi:10.4304/tpls.3.2.254-262

Zurita, G., & Nussbaum, M. (2007). A conceptual framework based on activity theory. *British Journal of Educational Technology, 38*(2), 211-235.

Ethical Clearance Report

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

13 March 2017

Mrs Sharda Hansraj 208526202
School of Education
Edgewood Campus

Dear Mrs Hansraj

Protocol Reference Number: HSS/0043/017D
Project title: Exploring the use of technology based teaching methods when teaching shape and space in Grade 10 Mathematics Literacy)

Full Approval – Expedited Application

In response to your application received 6 January 2017, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

[redacted]

.....

Dr Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

cc Supervisor: Dr Jayaluxmi Naidoo
cc. Academic Leader Research: Dr SB Khoza
cc. School Administrator: Ms Tyzer Khumalo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

Editor's Report

Angela Bryan & Associates

6 Martin Crescent
Westville

Date: 10 January 2020

To whom it may concern

This is to certify that the Thesis: Exploring the Use of Technology-Based Teaching Methods when Teaching Shape and Space in Grade 10 Mathematical Literacy written by Sharda Hansraj has been edited by me for language.

Please contact me should you require any further information.

Kind Regards

Angela Bryan

angelakirbybryan@gmail.com

0832983312

Turnitin Report

Exploring the use of technology-based teaching methods when teaching shape and space in grade 10 Mathematics Literacy

ORIGINALITY REPORT

18%	10%	7%	15%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.suagm.edu Internet Source	<1%
2	www.pythagoras.org.za Internet Source	<1%
3	Submitted to University of Johannsburg Student Paper	<1%
4	Submitted to University of Cape Town Student Paper	<1%
5	www.scribd.com Internet Source	<1%
6	www.tandfonline.com Internet Source	<1%
7	scholarworks.gsu.edu Internet Source	<1%
8	scholar.ufs.ac.za:8080 Internet Source	<1%
9	hdl.handle.net	

Appendix A

The Principal / School's Governing Body

Ferndale Secondary School

Cnr Redfern and Phoenix Industrial Park Drive

Phoenix

4068

3 March 2017

Dear Sir

Re: Permission to conduct research

I am currently a PhD student at the University of Kwa Zulu Natal and as part of the degree I am currently exploring the use of technology-based teaching methods when teaching shape and space in Grade 10 Mathematics Literacy.

I therefore seek permission to engage with learners from your school in order to collect data for the purposes of my research.

I am willing to meet with you to discuss the data collection techniques and methods which I plan to use when engaging the learners. I have sent a letter to the Department of Basic Education requesting permission and I have drafted out a consent form to be sent to parents. I enclose all of these forms for your perusal.

I assure you that my data collections methods will be ethically employed, ensuring the physical, emotional and psychological well-being of the learners. My supervisor is Dr. Jaya Naidoo. She can be contacted (074 475 2938) to verify all the information provided.

During the interview stage, I will have a qualified and registered counselor to ensure no trauma is inflicted on the learner.

I trust that my request will be considered favourably.

Yours faithfully

Sharda Hansraj

0846218878

Appendix B

Ferndale Secondary School

Cnr Redfern and Phoenix Industrial Park Drive

Phoenix

4068

3 March 2017

Dear Parent/ Guardian/ Caregiver

My name is Sharda Hansraj. I am currently a teacher at Ferndale Secondary School, and I am doing a PhD in Education degree at the University of KwaZulu-Natal. My research focus explores the use of technology-based teaching methods when teaching shape and space in Grade 10 Mathematics Literacy.

I hereby request permission to conduct my research with your child / ward by asking him / her to fill in questionnaires about his / her experiences as a learner at this school. He / She will also be expected to write out daily reflections after the lessons have been taught.

An interview will, be conducted with your child / ward on a stipulated date. Learners will be compensated for transport cost if they attend the interview process outside of school hours. A counselor will be present / available throughout the interview to ensure the well-being of your child /ward.

I want to assure you that all information received will be treated confidentially and will be used for research purposes only. I promise not to disclose your child's / ward's identity in the dissertation write-up. I will also make my findings available to you for your perusal should you wish to be informed of the findings.

Your support will be greatly appreciated.

Yours faithfully

---------- ----------

Sharda Hansraj (0846218878) Prof. J. Naidoo (Supervisor) +27312601127

Detach and return with learner

I,_____ (Name of parent / guardian / caregiver) do hereby grant permission for my child / ward _____ in Gr._____ to participate in the research project. I am aware that no information will be obtained without my child's/ ward's willingness to share such information. I accept that the researcher cannot be held responsible for the safety of my child / ward in getting to the selected venue. During the interview I accept that all necessary codes of ethics will apply. I accept that payment for the transport for the day of the interview only will be available to my child/ ward on that day.

_____ _____

PARENT/ CAREGIVER/ GUARDIAN WITNESS 1

DATED: _____ _____

WITNESS 2

Appendix C

Dear Learner

Ferndale Secondary School

INFORMED CONSENT LETTER

My name is **Mrs. Sharda Hansraj.** I am a Doctoral student studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in exploring the teaching of shape, space and measurement to grade 10 Mathematical Literacy learners' using technology. To gather the information, I am interested in asking you some questions.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person but reported only as a population member opinion.
- The interview may last for about 45 minutes to 1 hour.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment	**Willing**	**Not willing**
Audio equipment		
Photographic equipment		
Video equipment		

I can be contacted at:

Email: shardahansraj1@gmail.com

Cell: 084 6218878

My supervisor is **Prof. Jayaluxmi Naidoo** who is located at the School of Education, Edgewood campus of the University of KwaZulu-Natal.

Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127

DECLARATION

I _____(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

---------- ----------

SIGNATURE OF PARTICIPANT DATE

Appendix D

FOCUS GROUP INTERVIEW QUESTIONS

1. Briefly explain how you felt about your Mathematics literacy before this study.
2. How do you normally cope with your Mathematical Literacy schoolwork?
3. What are the challenges you experience with Mathematical Literacy at school?
4. What are some of the academic challenges you are experiencing?
5. What do you think can be done to assist you with your academic challenges?
6. How can I improve my teaching methods to help you learn more effectively?
7. How has your school / teacher assisted you in coping with Mathematical Literacy?
8. What resource do you find most helpful when studying Mathematical Literacy?

Appendix E
LEARNER QUESTIONNAIRE NUMBER 1

THIS QUESTIONNNAIRE IS TO BE COMPLETED BY MATHEMATICAL LITERACY LEARNERS IN THE SCHOOL PARTICIPATING IN THIS RESEARCH FOR THE PURPOSES OF DATA COLLECTION. ALL INFORMATION DISCLOSED IN THIS QUESTIONNNAIRE IS TREATED WITH THE STRICTEST CONFIDENTIALITY AND WILL BE USED FOR RESEARCH PURPOSES ONLY. YOUR CONTRIBUTION IS IMPORTANT.
PLEASE TICK THE APPROPRIATE BLOCK, WHERE APPLICABLE.
THANK YOU

Biographical Information

1. How old are you?
   1. ☐ 15 yrs 2. ☐ 16 yrs. 3. ☐ 17 yrs. 4. ☐ over 17yrs
2. Gender.
   1. ☐ Male 2. ☐ Female

3. What language/s do you speak at home? _____
   _____ _____

4. Have you ever repeated a grade in high school?
   1. ☐ Yes 2. ☐ No

Personal Experiences
Education

5. When did you enrol at your present school?
   Year: _____
   Gr. : _____

6. Did you attend any other Secondary School?
   1. ☐ Yes 2. ☐ No

7. When did you decide to do Mathematical Literacy?
   State grade: ___

8. What prompted your decision to do Mathematical Literacy?
   1. ☐ Self
   2. ☐ Parent
   3. ☐ Teacher
   4. ☐ Found Mathematics a challenge
   5. ☐ Other (Specify) _____

9. Do you struggle with any section of Mathematical Literacy at school?
If you do, name the sections.

1. ☐ _____ 2. ☐ _____

3. ☐ _____

10. If you had a choice, would you revert to learning Mathematics?

1. ☐ Yes 2. ☐ No

Why?

_____

_____

11. How would you rate the way you learn at this school?

1. ☐ Very good 2. ☐ Good 3. ☐ Satisfactory

12. How do you rate yourself in Mathematical Literacy?

1. ☐ Good

2. ☐ Satisfactory

3. ☐ Weak

13. How did you perform in Mathematical Literacy in your **2017**June Examinations?

1. ☐ Very good 2. ☐ Good 3. ☐ Satisfactory

14. Do you feel that your academic needs are being catered for at school?

1. ☐ Yes 2. ☐ No

Explain:

_____

_____

_____

_____

15. Do you think that your teacher is helpful to you in dealing with your Mathematical Literacy challenges?

1. ☐ Yes 2. ☐ No

Explain:

_____

_____

16. How has your teacher assisted you in dealing with difficulties you may have experienced?

_____
_____
_____
_____
_____
_____
_____

17. Suggest some methods that you would like to be included in the teaching of Mathematical literacy which could help you understand the concepts more effectively.

_____
_____

18. Are you able to use a computer and the internet whilst doing Mathematical Literacy at school?

1. ☐ Yes 2. ☐ No

Social Life and use of technology.

19. Who assists you with schoolwork outside school?

1. ☐ Parent 2. ☐ Guardian 3. ☐ Friend

4. ☐ Relative 5. ☐ Other (Specify) _____

20. Which language do you usually get academic assistance in?

1. ☐ English 2. ☐ Afrikaans

3. ☐ isiZulu 3. ☐ isiXhosa

5. ☐ Other (Specify) _____

21. Which language do you think in?

1. ☐ English 2. ☐ Afrikaans

3. ☐ isiZulu 3. ☐ IsiXhosa

5. ☐ Other (Specify) _____

22. Which language would you prefer to communicate in the Mathematical Literacy class?

1. ☐ English ☐ 2. Afrikaans

3. ☐ isiZulu ☐ 4. isiXhosa

5. ☐ Other (Specify) _____

23. Do you have access to a computer and internet when doing Mathematical Literacy homework?

1. ☐ Yes 2. ☐ No

24. What do you want to do after you finish high school?

1. ☐ Work
2. ☐ Study at a tertiary institution
3. ☐ Work and study part time
4. ☐ Start a business
5. ☐ Unsure

25. Do you think studying Mathematical Literacy will assist you in your tertiary studies?

1. ☐ Yes
2. ☐ No

Explain how:

_____

_____

Thank you for taking your time to complete this questionnaire.
All the best in your future endeavours.

Appendix F

Learner questionnaire number 2

DIRECTION FOR LEARNERS

Here are some statements about the technology aided instruction and the online mathematical literacy program that you used this term. Please read each statement carefully. Circle the number that bests describe what you think about these statements.

Please note that all responses are voluntary, and you may leave blank any question you do not wish to answer.

There is no "right or wrong" answer.

		STRONGLY DISAGREE	DISAGREE	NOT SURE	AGREE	STRONGLY AGREE
1	I know how to use a computer / laptop/ tablet/ iPad.	1	2	3	4	5
2	The technology used in the teaching process helped me understand shape, space and measurement better.	1	2	3	4	5
3	The technology used in the teaching process helped me understand difficult concepts that I learnt in class.	1	2	3	4	5
4	I used the technology used in the teaching process outside regular class time.	1	2	3	4	5
5	I think I can learn more in my next mathematical literacy lessons if it includes the use of technology	1	2	3	4	5
6	Using the computer / technology and its online features helped me understand the lesson better.	1	2	3	4	5

7	The use of the technology encouraged me to learn independently.	1	2	3	4	5
8	The technology was difficult to use.	1	2	3	4	5
9	I prefer doing math without the use of technology.	1	2	3	4	5
10	I do not have easy access to a computer after school hours.	1	2	3	4	5
11	The technology did not help me in my mathematical literacy lesson.	1	2	3	4	5
12	Technology should not be used to teach mathematical Literacy.	1	2	3	4	5
13	The teacher only uses the board to teach concepts.	1	2	3	4	5
14	I enjoyed being able to see on the computer and videos what was explained to us on the board.	1	2	3	4	5
15	The videos made the concepts more visual.	1	2	3	4	5
16	I enjoyed completing my homework and assignments using technology.	1	2	3	4	5
17	I looked forward attending the mathematical literacy lessons using the technology.	1	2	3	4	5
18	I don't need the teacher anymore. I can learn mathematical literacy concepts by using technology only.	1	2	3	4	5
19	I am satisfied with how I am able to apply what I have learnt.	1	2	3	4	5
20	I believe I will be satisfied with my final mark in this section.	1	2	3	4	5

Appendix G

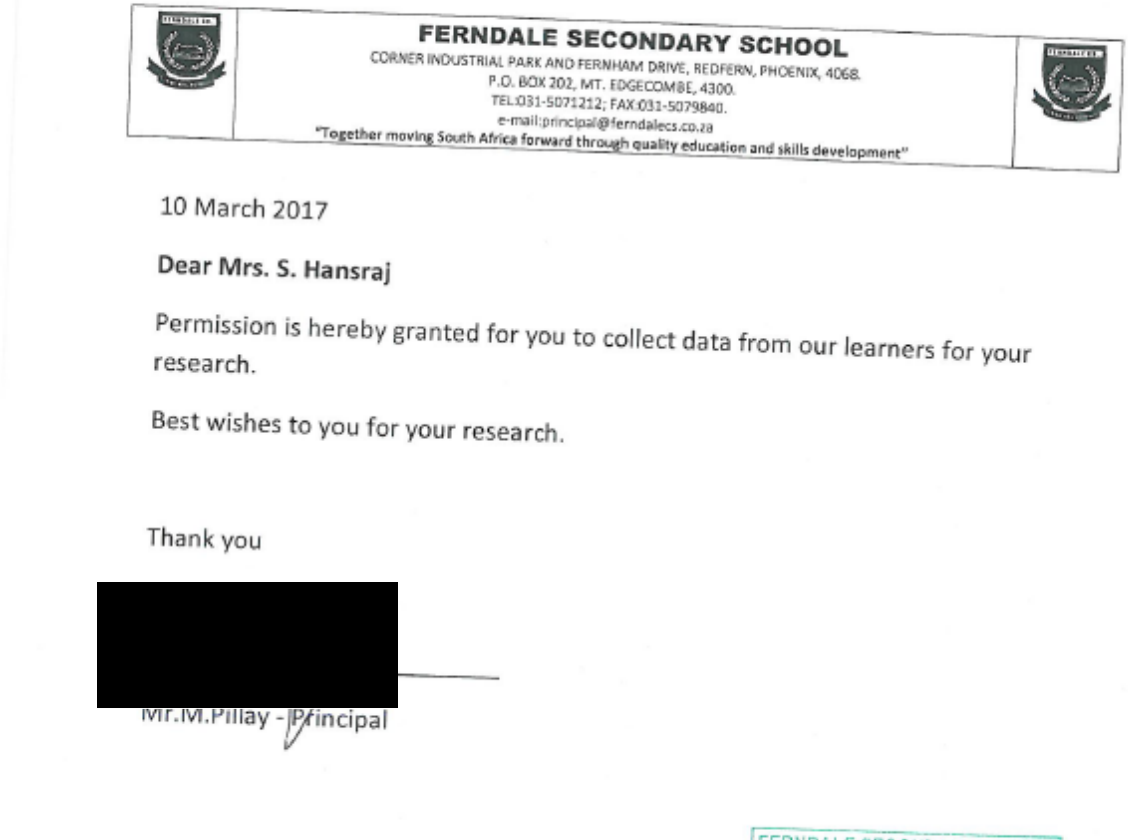
Daily reflections sheet

Depict your experiences illustrating all the challenges/ successes which you have experienced during the Mathematical Literacy lesson. Mention ways in which the teaching process can be improved to assist you in future lessons.

Topic:	Date: Day:
Briefly described the format of today's lesson:	
How do you feel about the work that you were taught today?	
How can I improve my teaching method so that it can benefit you?	

Appendix H

Informed consent



FERNDALE SECONDARY SCHOOL
CORNER INDUSTRIAL PARK AND FERNHAM DRIVE, REDFERN, PHOENIX, 4068.
P.O. BOX 202, MT. EDGECOMBE, 4300.
TEL:031-5071212; FAX:031-5079840.
e-mail:principal@ferndalecs.co.za
"Together moving South Africa forward through quality education and skills development"

10 March 2017

Dear Mrs. S. Hansraj

Permission is hereby granted for you to collect data from our learners for your research.

Best wishes to you for your research.

Thank you

[redacted]

Mr.M.Pillay - Principal

FERNDALE SECONDARY SCHOOL
KZNDE
2017 -03- 10
TEL: 031 5071212 FAX: 031 507 9840
E-MAIL: principal@ferndales.co.za
P.O. BOX 202, MT. EDGECOMBE, 4300

Appendix I

Transcription – Focus group 1

CODE	EXPLANATION
1.	Teacher competence
2	Extra help
3	Technology
4.	Language
5	Teaching methods
6	Classroom control
7	Coping strategies
8	Language barrier

Interviewer: **Sharda**

Interviewees: **Various Names**

Time	Name	Transcription
00.01	Sharda	Okay boys and girls I want to welcome you to this interview session. I want to thank you so much for being part of this study and for being part of my class and for agreeing to be part of the interview session. Now I gave you a group of a whole lot of questions last week so that you can get familiar with it so you will know what it is you want to talk about. This is what I want you to do while we are doing this interview session. When I ask the question and you need to answer state your name and then your answer. We don't have to go in any order but I would like all of you to respond to all of the questions. My first question is briefly explain how you feel about Math's Literacy.
01.17	Judelle	I feel good. It is easy. I understand what is going on.
	Sharda	Not only now when we are dealing with this research but throughout.
	Judelle	It is okay
	Sharda	You not struggling with Math's. Wayne
	Wayne	It is not that hard. Some of the work is easy. Mam you are teaching us well.
	Zodwa	I feel good about Math lit. I don't think it is the teacher he is teaching very nice he is doing his job very well. Sometimes there are things I don't understand.
02.10	Sharda	What do you do when you don't understand? You ask for help?
	Zodwa	Yes, I ask for help.
	Sharda	Do you get help?
	Zodwa	Yes. But if the lessons were not just talking, I will understand better.

	Sharda	Okay
	Zinhle(Lungi)	I feel that math lit is a good thing and it is easy.
	Mphetu	Math lit is like I like to push more
	Sharda	So if you think you work harder it will get better for you.
	Mphetu	Yes
	Marlene	I feel that math literacy is very wonderful from the time I am doing the subject. I was doing really good at it. (After we are having these using the videos, classes with you I feel like I am improving.) 3
03.21	Sharda	Now how do you normally cope with your math's literacy homework. What is it that you do in order to make sure you cope with the homework? Do you get help from somebody or do you use the internet? How do you cope?
	Zinhle	(By looking through my math book and seeing if my answer is okay with the one the teacher teach us (too much noise))3 (I wish I had a computer to download the videos and the things you are using.)3
04.03	Sharda	Who wants to go next?
	Marlene	(First of all, what homework I get I do and if I don't understand it I ask my aunt for help. Sometimes she gives me the phone or sometimes she helps.) 3
	Sharda	And if she gives you the phone what features or facilities do you use?
	Marlene	(Sometimes I use the internet if I don't understand it or I use the calculator.) 3
	Sharda	Okay
	Mphetu	(My brother helps me and if not my brother then my sister). 7
	Sharda	How old is your brother?
	Mphetu	He is 20 and my sister 18.
	Sharda	Okay so they help you with your homework.
	Judelle	(If I don't understand my granny is good at math's and she helps me.)7
	Wayne	(My mother and the calculator.)7
	Sharda	Do you know how to use all the features of the calculator?
	Wayne	Not all mam.
05.12	Amahle	(My neighbors)7
	Sharda	They have knowledge of math's.
	Amahle	Yes, they do all the subjects that I do.
	Sharda	How old are they?
	Amahle	18
	Sharda	I am going on to my third question. What are the challenges you experience with math's literacy at school, challenges meaning the problems or the difficulties you are experiencing?
	Marlene	(When the teacher comes to class to teach and when he tells the learners to keep quiet they still carry on making noise so that is a very big challenge for us because we can't hear what he is talking about. There is no discipline when he is teaching.)6
	Sharda	Is that your only challenge in the math literacy class. Academic Challenges?
	Marlene	Yes
06.08	Sharda	Mphetu

	Mphetu	(The noise) 6
	Sharda	The noise?
	Zinhle	(I get disturbed by my friends and I concentrate more on my friends than my schoolwork and I lost my focus.)6
	Sharda	So you have to focus now. Every subject you have to focus. So you realize that is the problem you are creating.
	Zinhle	Yes
	Amahle	(The challenges are that the learners are making noise when you tell them to keep quiet. They just tell you some other things. I don't understand the work.) 6
	Sharda	Have you complained to your teacher?
	Amahle	No. I think if the teachers use the powerpoint and videos like now then the children will listen to him 3
07.05	Wayne	The challenges are the noise.
	Sharda	Are you creating the noise Wayne?
	Wayne	No
	Wayne	(The noise and the teacher because he is like too calm he tell them to sit down but they don't)6
	Sharda	We are going on to our fourth question. What are some of the academic challenges you are facing? Remember when you spoke to me now you spoke to me about the noise factor in the class now we talking about math's literacy what is it that you struggle to learn with the content for e.g. if you doing tariffs if you are doing probability what is it that you don't understand. Who wants to go first?
	Marlene	(I understand some of it but when it comes to volume things like that I get confused. I think if see it, I will learn it.) 3 (M (but when he used to teach us he puts the work up on the board and tell us and he walks up and down.)1
	Sharda	Is that the only section that troubles you? Are there any other sections that trouble you?
	Marlene	No
	Sharda	Is there any section in particular that bothers you'll?
	Amahle	No just math's.
	Sharda	Which section in math.
	Amahle	Rounding off
	Sharda	Rounding off. Is that your only problem?
	Amahle	Yes
	Sharda	Are you getting better at it now?
	Amahle	Yes
	Mphetu	I think it is the tariffs.
	Sharda	It is the tariffs. You are having trouble with tariffs. The only section that bothers you.
	Mphetu	Yes
	Wayne	Area and perimeter
	Sharda	That is the only thing that troubles you Wayne.
	Marlene	Tariffs and compound interest.
10:00	Sharda	What can be done to assist you with your challenges? You are having these problems, academic problems what do you think can be done to help you get better

	Amahle	(The teacher because he is too soft for us because (too much noise) and we are losing control. He just talk and talk. Maybe he should teach differently. Make it more practical)5
	Sharda	Anybody else? What can we do to help you get better at this subject? Extra classes okay.
	Mphetu	(Intervention)7
	Sharda	Intervention 5 okay, what else? What about your attendance to school? Doing your homework on time.
	Lungi	I think we should come to school early and the math's teacher can come and do some work with us.
	Sharda	Do you always do your homework.
	Marlene	We hardly have any homework.
11.14	Sharda	Wayne, (how much of homework do you get.
	Wayne	No Homework.) 5
	Sharda	No let's just say you were talking to your math teacher how can he change his way of teaching to make you learn better.
	Mphetu	To explain because it is like.. using examples and other means of showing us what he means3 (I don't understand the teacher.) 8
	Sharda	So how do you want him to explain. Is it the language?
	Mphetu	No I understand the language. It is like I don't understand. Maybe he should show us how it works.
	Sharda	Judelle, sorry Wayne.
	Wayne	Discipline
	Sharda	Okay discipline but how can he change his teaching method.
	Amahle	Like pay more attention to school work like he must push us so he can make us understand the work.
	Sharda	Yes Wayne
	Wayne	He must give us more homework so we can revise our work at home.
	Amahle	I think he should be stricter and not so nice to us.
	Sharda	So now you are here sitting here and telling me that but I am sure you are enjoying it when you have lots of free time.
	Marlene	Sometimes but mam when it comes to revision and exams we don't know what is happening. Too many children fail at our school. The teaching methods must change.
	Sharda	So don't you think you should have set this straight rather at the beginning and say no more free time sir, let's just get on with it, the work. Ask him to teach using different methods.
	Marlene	But when sir comes and gives the work we say sir, sir, sir he doesn't come. He shouts at us.
	Zinhle	He says shut up and sit down. Even if you go and ask someone for help he will say sit down in your place.
	Sharda	So is there any way that he could teach and you could learn better. Is there anything he could do differently with the teaching
	Zinhle	I think when he is explaining he must not go fast. He must show us not tell us.5
	Sharda	Does he go too fast.
	Wayne	Yes
13.38	Sharda	But you do know that the syllabus is long and there is an annual teaching plan and he has to follow the plan.

	Marlene	But he does the same examples but we don't understand because we can't understand.
	Sharda	He does the same examples
	Amahle	Like today we was doing the sign with the S
	Marlene	Money
	Amahle	(Yes, money, the dollar sign he always teach the same thing mam. In this week we have been doing the same thing over and over) 1.
	Sharda	Does it help you to get better to understand it if he repeats it?
	Amahle	(Mam, I understand it from the first time. Even tomorrow he will doing the same thing.)1
	Sharda	Is this conversion of currency?
	Amahle	Yes
14.33	Sharda	Okay so how can any teacher now change his teaching methods to help you. What do you think. If you were in a different classroom what is it that you would like to see that is presented differently to you. So do you want peer teaching.
	Wayne	(Discipline)6
	Marlene	Silence
	Sharda	So Zinhle you said peer teaching. In your school I am sure the math teacher over the year because you have chosen math literacy this year I am sure that he has assisted you in coping with Math Literacy, how has your teacher or school assisted you to cope with math's literacy. There must be some positives come on.
	Amahle	I think maybe since you came.
	Sharda	But I have only seen you for a few lessons. So now if a teacher had to teach you what textbook, website or what tool will you find helpful in studying math's literacy. What is it that you will find to help you learn better.
	Wayne	(Videos)5/ charts /worksheets anything that can help us to see the concept.
16.30	Sharda	But you can't always do videos.
	Marlene	(Explain to us properly , teach and then use the computer and show us using the computer)5
	Sharda	Graphs?
	Marlene	(Take us to other schools math's quiz.)5
	Sharda	Math Quiz, that is a good one. What can we do to make it better for you? (I notice that most of you don't know how to use your calculators well. Why is that so.
	Amahle	Because they never teach us.) 5
	Wayne	The math's teacher never teaches us how to use it.
	Sharda	But your calculator comes with instructions
	Marlene	(But you can't read it properly.)8
	Sharda	You can't read it properly.
	Mphetu	I never read it.
	Sharda	So don't you think you are being lazy.
	Mphetu	It is being lazy

	Sharda	But we want to get better in this situation and you tell me how can we get better. If we want to get better at math's literacy you tell me. How do you think that your math literacy results can get better?
	Zinhle	(I think we should have math classes
	Wayne	**Different teacher) 1**
	Sharda	You think with a different teacher you will get different results.
	Wayne	Yes
	Mphetu	(With a more strict teacher)1
	Amahle	Who can push
	Judelle	To revise our work and do examples and if we need help to ask our friends and teachers and our parents.
	Sharda	(How many of you have internet at home?) 3 Mphetu do you have internet.
	Mphetu	No
	Sharda	Do you have a computer
18.43	Mphetu	Yes
	Sharda	So no internet, (if you have internet do you think it will help you.)3
	Mphetu	It will help me.
	Sharda	How
	Mphetu	(Most of my time I spend on the computer so I can try in doing it)3.
	Sharda	Do you have internet
	Zinhle	No
	Sharda	Do you have a computer?
	Zinhle	No
	Sharda	(Is there anyone around you that helps you with the internet or their computer a friend or family)3 How do you know how to use the computer then
	Zinhle	A computer is just like a cellphone and all school children know how to use it. It is my aunt but sometimes they go to work and when they come back they very tired.
	Sharda	You know there is lots of information available on the internet, there are a lot of videos, worksheets, presentations. Do you have internet at home Amahle?
	Amahle	No
	Sharda	No internet? No Computer?
	Amahle	No
	Sharda	Do you know how to use the internet? Do you think that if we use the computer when we are teaching, we use the internet and when we use the videos you think it will help you?
	Amahle	Yes mam. I use it on my friends' phone. I sometimes download the lessons and watch them
	Sharda	How
	Amahle	Because of the ways they show us the shows.
20.00	Sharda	Wayne do you have internet at home?
	Wayne	No
	Sharda	Do you have a computer?
	Wayne	A laptop
	Sharda	Do you have internet access, no Wi-Fi
	Wayne	No

	Sharda	So who helps you with your work when you are stuck when you need internet for a project or something.
	Wayne	My aunty.
	Sharda	Have you browsed and looked at all the literacy resources that are available?
	Wayne	No
	Sharda	(Do you think if you had access to it in school it will help you?)3
	Wayne	Yes it will help me to google for information.
	Sharda	Judelle do you have access to internet at home? Do you have a computer?
	Judelle	Yes
	Sharda	If you need to research something how do you do it.
	Judelle	(I go to the library.)3
	Sharda	The library has free internet?
20.45	Judelle	Yes.
	Sharda	And you can google as much as you want. Have you googled any math literacy site?
	Judelle	No they restrict us with the amount of googling.
	Sharda	And if you need help is there somebody who can get it for you, and you Marlene? No internet or computer?
	Marlene	I have a laptop
	Sharda	Do you have a laptop? But no internet access?
	Marlene	No
	Sharda	Is there anyone who thinks or believe that if you use the internet and download stuff it will help you.
	Wayne	Yes, the videos, download the videos.
	Sharda	What else except the videos. What else can help you with your literacy?
	Wayne	Examples
	Sharda	From Where?
	Wayne	The internet.
	Sharda	Okay is there anything else you want to tell me about how your literacy year has been going so far.
	Amahle	It was easy mam. It is easy to do.
	Sharda	To understand it.
	Amahle	(Yes, we are putting more attention) 1.
	Sharda	Because they are showing you where the changes are taking place and where you getting information from. Mphetu
	Mphetu	The videos and worksheets
	Sharda	What about the worksheets with the videos? Does the worksheet help you?
	Amahle	Yes it does.
	Sharda	Is it getting better? Now you know after I finish the next few lessons I will interview you again to understand how much you learned or whether the situation has improved or hasn't improved. Right so you have one more interview with me and another set of questionnaires to fill out for me. That will be slightly easier than the first one. Again I want to thank you so much for being part of the interview and part of my research and I want to wish you all the best and I want to tell you

		in spite the fact that you doing math literacy It does mean to say that the math students are better than you. You can achieve you are aware of it. I want to wish you all the best and I will see you here next week to do the interview. Thank You.
		END ON INTERVIEW FOCUS GROUP ONE

Appendix J

Transcript: Focus group 2

Interviewer: **Sharda**

Interviewees: **Various Names**

Time	Name	Transcription
00.01	Sharda	Okay learners I want to welcome you to this group interview and I want to thank you for volunteering to be part of this. I am going to ask you the eight questions that I have given you last week. What I want to do is I will address each person and before you answer the question I want you to state your name and then answer the question. I will start with you Tumo. Briefly explain how you feel about Math Literacy.
	Tumo	To me it's a very nice subject.(But it depends the teacher who is teaching)1 it. It is a very nice subject.
	Sharda	You are enjoying it.
	Tumo	Yes, I am enjoying it (but it depends on the teacher who is teaching it.)1
	Noma	Hi. I don't have a problem with school but I think the work we do in Maths Lit is work done on the chalkboard. If any child doesn't understand the first time, they cant get help again.
	David	(It is very simple to understand and it all depends on the teacher who is teaching it.)1 If the teachers uses charts and things to show us rather than tell us.
	Sharda	What do you mean it depends on the teacher?
	David	(How they explain it to us and whether they take time to teach us.)1 If they use examples then it will make more sense to us.
	Sharda	Okay
	Sanele	I feel like math lit is a weak subject. Some of the learners should be doing pure math but pure math may be hard but it is a better subject than math lit but it is okay. Maths Lit can be such a practical subject.
	Sharda	Are you coping with math lit.
	Sanele	I am coping but not that well. I feel like if I was doing pure math I will be better because math lit is quite hard sometimes to understand. (Because of the teacher.)1. He uses the board and he talks and I don't understand the concept he is explaining.
	Arlene	I feel math literacy is quite boring math's(because if the teacher wants to teach you something children are making noise or he is screaming at you. But for pure math the teacher is quite strict and wants you to learn but it depends if you want to learn. I feel math literacy is not for me.) 6. Also if we get different ways of teaching, it may help.

	Sharda	What do you think you should be doing Arlene?
	Arlene	Pure math's.
02.22	Sharda	Okay
	June	I think it is a good subject and it is right for me but it depends how the teacher is teaching the learners. . He uses only one method. He tells us . He doesn't show us.
	Sharda	We are looking at question number two, how do you normally cope with your math literacy homework.
	Tumo	To me mam there is (a programme that play in Dstv for schoolwork so I normally watch it I can incorporate and see how they do the math's.)3 (Sometimes they tell us we have to do on our own and they pause and they come back and see if it corrects or wrong.)3
	Sharda	(What channel is this.)3
	Tumo	I forgot.
	Sharda	Mindset
	Noma	I ask people to help me. Sometimes I watch the tv where they teach us sections. It also teaches other subjects.
	Tumo	(Mindset. That is the right channel.)3
	Sharda	That helps you to cope with your schoolwork.
	David	(I usually complete all the activities that sir give us if I don't understand anything I ask my friends for help.)7
	Sharda	(So you don't ever go back to the teachers for help.)7
	David	(I ask my friends.)7 Sir will say it in the same way and I wont understand.
03.48	Sanele	I normally do my schoolwork on time and sometimes when I really don't understand something (I ask sir but sometimes sir does not give us that concern he just says I will be back in a second and he says he is going to another child but you still waiting for sir's help.)1
	Sharda	You are saying that there are times you don't get the help when you need it.
	Sanele	Yes
04.23	Arlene	(My math literacy homework is quite easy for me although I do have an app on my phone.)3 It helps me with things I don't understand. If I don't understand by using the app I come to sir and ask him or I ask my mum. If sir can use the app in class and then explain to me, I am sure it will be better.
	Sharda	What app is that Arlene.
	Arlene	It is just called mathematics.
	Sharda	And it is on your phone
	Arlene	My tab. I downloaded it . But I need a teacher to help me to apply what the lessons on the app is covering otherwise it doesn't make complete sense to me.
	Sharda	On your tablet.
	Arlene	Yes
	June	(Okay with my math lit homework sometimes when we are in class I used to ask sir and sir used to come to me and explain to me how to do it. I used to ask my brother too when I don't understand something and he used to try to explain to me on and show me how to do it.)7

05.14	Sharda	There are challengers you are having and that's brings us to our next question. What are the challengrs that you are experiencing at your school?
	Tumo	To me mam it depends on the topic. Which topic is more easy, which topic is hard and which topic I am good at and it is nice mam and it is cool and I really enjoy it but depends on the topics.
	Sharda	So what topics you find challenging. Which sections of math literacy troubles you.
	Tumo	I think rectangles no I forget that thing but it is very difficult. I think it is this volume and surface are.
	Sharda	What are you expected to do in solving that problem?
	Tumo	I think we should watch more videos for math's because it is very difficult. If we want we can watch the video of a section again in case we didn't understand it the first time.. I do struggle with the work. Maybe I would pass if I can learn better.
	Sharda	It is very difficult okay. Thank You
	David	The challenges I face with math lit is Geometry and tariff section
	Sharda	Tariffs
	David	Yes tariffs
	Sharda	And geometry you mean the shapes, perimeter and area and pie.
	Noma	I battle with the shapes that have to many parts to it. A house has a triangle and rectangle.. I get so confused.
	Sanele	The problems I have with math lit is volume and tax.
	Sharda	Tax?
	Arlene	The challenges I experience for math's is the tariff section.
07.02	Sharda	You want to add something
	Tumo	Yes, mam, it is geometry and tariffs. It confused me because we have to use many steps to solve a problem.
	Sharda	By geometry u mean space and shape.
	Tumo	Some of them are easy but some of them are hard. Especially is the shape is not straightforward.
	June	The problem I used to get is rounding off. I don't understand.
	Sharda	Rounding off and the other sections June
	June	Area. I get confused with what area means and what surface area means.
	Sharda	We will go to question number four. What are some of the academic challengers in math literacy? The academic challenges you are experiencing at school besides math literacy. What other subjects are you having trouble with?
	Tumo	For me it is Tourism
	Sharda	Tourism okay.
	Tumo	Only tourism and math's lit. Tourism is a very nice subject but there is a lot of work and many notes so there is many assignments and many pracs and that is a problem.
	Sharda	Pracs okay. But isn't tourism a fun subject?
	Tumo	It is very fun but when it comes to doing the work okay fine we have to do the work but when it comes to making the assignments and exams and when you see the page and trying to figure out it is very difficult.

	David	The other subject is Afrikaans.
	Sharda	What is the problem.
	David	Reading Afrikaans
	Sharda	Have you only experienced the problem this year?
	David	No from last year.
	Sanele	(The problem that I have is one subject Zulu. In Primary school I used to do Afrikaans. So when I came here they told me I can't do Afrikaans I must do Zulu because I am a Zulu learner.)8
	Sharda	So they did not give you a choice between Afrikaans and IsiZulu.
	Sanele	No they didn't.
	Sharda	Okay but do you prefer to do Afrikaans or IsiZulu.
	Sanele	I prefer to do Afrikaans maybe like next year because it is the end of the year now.
09.46	Sharda	That is true.
	Arlene	The subject I am struggling with is computers. My understanding basics how to count and stuff on the computer.
	Sharda	That is what you are struggling with.
	June	The challenge is in the other subjects is History and math lit.
	Sharda	Can you briefly explain what the problem is in History,
	June	The essay you have to learn about Shaka. Many things cannot get into your head at the same time because there is 2 pages or 1 page. It cannot get into your head.
	Sharda	Tumo do you want to say something
	Tumo	No mam it is cool.
	Sharda	Are you sure
	Tumo	Yes
	Sharda	So for you it is the learning of the essay.
	June	Yes
	Sharda	That is the problem. You don't understand it so you learn the essay off.
	June	Yes
	Sharda	Okay let's go to the next question. What can be done to assist you with your academic challenges in math literacy. So if you were to tell the teacher how can he help you to make your problems in math's literacy go away where the understanding gets better what will you suggest to him, what will you recommend to him.
11.21	Tumo	To me mam (although I am in the English school but some of us mam, we usually understand English but some work we don't understand and the teacher has to explain to you in Zulu so there is my problem mam.)8
	Sharda	For you it is the language that is the problem. So if you think if the teacher is able to switch from IsiZulu to English it will help you more.
	Tumo	I(t will help me but he or she can use mix and explain to Zulu and English)8.
	Sharda	Okay
	David	I(think the teacher can give us a better understanding if he shows us a video.)3 I want to see what he means. I don't understand unless I can see it .
	Sharda	Only videos anything else. What else do you think will help?

	Sanele	Worksheets and examples that we can see will help me. If the shape is on a projector and the teacher shows us how to break it up, then we can see the parts of that shape and it will make sense.(I think maybe stay in after school and tell sir the problems we have and maybe if he could try and explain them more or better.)7Then we can start learning very well and in the weekend some of us go to our friend's house instead we can come to school and learn more other subjects that might improve our schoolwork and our marks.
	Sharda	So you are saying extra lessons will help you.
	Arlene	(I prefer going to excursion on math where there is a person that guides us as to how they do it in person where you can understand something if you don't understand and they can show you the proper way you can understand. I also prefer having extra classes over the weekend, that's about it.) 5
13.42	Sharda	June
	June	(I think videos are right for us learners the way we can understand; videos are better than the teacher explaining on the board.) 3 (Sometimes the teacher he or she maybe is rushing or getting fast the time she is writing but videos are better because you can understand. Like yesterday Method there was a difference and sometimes it is getting difficult. We used to forget and yours is easy. It was not difficult mam. I can still remember it today.) 5
	Sharda	Are there any other ways we can introduce things to the class to make learning easier for you?
	Tumo	I think we should help the learners to understand the work. Sometimes use isizulu so that the children who struggle with the Mathematical terms can understand. . Just now and again.
	Noma	If we have a computer room for us to work in the breaks and after school, we can go and view the online lessons. This will really help me.
	Sharda	Another voice
14.48	Tumo	We don't get to use a computer at school unless we study CAT. It will help if we can use the internet at school. Another voice and if we have to go to excursions. If you don't understand then we can go and ask he or she how he do it.
	Sharda	Can we go to the next question? How can the teacher improve the teaching method to help you more effectively? The teaching methods meaning how he or she teaches in class if they were to change that how can that help you and what change would you like to see.
	Noma	It will help if we can use textbooks and worksheets. Then is the lesson is mixed with videos, PowerPoint etc. we can actually see what the teacher means.
	Tumo	I think he or she(must not rush they have to take it slow because some of us are slow learners so we don't actually understand the topic.)5 I agree we have many methods so if we don't understand in one wat then the other way will make it clear.
	David	The teacher must not rush with the work. He must take time to explain to us properly and he can show us by using practical examples. He must make the lessons real.

	Sharda	But you know there is an annual teaching plan the teacher has to follow what has to be done in week one. What has to be done in week two. You know that.
	David	Yes. It doesn't help if the work is done but we don't understand it.
	Sanele	I think we should give sir more attention like if we could stop misbehaving maybe we might understand better. (Because sometimes it is not the teacher it is the learners.)6
	Tumo	Can I say something Mam.
	Sharda	Sure
	Tumo	Mam there are some of the teachers (there are some of them who don't know how to control the class. I am talking about my class for math's we need a stronger teacher who can put us into the line, who can guide us so if we are misbehaving and put us into the line so we must not misbehave)6.
	Sharda	We have two points here one is learner discipline and the other one is classroom control.
	Arlene	I prefer that as soon as Sir walks in the classroom we must be quiet with our work out waiting for him to teach and the other thing is that when sir writes on the board (there is someone talking and the whole class gets disruptive and sir stops everything and tells us to sit down, keep quiet and we are getting more of sir talking) 6 towards our discipline than more math's work with us.
17.33	Sharda	So you feel a lot of time gets wasted
	Tumo	Yes
	Sharda	So if we have greater control that will be better.
	Arlene	Yes
	Sharda	June
	June	(I think that the teacher he or she is teaching us she has to give us more time. She must not rush she must come to the learners or she must ask if we understand that.) 1
	Sharda	And you think this will help you to cope better.
	June	Yes
18.00	Sharda	Question number seven, how has your teacher assisted you in coping with math literacy. They have done so much for you what have they done that has assisted you in your learning process.
	Noma	Sir is very good but the class is badly behaved . maybe they will listen if he adds other things to the lessons. If he teaches and then asks us to work using the computer or if he shows us videos.
	Tumo	I think sir is always pushing me to do my work and to me mam I think sir is a good teacher but not in our class. (To be honest mam sometimes we have to scream and shout whilst he is teaching us we have to scream and shout and some of them fight and some of them are talking their own stories. Sir is busy teaching us and then he has to stop teaching us to go and deal with them.)6
	David	Whenever I did not understand the question sir was always there to help me
	Sharda	And that will help your math literacy to improve.
19.15	Sanele	I do my schoolwork but most of the time(I ask sir to help he just ignores you. It seems like he does not care only if I do my work being a

		teacher I will be paid I don't care about you so if he could give us more attention maybe try to understand us better, talk to us like we are his own kids maybe it might be better.) 1.He needs to do something to get the children's attention. Maybe change the method.
	Arlene	Sir has helped me a lot this whole year if we don't understand something we ask him he teaches the whole class but they don't ever listen to him.
	Sharda	So discipline is a problem.
	Arlene	They don't ever listen to him most of the Indian children the boys they just like walk out of the class
	David	That is how we get distracted.
20.12	Arlene	(And sir loses his concentration on us and they make him run around the school for them.)6
	Tumo	Mam they taking advantage because sir is quiet.
	Arlene	He does not do anything.
	Tumo	So they taking advantage of him. They say they don't care about him.
	Arlene	They basically disrespecting him.
	David	They come to class anytime they feel like.
	Sharda	I want to ask a question that is not here. Do you think in a math class children are better behaved or is it the same in your class?
	June	It is not the same mam. In our class when there is sir they are busy making noise, running around but when he comes to you and when he is with you in class there is a big difference between you and sir. Your mam they really respect you but when it comes to sir they don't respect at all.
21.15	Sharda	Do you think discipline is a problem in a math literacy class because they think there is a stigma attached to math literacy?
	Sanele	I think so it is just not our class some of the learners in this school have a problem with discipline if your parent does not teach you at home definitely if you come to school you won't respect the teacher because you will say he is just joking. It is not my mother or my father. I am not going to respect him.
	Tumo	There is some of them when you know their background you see he is a good child he behaves at home but when he comes to school you hang out with your friends you disrespectful. Mam like there was another boy I think it was last year he was a very good boy he behaved at home then he was misbehaving at school so they called his mother and his mother was so disappointed because she was telling he was a very good boy at home.
22.18	Sharda	So you don't think doing math literacy has anything to do with bad behavior. It is just that they want to behave badly.
	Tumo	Yes
	Sharda	I will go to our next question what textbooks or website or tools are you using or you find will be helpful when you are studying math literacy.
	Tumo	(The website I use I forgot the name but I found it last year it is a very good website for me) 3
	Sharda	Is it a math lit website or an educational website?
	Tumo	Both but it depend which subject if you go to website and say www.mathlit they will give you all the information.

	Sharda	You have internet at home
	Tumo	Yes
	Sharda	You have your own computer
	Noma	No, I don't have a computer or cellphone.. we can use the computers at school, it will help me to get information for my schoolwork. The internet has so many past year papers .It will help us.in all our subjects.
	Tumo	I had a computer (my uncle has a laptop I usually borrow from him. If he is busy with the laptop I use my phone. My mother's phone.)3
	David	Mam (the website I am using in the internet. If I don't understand a question like tariffs or anything I can type in tariffs math lit to find out the solutions how to complete it.)3. If we use the internet at school maybe sir can help us to get the correct information so we wont waste our data.
	Sharda	So the internet is helpful.
	David	Yes, it is helpful. It is also expensive if you have to buy data..
	Sanele	(I normally watch videos in you tube for math's and google because I have a Wi-Fi nearby my house so it is normally easier for me.)3
	Sharda	You have Wi-Fi at home?
	Sanele	Nearby my house not at home. It is far and I have to walk and stay in the park and do my schoolwork.
	Sharda	At the park?
	Sanele	Yes, nearby Gandhi
	Sharda	Is it not dangerous?
	Sanele	No its not.
	Sharda	And you take your tablet along with you or your computer?
	Sanele	My phone. I use my phone.
	Sharda	David you have a computer at home?
	David	(No my aunty Wi-Fi and she has a computer)3
	Sharda	She has Wi-Fi on her computer?
	David	Yes
	Sharda	Okay
	Arlene	The tool that I use honestly is my relative . She is like a math's pro over there. When I go my uncle's house I ask him to help me. (I also do use google but not all the time because I don't have access to internet.)3
	Sharda	And a computer?
	Arlene	I have a computer.
25.01	June	The tool that I use (I am using right now is text book but I don't like textbook because there is no one who is explaining to me you can only see maybe examples)7there is no one who is explaining to me but when you are using internet there is like mam what you showed us yesterday there was a man who was speaking there he was explaining there to me the textbook no one is explaining to me there is only examples.
	Tumo	We don't understand the examples.
	Sharda	So you are saying that if you have somebody, a teacher teaching you and talk to you step by step and use another tool will that be helpful.
	June	Yes, definitely
	Sharda	Using textbook and your calculator and maybe a power point will that help.

	David	Yes, then we can understand
	Arlene	Honestly our (last exams like some of them don't have calculators it is very hard for them to do it.)3
	Sharda	Were you'll not issued with calculators by the school at the beginning of the year.
	Arlene	(Some of them steal them) 3. There are people that steal our calculators.
	Sharda	So a lot of you are sitting in the class without calculators?
	Arlene	Yes
	Tumo	Last term mam we were suffering because there was a paper that said calculators were not allowed. So we had to give all our method but calculator is a very short thing.
	Arlene	I feel we are not using our brains for all of that.
26.47	Sharda	Is there anything else you want to tell me about how you feel about math literacy and how we can make it better in the classroom. How can we improve our marks?
	Tumo	I think mam to me we need a strong teacher who can like tell us and put us to the line. There is a teacher I think T Naidoo to me he is a very strong teacher because he does not take nonsense he just put you into the line. He is a very good teacher.
	Arlene	I don't agree with you because honestly (it is not about the teacher it is about the learners who want to learn. If they want to learn they will put their mind to it)6. They will sit down and wait for sir to come. Everyday sir comes into the classroom he just does work with us and no one ever pays attention to him. See in my case (I have my four friends who sit together. We help each other with our work that we don't understand and if we all don't understand it altogether we ask sir. Sir explain it to us we still don't get it because learners are walking around.)7 They walk out of the classroom and sir is concentrating on them. Basically he is spending 5 minutes with us and the rest of them just walking around.
	Tumo	I think mam to me if they doing noise and say to them after school those who want to do the work after school just come if you don't want to do the work just go home and make fun thing in your own yard.
28.45	Sharda	Is that what you are suggesting to solve the problem.
	Sanele	I feel like have extra lessons in school because I don't think it is only math's we are having a problem with I think there are more subjects its only if the teachers put an interest and show love. (Teachers who love and care and sometimes teachers don't even care about you they call you names such as me)?? teacher he calls us stupid names that your parents will not call you so it kind of annoying and frustrating. So if we might have like extra lessons and we can get to know each other better as a teacher and a learner we might understand so we will know that this is wrong and this is right.
29.46	Sharda	Anybody wants to add anything. You know we have mentioned people from this school so I am going to tell you again this audio is confidential, nobody will be listening to it so you don't have to be afraid that somebody is going to find out this and the audio will be sent to somebody for script writing I have to tell you that and the only

		person who can see this is my supervisor Dr Jaya Naidoo but in no way will anyone at the school see it so don't feel afraid.
	Arlene	Not even the principal
	Sharda	No not even the principal. Remember you are doing me a favour by being part of this discussion so I can't tell anybody not even your parents what you told me. Remember you signed an indemnity form and your parent has signed. Again I want to thank you so much for being part of this discussion when we finished all of our lessons I will have a discussion with you again to see if you are feeling differently or the same about things. I will have a discussion with the same group like we are meeting here in the conference room we will do this again. Thank you so much
31.01	Tumo	There is some teacher's mam they say we have to do our work we have to do the assignment and classwork and if we are doing our work some of the teachers are saying they promise us some things that will count into the exams from January to December and if you get your report how can I fail this subject because I have done my homework, my everything. They say it will be combined and give you the better mark.
	Sharda	Maybe you don't know this Tumo but there is a weighting for example if you take IsiZulu in the first term you would have done 4 tasks. Task one would have been listening and comprehension- 10 marks. Your task two would have been an essay for 50 marks. Task three would have been long term for 30 marks and task four your language and comprehension for 40 marks. Let's say you did all these tasks and you passed. Maybe you did badly in one task that was the written component but each task has a weighting so there is a possibility that even if you did all your Cass work you can still fail because the weighting of the exam is so much more than the Cass tasks. Do you understand that.
	Tumo	Yes
32.42	Sharda	The June exams for example for language is 250 marks the Cass is only about 40 for that term. You may have done well out of the 40 mark but the 250 is the bulk.
	Tumo	Now I understand.
	Sharda	Is there anything you want to ask me? Anything you want to say to me. Are you excited about being part of this research project?
	David	Yes, you must continue with this method of teaching by giving us activities.
	Arlene	I feel like from next year we should go on excursion on mathematics, educational excursions
	Sharda	Arlene what you mean by excursion for mathematics.
	Arlene	We can have (just like the video you have a person talking and showing us. But asking the person how to do it step by step.)7
33.44	Sharda	Like a math studio where somebody else is teaching.
	Arlene	Let's say the teachers have a problem with people being absent, children absent
	Sharda	Absenteeism is a big problem at our school.

	Arlene	Yes, that is why they are not taking us on any excursions. We are not having anything in this school. It's like we have no freedom of learning at all.
34.11	Sharda	Are you saying they should vary the way they teach? Not have only teachers talk and write on the board. You want them to take you'll out so someone else can teach
	Arlene	We can learn what they are understanding and our own knowledge and combine it with the sirs
	Sharda	So you saying mixed methods, different ways of teaching.
	June	(And short videos especially for history)3
	Sanele	I feel like next year they should start having extra lessons maybe our progress in school might be better because our matric is really failing maybe for them it might be easier and for us it might be easier.
	Sharda	Again I want to thank you so much and after our lessons I will meet you again and we will have a discussion again and see if things are the same or have they changed, only you can tell us.
		END OF FOCUS TWO INTERVIEW

CODE	EXPLANATION
1.	Teacher competence
2	Extra help
3	Technology
4.	Language
5	Teaching methods
6	Class room control
7	Coping strategies
8	Language barrier

Appendix K

Transcript: Focus group 3

Interviewer: Sharda

Interviewees: Various Names

Time	Name	Transcription
00.01	Sharda	Okay welcome to our final session of the focus group interview I know it has been nearly four months that I last taught you but I wanted some feedback to tie up our lesson so that I could do my write up and I again want to thank you very much for being part of this study. I have some very basic questions to ask you and our participants for today are Marlene; June; Tumo; Arlene; Wayde and Noma. For the purposes of writing I will not use your own name I will use other names in place of your names. So be rest assured that this recording will not get into anybody's hands neither will they know what you said. The first question is now you are in grade 11 and when we did our study it was the end of your grade 10 year and we used all the free time we could because we could not cut across time that was meant for your teaching so we did it in our extra time I just want to know a few things. Are you people enjoying your grade 11 here
	Various	Yes
	Sharda	All of you? Is there anyone not enjoying grade 11? You all are enjoying it. It is a challenging year, there is a lot of work and lots of pressure. Are you enjoying the pressure?
	Various	No
01.32	Sharda	Okay, are you enjoying Math Literacy?
	Various	No
	Sharda	Okay who wants to go first? Noma
	Noma	Yes, we are not enjoying our math's lit this year because (we don't have a very good teacher) 1.
	Sharda	What is the problem?
	Noma	(It's the teacher mam. Even in some sections we don't do corrections and we don't know if we are right or wrong.) 1
	Sharda	But you are being taught according to Caps that means that if you supposed to do tax are you doing tax. If you supposed to do probability you are doing probability. Are you following that order?
	Noma	No
	Tumo	We understand (he is slow but he can't teach us how to deal with Math Literacy) 1
	Noma	In every section (we don't have full explanations and examples)1.

02.43	Sharda	So you just get an exercise.
	Tumo	(But no explanations)1.
	Sharda	Sometimes you get worksheets and the other times you get notes on the board. I can see you are having some challenges. So some of the challenges you are experiencing that the teachers are not teaching, he is just giving an exercise and other challengers?
03.09	Noma	If we were doing a section (like today if tomorrow, we were going to start a new section there is no explanation about the previous work)1.
	Sharda	Okay so you don't have rounding off. You don't go back and recap.
	Tumo	We go straight to the new section.
	Sharda	Anybody else wants to say anything. What do you think can be done to assist you with the challenges you are currently having?
	Noma	(Maybe we can have the extra lessons that we are have the lessons with him. Maybe that could help.)2
	Marlene	You want to say something.
	Wayde	We need to have extra lessons
	Sharda	You think that will benefit you.
	Noma	Maybe like if we had math's in the morning maybe in the afternoon you can come and just recap us on the work that we did in the morning.
04.13	Sharda	Okay, (now you remember last year when I taught you the lessons you remember that we used different kind of teaching methods)3
	Various	Yes
	Sharda	Now are you at the moment trying to find other ways of teaching yourself. For example are you using any extra tools, extra text books, extra technology is there anyone here using anything extra when you are doing work,
	Noma	We don't normally understand the work we just can't go research maybe if we get some information about that section (maybe we can go and try and find some other way to understand that section.)4
05.03	Sharda	So none of you here is using anything extra at the moment.
	Arlene	(You tube)3
	Sharda	Does it help you. So what you didn't understand in class you watched the you tube video and it helped you. Anybody else, like other textbooks, worksheets from else where
	Various	No
	Sharda	As I said it has been about 4 months and this is a round up focus group because we wanted to put some distance between the lessons and to see how you feel. Do you remember the sections we did last year?
	Various	Yes
	Sharda	Okay what were the sections Marlene.
	Marla	Area, perimeter, surface areas.
	Wayde	Tariffs.
	Sharda	Okay so do you remember the sections so when it comes out in the exams do you know how to do it.
	Various	Yes
	Sharda	Do you know it well?

06.03	Various	Yes
	Sharda	Is anyone here that is not sure and needs to do brush up on that.
	Various	No
	Sharda	So you are saying that videos helped you.
	June	(A lot)3
	Sharda	What about the power point presentation to show how you get surface area, how to work out volume? Was it helpful?
	Various	Yes
	Sharda	And how about the worksheets that we used at the end of each lesson. Do you remember I gave you a worksheet to round up each day and we would mark it the next day?
	Tumo	Yes
	Sharda	Do you remember those worksheets were it all helpful to you? Do you use them now for revision?
	Various	No
	Sharda	Why
	Noma	We have not come to that section
07.03	Sharda	You have not done space and shape as yet.
	Tumo	No
	Sharda	So have the lessons from last year benefitted you. So you all saying that it benefitted you I want to know how it benefitted you.
07.10		Too much outside noise.
07.16	Sharda	Did you manage well in the section, anyone struggled with that section in the exam. I want you to compare your lessons from the six lessons since I did with you last year and compare them with the lessons you are doing now how are they different.
	Tumo	I(t is very different.) 3
	Sharda	Tell me what the difference is.
	June	(When you were there we had a video and the explanation and now we have no videos and no explanation.) 3
	Arlene	(Last year it was easier.)3
	Sharda	Was it easier?
	June	(Yes, you did corrections every day and now don't.) 5
	Sharda	How did it benefit you?
	Marlene	(I passed and comparing last year to this year it is way different because you explained to us and you used to come by us and help us he is there by the board)5.
	Tumo	(Yes, that's right. He is paying attention to those who is not doing the work.) 6
	Arlene	(He screams more at them than do the work. Last year I had a work in my notebook this year I don't have any.)
08.44	Tumo	To me on my side I understand sir is so humble but he is a teacher and he has to be responsible to take care of us because he is a math teacher and I think math is a difficult subject and he must be like more strict because my class is very noisy there is another teacher that can control us but with him you must just do the notes
	Sharda	Last year when we had the discussion you brought up the same issue of discipline and that was a different teacher now you have another

		teacher and you raising the same issue of discipline. So you don't think maybe it is the class.
	Arlene	(We don't have a strong teacher.) 1
	Wayde	(A strict teacher)1
	June	(Like your mam when you in the class everybody is keeping quiet. You even make us want to do work.)6
	Arlene	(You don't have that no care attitude)6.
	Sharda	You guys are the committed ones. You normally do your work.
	Tumo	You get with the people and the class even if you get a chance to sit as us you will just come and say go sit down in your places.
10.21	Sharda	(So you are saying you are trying to help each other)
	Various	Yes
	Sharda	That is a good thing. But I also want to encourage you that if you find there are gaps in your knowledge there is lots of information available out there. Even if you don't have access to internet we discussed it last year some of you said you had access to internet and some said you didn't. Our school has internet facilities so I want to encourage you that if you don't have internet facilities at home come to school and get somebody to help you to download something, to watch it, to download a worksheet so use the resources that are available. Is there anything that you would like to tell me. Any challengers or any strengths you find within yourself right now with math's.
	Various	No
11.38	Sharda	So you think that if I am your teacher and if you think you have a text book that might help.
	Tumo	(Some of us have textbooks. Sir does not use the textbooks.) 7
	Wayde	(I don't think he knows we have textbooks.) 2
	Sharda	Did you tell him.
7	Marlene	The textbooks and the syllabus has different sections over there. What we do is totally different.
	Sharda	Do you know you are writing common papers
	Various	Yes
	June	The other test he gave us was (too much noise) we don't know how the syllabus go.
	Sharda	You must use last year paper as a resource that will give us some guideline as to what you can focus on. Whenever you are in a difficult situation when it comes to academics don't sit back do something about it get some help and once again I want to thank you so much for being part of the study and I promise to keep you'll informed as it progresses and perhaps at the end of the year I can have some good news for you'll. Thank You so much
		END OF FOCUS GROUP FINAL INTERVIEW

CODE	EXPLANATION
1.	Teacher competence
2	Extra help
3	Technology
4.	Language

5	Teaching methods
6	Class room control
7	Coping strategies
8	Language barrier

Appendix L

Samples of pre and post-tasks

Question 1

1.1 Area of a triangle = ½ 6×3 ✓

1.2 Area of a Circle = $\pi r^2 \times 4^2$

$A = \pi r^2$

$3,142 \times 4^2$

$P = 2\pi r$

$2 \times 3,142$

$= 6,284$ ✓

3 + 2 + 32

Question 2

2.1 $A = L \times B$

100×50

$= 5000 m^2$

$P = 100 \times 2 + 50 \times 2$

$200 + 100$

$= 300$

2.2 $A = L \times B$

20×63

$= 1260 m$ ✓

$P = 20 \times 2 + 2 \times 63$

$40 + 126$ ✓

$= 5040$

(b) $P = (16 \times 2) + (8 \times 2)$

$32 + 16$

$= 48\ m$ ✓2

(c) $P = (12 \times 2) + (16 \times 2)$

$= 24 + 32$

$= 56\ m$ ✓2

(c) 104 ✓2

Question 3

(a) (i) $A = L \times B$

$8 \times 5 \times 12$

$= 400$ ✓2

$= (8 \times 2) + (5 \times 2) + (12 \times 2)$

$16 + 10 + 24$

$= 50$ ✓2

Name: [redacted]

1.1.1) A = 1/2 x base x height
= 1/2 x 6 x 3
= 9

9/30

1.1.2) C = π x diameter
= 3.142 x 4
= 12,560

1.2.1) (4m + 2m)° + (2m + 2m)°
= 6m + 4m
= 10m 14m

1.2.2) R19,50 x 14m
= R195 273

2.1) P = l x b
= 100m x 50m
= 5 000m

2.2) P = l x b
= 63m x 20m
= 1260

2.3) a) P = 5 x 4
= 8m x 4
= 32

b) P = l + b + h

= 10m + ✓

c) P = ✓

3.1) A = L x B

= 2cm x 5cm x 8cm

= 3.840 cm ✓

3.2)

A = L x B

= 8m x 2 x 4 x 2

= 128m ✓

3.3.1) A = L x B

= 6cm x 2.5cm x 1.5cm

= 22.5 cm ✓✓

3.3.2) V = 1.88 ✓

[redacted]

15/30

1.1. $\frac{1}{2}$ × base × height

= $\frac{1}{2}$ × 6 × 3

= 9 m^2

1.2. π × radius²

3,142 × 4

= 12,568 m^2

1.2.2. Square = Side × side

= 2 × 2 × 2 × 2

= 8

rectangle = L × B

= 4 × 2

= 12

= 8 + 12 = 20

= 20 × 19,50

= R 390

2.1 L × B

= ~~100 + 50~~ 100 + 100 + 50 + 50

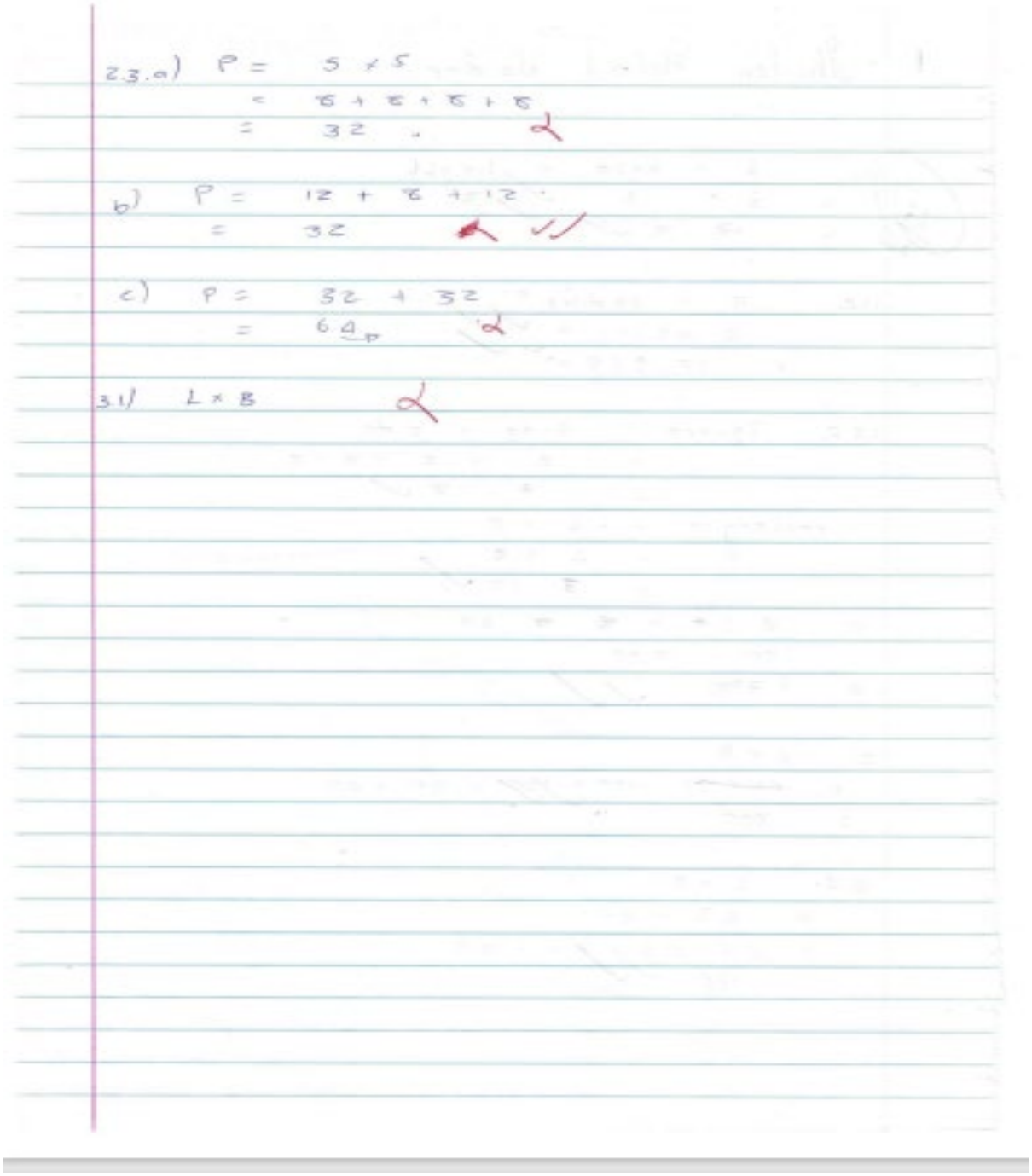
= 300

2.2. L × B

= 63 × 20

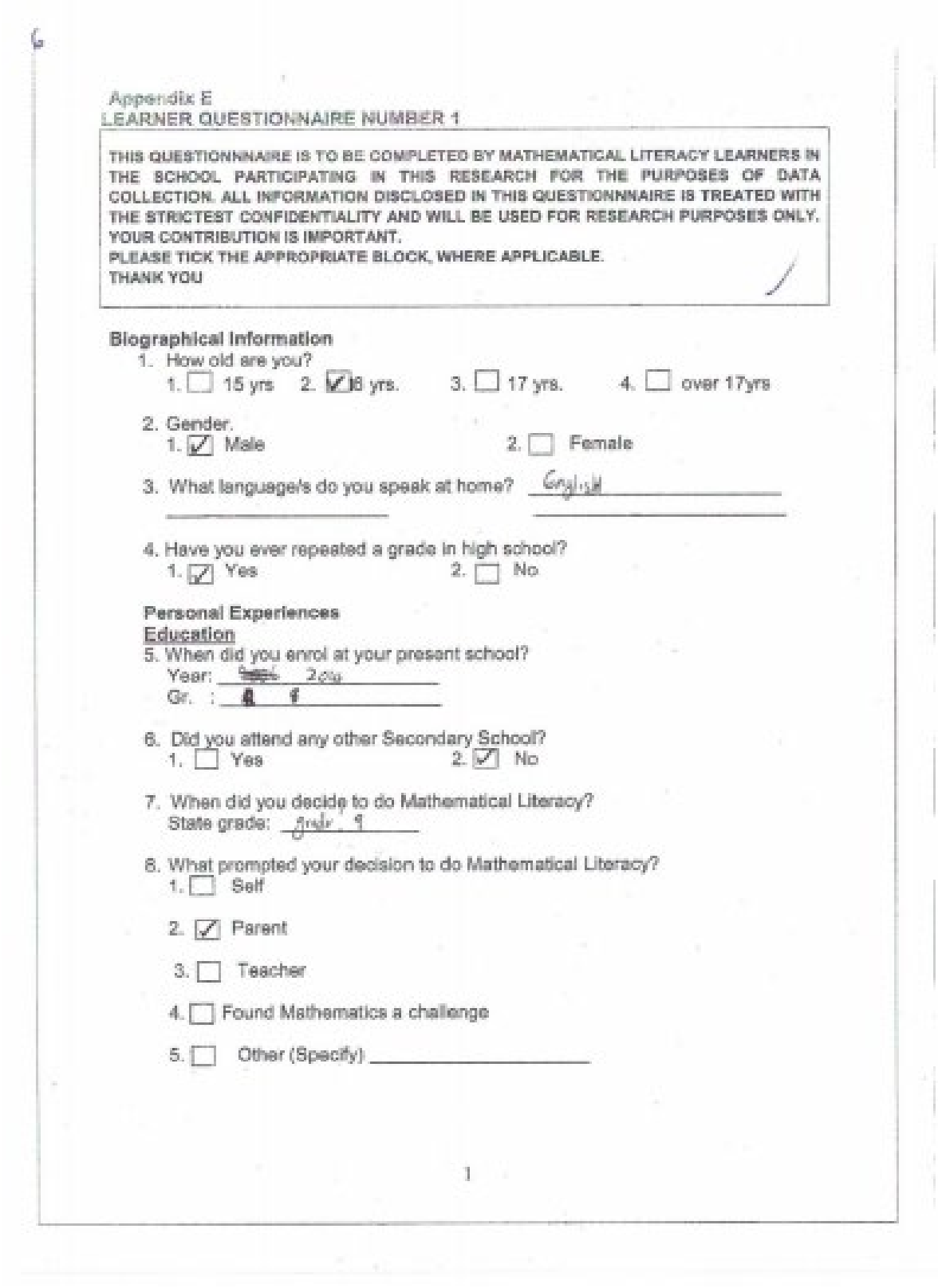
= 63 + 63 + 20 + 20

= 166


2.3.a) P = 5 × 5
= 8 + 8 + 8 + 8
= 32 .
b) P = 12 + 8 + 12
= 32
c) P = 32 + 32
= 64 p
3.1/ L × B

Appendix M

Samples of completed questionnaire 1



Appendix E
LEARNER QUESTIONNAIRE NUMBER 1

THIS QUESTIONNNAIRE IS TO BE COMPLETED BY MATHEMATICAL LITERACY LEARNERS IN THE SCHOOL PARTICIPATING IN THIS RESEARCH FOR THE PURPOSES OF DATA COLLECTION. ALL INFORMATION DISCLOSED IN THIS QUESTIONNNAIRE IS TREATED WITH THE STRICTEST CONFIDENTIALITY AND WILL BE USED FOR RESEARCH PURPOSES ONLY. YOUR CONTRIBUTION IS IMPORTANT.
PLEASE TICK THE APPROPRIATE BLOCK, WHERE APPLICABLE.
THANK YOU

Biographical Information

1. How old are you?
   1. ☐ 15 yrs 2. ☑ 16 yrs. 3. ☐ 17 yrs. 4. ☐ over 17yrs
2. Gender.
   1. ☑ Male 2. ☐ Female
3. What language/s do you speak at home? English
4. Have you ever repeated a grade in high school?
   1. ☑ Yes 2. ☐ No

Personal Experiences

Education

5. When did you enrol at your present school?
   Year: 2010
   Gr. : 8 9
6. Did you attend any other Secondary School?
   1. ☐ Yes 2. ☑ No
7. When did you decide to do Mathematical Literacy?
   State grade: Grade 9
8. What prompted your decision to do Mathematical Literacy?
   1. ☐ Self
   2. ☑ Parent
   3. ☐ Teacher
   4. ☐ Found Mathematics a challenge
   5. ☐ Other (Specify) _____

1

9. Do you struggle with any section of Mathematical Literacy at school?
If you do, name the sections.
1. ☐ Data Handling   2. ☐ Tariffs
3. ☐ ________

10. If you had a choice, would you revert to learning Mathematics?
1. ☐ Yes   2. ☑ No

Why? because its very hard for me to cope with

11. How would you rate the way you learn at this school?

1. ☐ Very good   2. ☐ Good   3. ☑ Satisfactory

12. How do you rate yourself in Mathematical Literacy?
1. ☐ Good

2. ☑ Satisfactory

3. ☐ Weak

13. How did you perform in Mathematical Literacy in your 2017June Examinations?
1. ☐ Very good   2. ☑ Good   3. ☐ Satisfactory

14. Do you feel that your academic needs are being catered for at school?
1. ☑ Yes   2. ☐ No
Explain: They help by doing the right things helping us in the right way

15. Do you think that your teacher is helpful to you in dealing with your Mathematical Literacy challenges?
1. ☑ Yes   2. ☐ No
Explain: He helps us with the question he shows us how to work the things that we did

16. How has your teacher assisted you in dealing with difficulties you may have experienced?
He comes up to us and helps untill we get the answer right

2

17. Suggest some methods that you would like to be included in the teaching of Mathematical literacy which could help you understand the concepts more effectively.

Also be the work.

18. Are you able to use a computer and the internet whilst doing Mathematical Literacy at school?

1. ☑ Yes 2. ☐ No

Social Life and use of technology.

19. Who assists you with school work outside school?

1. ☑ Parent 2. ☐ Guardian 3. ☐ Friend

4. ☐ Relative 5. ☐ Other (Specify) _____

20. Which language do you usually get academic assistance in?

1. ☐ English 2. ☑ Afrikaans

3. ☑ isiZulu 3. ☐ isiXhosa

5. ☐ Other (Specify) _____

21. Which language do you think in?

1. ☑ English 2. ☑ Afrikaans

3. ☐ isiZulu 3. ☐ isiXhosa

5. ☐ Other (Specify) _____

22. Which language would you prefer to communicate in the Mathematical Literacy class?

1. ☑ English 2. ☐ Afrikaans

3. ☐ isiZulu 4. ☐ isiXhosa

5. ☐ Other (Specify) _____

23. Do you have access to a computer and internet when doing Mathematical Literacy homework?

1. ☐ Yes 2. ☑ No

24. What do you want to do after you finish high school?

1. ☑ Work
2. ☐ Study at a tertiary institution
3. ☐ Work and study part time
4. ☐ Start a business
5. ☐ Unsure

25. Do you think studying Mathematical Literacy will assist you in your tertiarystudies?

1. ☑ Yes
2. ☐ No

Explain how: Yes because it will help me.

Thank you for taking your time to complete this questionnaire.
All the best in your future endeavours.

Appendix E

LEARNER QUESTIONNAIRE NUMBER 1

THIS QUESTIONNNAIRE IS TO BE COMPLETED BY MATHEMATICAL LITERACY LEARNERS IN THE SCHOOL PARTICIPATING IN THIS RESEARCH FOR THE PURPOSES OF DATA COLLECTION. ALL INFORMATION DISCLOSED IN THIS QUESTIONNNAIRE IS TREATED WITH THE STRICTEST CONFIDENTIALITY AND WILL BE USED FOR RESEARCH PURPOSES ONLY.
YOUR CONTRIBUTION IS IMPORTANT.
PLEASE TICK THE APPROPRIATE BLOCK, WHERE APPLICABLE.
THANK YOU

Biographical Information

1. How old are you?
   1. ☐ 15 yrs 2. ☐ 16 yrs. 3. ☑ 17 yrs. 4. ☐ over 17yrs
2. Gender.
   1. ☐ Male 2. ☑ Female
3. What language/s do you speak at home? Isizulu
4. Have you ever repeated a grade in high school?
   1. ☐ Yes 2. ☑ No

Personal Experiences

Education

5. When did you enrol at your present school?
   Year: 2015
   Gr. : 8
6. Did you attend any other Secondary School?
   1. ☐ Yes 2. ☑ No
7. When did you decide to do Mathematical Literacy?
   State grade: 9
8. What prompted your decision to do Mathematical Literacy?
   1. ☑ Self
   2. ☐ Parent
   3. ☐ Teacher
   4. ☐ Found Mathematics a challenge
   5. ☐ Other (Specify) _____

1

9. Do you struggle with any section of Mathematical Literacy at school?
If you do, name the sections.
1. ☐ Rounding off 2. ☐ _____
3. ☐ _____

10. If you had a choice, would you revert to learning Mathematics?
1. ☐ Yes 2. ☑ No

Why? Because I am not good for maths

11. How would you rate the way you learn at this school?

1. ☐ Very good 2. ☐ Good 3. ☑ Satisfactory

12. How do you rate yourself in Mathematical Literacy?
1. ☐ Good

2. ☐ Satisfactory

3. ☑ Weak

13. How did you perform in Mathematical Literacy in your 2017June Examinations?
1. ☐ Very good 2. ☐ Good 3. ☑ Satisfactory

14. Do you feel that your academic needs are being catered for at school?
1. ☑ Yes 2. ☐ No
Explain:
Because my maths teacher is doing has best to make me know something better.

15. Do you think that your teacher is helpful to you in dealing with your Mathematical Literacy challenges?
1. ☑ Yes 2. ☐ No
Explain:
He is trying has best to make you know what he is doing in class,

16. How has your teacher assisted you in dealing with difficulties you may have experienced?
He is asking questions tell you to ask when you do know something.

17. Suggest some methods that you would like to be included in the teaching of Mathematical literacy which could help you understand the concepts more effectively.
Give us papers make us understand.

18. Are you able to use a computer and the internet whilst doing Mathematical Literacy at school?
1. ☑ Yes 2. ☐ No

Social Life and use of technology.

19. Who assists you with school work outside school?
1. ☐ Parent 2. ☐ Guardian 3. ☑ Friend
4. ☐ Relative 5. ☐ Other (Specify) _____

20. Which language do you usually get academic assistance in?
1. ☑ English 2. ☐ Afrikaans
3. ☐ IsiZulu 3. ☐ IsiXhosa
5. ☐ Other (Specify) _____

21. Which language do you think in?
1. ☑ English 2. ☐ Afrikaans
3. ☑ IsiZulu 3. ☐ IsiXhosa
5. ☐ Other (Specify) _____

22. Which language would you prefer to communicate in the Mathematical Literacy class?
1. ☑ English 2. ☐ Afrikaans
3. ☐ IsiZulu ☐ 4. IsiXhosa
5. ☐ Other (Specify) _____

23. Do you have access to a computer and internet when doing Mathematical Literacy homework?
1. ☑ Yes 2. ☑ No

24. What do you want to do after you finish high school?

1. ☐ Work
2. ☐ Study at a tertiary institution
3. ☑ Work and study part time
4. ☐ Start a business
5. ☐ Unsure

25. Do you think studying Mathematical Literacy will assist you in your tertiarystudies?

1. ☐ Yes
2. ☑ No

Explain how:

because if I want a buisnes about making money it will be best

Thank you for taking your time to complete this questionnaire.
All the best in your future endeavours.

Appendix N

Samples of daily reflections sheets

APPENDIX G

DAILY REFLECTION SHEET

Describe your experience of the Mathematical Literacy lesson. Mention ways in which the teaching process can be improved to assist you in future lessons.

Topic: PERIMETER	Date: 24/10/2014 Day: Tuesday
Briefly described the format of today's lesson: MAM EXPLAIN TO US ABOUT PERIMETER, THEN SHE MADE US WATCH A VIDEO, THEN SHE EXPLAIN AGAIN, THEN WHO DID NOT KNOW SHE HELPED THEM WITH THE WORK.	
How do you feel about the work that you were taught today? I FEEL THE LESSON WAS WONDERFUL, I KNOW EVERYTHING.	
How can I improve my teaching method so that it can benefit you? GIVE MORE LESSON.	

APPENDIX G

DAILY REFLECTION SHEET

Describe your experience of the Mathematical Literacy lesson. Mention ways in which the teaching process can be improved to assist you in future lessons.

Topic: Volume	Date: 31/10/2017 Day: Tuesday.
Briefly described the format of today's lesson: Today's lesson was all about volume of shapes.	
How do you feel about the work that you were taught today? I feel a lot more good in working out the volume.	
How can I improve my teaching method so that it can benefit you? put more video clips because videos are much more easier to learn from.	

APPENDIX G

DAILY REFLECTION SHEET

Describe your experience of the Mathematical Literacy lesson. Mention ways in which the teaching process can be improved to assist you in future lessons.

Topic: Perimeter	Date: 24-10-2017 Day: Tuesday
Briefly described the format of today's lesson: Firstly our lesson today was on Perimeter. We watched a video on how to work out Perimeter. Then after mam explained perimeter in an easy way. After that we did examples on our own.	
How do you feel about the work that you were taught today? I feel that I have improved in Perimeter Today and I want to learn more. Todays lesson was explained very well.	
How can I improve my teaching method so that it can benefit you? Give more lessons after school	

APPENDIX G

DAILY REFLECTION SHEET

[redacted]

Describe your experience of the Mathematical Literacy lesson. Mention ways in which the teaching process can be improved to assist you in future lessons.

Topic: Area	Date: 25 October 2017 Day: Wednesday.

Briefly described the format of today's lesson:

It was good, The lesson is helping me in my subject. The teacher showed a video and that also helped.

How do you feel about the work that you were taught today?

I feel happy about the work that was taught today. I feel like I learnt a lot today.

How can I improve my teaching method so that it can benefit you?

There's no need to improve, You teaching really good.

APPENDIX G

DAILY REFLECTION SHEET

Describe your experience of the Mathematical Literacy lesson. Mention ways in which the teaching process can be improved to assist you in future lessons.

Topic: Volume	Date: 31/10/17 Day: TUESDAY
Briefly described the format of today's lesson: It was great and interesting.	
How do you feel about the work that you were taught today? Good and exciting	
How can I improve my teaching method so that it can benefit you? To learn more everyday and have knowledge.	