

Digital storytelling as Mathematics teaching strategy to encourage positive learner engagement in the Foundation Phase

A. Schoonen
21616744

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Supervisor: Prof Lesley Wood
Co-supervisor: Dr Audrey Klopper

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DECLARATION

I, the undersigned, hereby declare that the work contained in this dissertation is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

A handwritten signature in blue ink, appearing to read 'A. M. M.', is written over a horizontal line.

Signature

23 October 2015

Date

PREFACE

What an amazing journey this study have been! It is without a doubt my proudest work and a moment of serenity to be able to submit this study.

I dedicate this study to:

- First and foremost our Lord Jesus, in whom I could find peace and courage to complete this study.
- My darling husband Johan, my parents and family and friends who always motivated me to give my best. I appreciate you more than words can describe!
- Teachers from Lydenburg High School, especially Mrs. Cornelia Nieuwoudt, up until today you are one of my silent motivators in life to NEVER GIVE UP. Thank you for the influence you have in my life.

I would like to extend a special acknowledgement to Prof Lesley Wood and Dr Audrey Klopper who were my supervisors for this study. Thank you for your guidance, patience, support and motivation in the past two years. I learnt so much from you and you helped me acquire academic writing skills. Thank you for all your support and motivation, especially at times when I felt I couldn't carry on, I value your time and effort in guiding me to complete this study.

ABSTRACT

Mathematics is a subject that generally awakens negative feelings in many learners, and even teachers. These negative feelings may be due to how the subject was taught, rather than a dislike of the learning area per se. Since it is important that sufficient learners enter the Science, Technology, Engineering and Mathematics-sector (STEM-sector), this study aimed to address the need for Foundation Phase teachers to use teaching methods that will promote positive learner engagement with Mathematics from an early age. Interactive digital storytelling has proven to be a suitable strategy for encouraging learner engagement.

Guided by the sociocultural theory of learning, the cognitive theory for multimedia learning and the ABC-model of attitudes, I worked collaboratively with purposively selected Foundation Phase teachers in an action research design, to design, implement and evaluate the use of digital stories, produced using a simple app (ComPhone™) that Foundation Phase learners could master.

As per usual in Participatory Action Research (PAR), there were two cycles that were followed to generate data. The first cycle consisted out of the identification and realisation of the challenge that the participant teachers face with the teaching of Mathematics and identifying their own feelings about Mathematics and teaching it to Foundation Phase learners. Cycle two consisted out of planning for action to address the identified issues of cycle one and reflecting on the effectiveness of digital storytelling as teaching method to address the challenges.

Data were generated from taped action learning sets, and classroom observations, as well as from the digital artefacts created in the study. The data was content analysed, using stringent methods to enhance trustworthiness.

The participant teachers identified the *overcrowded syllabus*, *gaps in the grades and learner understanding* and *time allocation* as the major challenges they face with teaching Mathematics. These challenges reported to have a negative influence on their teaching of Mathematics. The collaborative PAR-process also enabled a collegial relationship amongst the participant teachers of this study, which in effect could improve their teaching. Findings of this study indicated that using digital storytelling as Mathematics teaching strategy in the Foundation Phase can enhance positive learner engagement.

This study indicated the importance of factors impacting teachers' teaching strategies towards Mathematics and how these factors can be addressed to make teachers more positive about teaching Mathematics, which subsequently lead to more positive learning experiences for the learners.

Guidelines were determined to help teachers in the future to incorporate digital storytelling into their teaching methods. These guidelines can serve as a tool to help increase digital methods in education to enhance learner engagement in different disciplines nationally and internationally.

Key terms: Positive engagement towards Mathematics, negative attitude towards Mathematics, Foundation Phase, teaching strategies and digital storytelling

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CHAPTER 1

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

During my undergraduate studies for Foundation Phase teaching I observed that many students had a rather negative attitude towards Mathematics and Mathematics pedagogy. This was usually the class least attended, the module that everyone feared the most at examination times, and subsequently the least popular subject. I, in contrast, enjoyed the classes. I saw them as learning opportunities to become a teacher who could equip learners with not only the necessary skills and knowledge to do Mathematics, but also to develop a love for the subject, that would encourage them to pursue the Mathematics, science and technological field as a career path.

In the course of work integrated learning (teaching practice in schools), I discovered that Mathematics in the Foundation Phase is usually a rushed subject early in the morning with limited time spent on explanations of new and allied concepts. Teachers usually start the day off with counting in multiples, doing basic calculations, and unpacking numerators if time allows. Little or no attention is paid to learner understanding of the concepts. I witnessed learners with confused expressions on a daily basis, not to mention manifestations of anxiety such as frustration, avoidance, unwillingness to participate, sweaty palms, paleness, and crying. I came to the conclusion that these learners experienced Mathematics negatively because of the way teachers presented it to them.

I frequently witnessed teachers exhibit similar manifestations of anxiety and negative attitudes towards Mathematics. Anxiety about teaching Mathematics usually stems from teachers' own bad experiences in the Mathematics school classroom which then negatively influence their teaching practices in the subject (Aslan, Ogul & Tas, 2013: 45). Stuart (2000) found that Mathematics anxiety is closely linked to the poor teaching that teachers themselves received when they were students. Teachers who suffer from Mathematics anxiety or have negative feelings towards it are more likely to expose learners to negative Mathematics learning experiences (Hembree, 1990). This implies that Mathematics anxiety is more related to the strategy of teaching rather than content difficulty. Even when teachers have good subject knowledge, it does not necessarily mean that they can teach it well. This indicates that learners are more likely to develop negative attitudes towards Mathematics if the encounters they have with the subject are negative.

Researchers in education and educational psychology have investigated the causes that lead children to develop negative attitudes, and subsequently Mathematics anxiety. One cause that emerges very strongly is the teaching strategies used to present Mathematics (Finlayson,

2014:100) which implies that teacher behaviour contributes to learner attitudes, as Finlayson's research explains. Linking to Finlayson's research, the strategy of teaching Mathematics usually follows a tradition of accuracy, passive learning, timed activities, individualised work, memorisation, rote learning, and getting learners to reach a certain level of systematic performance rather than reaching a certain level of understanding and enjoyment of the subject (Brian, 2012:2; Cates & Rhymer, 2003).

Learners develop feelings of frustration and anxiety towards Mathematics when the subject is presented through the memorisation of facts rather than with the development of skills to comprehend concepts (Willis, 2010: 7); learners' "why" and "how" questions remain unanswered. A loss of interest in and negative attitudes towards the subject develops because the strategies teachers use to answer questions can either encourage or discourage learners to learn more about the subject (Willis, 2010: 9).

This phenomenon intrigued me, and I developed an interest in pursuing further research in this domain since I too, used to hold negative connotations to the specific domain of Mathematics.

1.2 Rationale for the study

I remember an encounter with trigonometry in high school: the educator scolded me because I did not grasp the abstract concept that she briefly explained. I was sent out of the class for misbehaving and from that date never understood a thing about trigonometry. As I think back now, I realise that I did not struggle with trigonometry because I could not understand it but from fear of being scolded again. I started to wonder if I, as an adolescent at that time, felt anxiety towards doing trigonometry, how much worse it must be for a Foundation Phase learner to be made to feel stupid. This led me to the question: if teachers can be more sensitive in the way they present the subject, how different will learner attitudes towards Mathematics be?

Learners in the Foundation Phase age group are more likely to be very curious but they are also very sensitive to negative remarks and critique (Willis, 2010:50). If they experience the Mathematics classroom as a negative space they are more likely to be demotivated and unwilling to participate, leading to the development of negative attitudes and subsequent avoidance of the subject (Mji & Makgato, 2006:256; Ashcraft & Moore, 2009:201). Perry (2004) found that when a teacher who makes the assumption that a student cannot do Mathematics, it impacts on the student negatively, instilling a belief that they cannot perform in the subject. Jackson (2008: 37) highlights that the lack of enjoyment in teaching Mathematics can also be a contributory factor to learners developing anxiety towards the subject.

Willis (2010:6) argues that the main causes of poor performance and participation in Mathematics are linked to both learners and teachers, being a combination of many factors such as learners' low expectations of their own performance in the subject, feeling pressured to excel, inadequate skills to do Mathematics effectively, and fear of making mistakes because teachers scold learners who commit errors. Added to these reasons are ineffective teaching, overcrowded classrooms, inadequate learning and teaching support materials (LTSM), and poorly trained and unmotivated teachers. Learners need to be more involved in the teaching process, and should explain their thoughts orally, practically, and in written format, as the Annual National Assessment Report of 2013 clearly stipulates (Department of Basic Education (DBE), 2014: 10).

It is very perturbing that in the 2013 ANA examination, Grade 9 learners had an adequacy percentage of 14% in Mathematics, while the Foundation Phase measured 60% adequacy (DBE, 2014:3), which is good, but it means that 40% of the fundamental skills are taught to learners in a less effective way. Furthermore, the statistics also showed that in 2013, 59% of Grade 3 learners achieved a mark of 50% and higher for Mathematics, compared to a mere 2% achieving the 50% benchmark in Grade 9. My argument is that learners are not receiving the necessary education fundamental Mathematics skills, hence the 57% difference between learners who passed Mathematics in Grade 3 compared to Grade 9. Although the Foundation Phase had a much higher pass rate, the real problem lies within the Intermediate and Senior Phase (Gr. 4-9). In these grades, learners who have fallen behind in the Foundation Phase will not be able to perform because they do not have the necessary skills and knowledge to do so. From a personal point of view, I argue that the assessment of learners in the Foundation Phase is still very abstract, resulting in the high pass rate of 59% of learners achieving above 50% (DBE, 2014:3), and after the Foundation Phase learners are assessed on abstract thinking-abilities. This transition in thinking and applying skills can be a terror for learners, as argued by Ashcraft & Moore (2009: 203).

Jameson (2010: 48-49) places emphasis on the cyclical nature of negative experiences in Mathematics; learners develop a pre-acquired negative attitude or anxiety. They then encounter poor teaching of the subject which leads to poor performance and increases their frustration, anger, and anxiety towards the subject. All of these factors subsequently lead to avoidance or unwillingness and a lack of interest in participating. These negative feelings and fear towards Mathematics can start as early as Grade 1, but for the purpose of this study I will focus on Grade 3. Sousa (2001:140) stresses that learners who experience Mathematics anxiety still have the capacity to perform well in the subject; they just need to be exposed to positive experiences in Mathematics. This is where teachers' pedagogical skills are critical, especially in the Foundation

Phase. Teachers need to create learning experiences that are positive and will optimise learning, understanding, interaction, and conceptualisation (Forgasz & Leder, 2008:178-179). Having a negative attitude towards Mathematics does not necessarily mean that a person will perform poorly in the subject; it only implies that the person will show symptoms of stress and anxiety when performing mathematical tasks (Maloney, Schaeffer & Beilock, 2013: 119). Ashcraft (2002:182) on the other hand, contrasts the research of Maloney and argues that people who have Mathematics anxiety and a negative attitude towards Mathematics are more likely to achieve poorly because they tend to avoid the subject, fail to learn from lessons what they are supposed to learn, and show disinterest in the subject. I agree with the findings of Maloney *et al.* (2013:119) that having a negative attitude towards Mathematics does not mean you will not perform well in mathematical tasks. However, I also agree with Ashcraft (2002:182) in the sense that feeling negative about Mathematics will lead to avoidance of the subject and consequently avoidance of following a career path in the Science, Technology, Engineering, and Mathematic (STEM) sector.

Ashcraft (2002: 182-183) reports that remedial action plans to reduce Mathematics anxiety and general negative attitudes towards Mathematics have proven to be successful; bringing highly anxious learners to low anxiety levels. These remedial action plans do not involve teaching or practising Mathematics, but were behavioural remedial action plans, aiming to expose learners to more positive encounters with Mathematics. Behavioural remedial action plans, such as the research of Hembree (1990), which involved behavioural therapy to address the fears and anxiety learners have developed towards Mathematics (Ashcraft & Moore, 2009: 203-204), also prove that the experience of more positive encounters in the Mathematics classroom increases performance without adding any extra classes. This study convinced me that learners can perform better in Mathematics once they are given the opportunity to reduce the negative attitudes they have developed towards it.

My understanding of the available body of scholarship on the topic of Mathematics anxiety and negative attitudes which learners develop towards Mathematics, motivated my interest in the manifestation of this phenomenon in Foundation Phase learners. I started researching the effects of this phenomenon on the teaching of Mathematics and how it ultimately influences subject choices learners make later in their school careers. This is an enormous source of concern for South Africa. To be a competitive country in the economic sector we cannot allow Mathematics anxiety, caused by negative experiences in the classroom, to be a barrier in the development of the STEM-sector. Maloney *et al.* (2013:116) emphasises how avoidance of STEM-career paths caused by anxiety and negative feelings towards Mathematics causes students to choose other tertiary options.

According to Jameson (2010:5) Mathematics anxiety is the single greatest reason why relatively few learners choose Mathematics as an area of speciality in tertiary studies, and also stresses that Mathematics anxiety and a negative attitude towards Mathematics is leading to a large gap in the STEM-sector (Willis, 2010:41). In 2011, only 224 635 of South Africa's 496 090 matriculants wrote the National Senior Certificate exam in Mathematics and less than half of them were able to achieve the 30% pass rate for the exam (Jansen, 2012; Parker, 2012). This implies that less than 22.6% of all the matriculants who wrote the exam in 2011 are 30% competent in Mathematics. These statistics are unsettling and constitute a desperate cry for help.

I therefore argue that urgent remedial action plans should be set to motion to change the general negative attitude learners have towards Mathematics, as supported by the relevant research (Willis, 2010). Remedial action plans to prevent the development of negative attitudes towards Mathematics which subsequently lead to Mathematics anxiety should start in the Foundation Phase in order to lay a solid foundation for learners to develop skills and acquire a positive attitude towards this subject. I argue for remedial action plans in the Foundation Phase because this phase is critical; it influences the very basic skills, knowledge, and attitudes learners will foster towards their Mathematics.

Given the harsh socio-economic realities of the majority of parents in this country, expensive behavioural therapy, as advocated by Hembree (1990) is, unfortunately out of reach for most, especially for families living in rural areas with limited or no access to specialised services which are mostly found in urban areas. In order to help reduce negative learner attitude towards the subject in the South African context, especially in the Foundation Phase, teachers need to be assisted to adapt their teaching strategies in such a way that learners are encouraged to engage with and enjoy the subject.

Teachers should ideally learn pedagogical strategies that can be implemented in classrooms in various contexts to improve the teaching of Mathematics to learners in the Foundation Phase. Since research has proven that teachers' approach to presenting Mathematics is one of the main causes of Mathematics anxiety and negative feelings towards the subject (Jameson, 2010: 5; Willis, 2010: 6; Stuart, 2000 and Perry, 2004), I am interested in investigating ways to help teachers to improve their teaching of Mathematics and thus reduce the chance of creating negative learner attitude towards the subject.

A teaching strategy worth exploring is digital storytelling. It is a modern approach to teaching which has been used in the USA since the early 2000s (Bull & Kajder, 2004: 47; Robin, 2008:220). Bull and Kajder (2004: 48) consider digital storytelling a valuable approach to teaching because

it helps struggling readers to learn actively and unlocks learners' potential to express their knowledge. Although the use of technology in education is sometimes criticised, experts argue that using technology in classrooms is far more than just placing a piece of software in the classroom (Robin, 2008:220). Criticism of technology in the classroom includes ineffective use and the lesson becoming more about the use of the technology (through overuse of features) than about using it to improve the instruction (Sorden, 2005: 264). Digital storytelling requires learners and teachers to be actively involved in writing up their own ideas and turning it into videos and narratives, ensuring that the stories and content are suitable for their own context and levels of understanding. This teaching strategy requires a fair amount of thought, but I believe it could be very useful (Bull & Kajder, 2004: 46) in preventing anxiety and negative attitudes towards Mathematics in learners in the Foundation Phase. In addition, the chances are learners will develop a positive attitude towards Mathematics and will be more likely to pursue further studies in this field, thereby helping to reduce the skills gap in the STEM-sector (Science-, Technology-, Engineering- and Mathematics-sector) as previously discussed.

1.3 Problem statement

Taking into account the above argument, there is a need for Foundation Phase pedagogical strategies to be adapted to ensure that young learners will be exposed to positive learning experiences in the Mathematics classroom. This will entail teachers also acknowledging and dealing with their own negative feelings about Mathematics, should it be the case.

The problem investigated in this dissertation, is therefore the following:

How can the use of digital storytelling as teaching strategy in Foundation Phase Mathematics classrooms help to encourage positive learner engagement and learning experiences, starting with changing the attitudes of teachers?

1.4 Purpose of the study and research aims

The purpose of the study was to assist teachers in the Foundation Phase to explore the use of digital storytelling as a means of assisting learners to positively engage in learning in the Mathematics classroom.

The objectives were:

- to establish what Foundation Phase teachers think, feel, and know about teaching Mathematics
- to assist teachers in the development of digital stories to encourage positive engagement with the subject

- to determine teacher perceptions of how effective digital storytelling is in helping learners to engage positively in the Mathematics class, and
- to determine guidelines for the use of digital storytelling in Foundation Phase Mathematics to encourage learner engagement.

1.5 Research questions

A research question guides the sourcing of suitable scholarly resources and the choices made around data generation (Jansen, 2007: 3). A research question is the cornerstone of good research and has the characteristics of being concise, clear, executable, open-ended, elegant, timely, and theoretically rich; has puzzle features; is self-explanatory; and is grammatically correct (Jansen, 2007:3-5).

Based on the above identifications, the following main and secondary research questions were formulated.

1.5.1 Main research question

The main research question which guides this study was:

How can Foundation Phase teachers use digital storytelling as a teaching strategy for Mathematics to create more positive encounters for learners?

This is an exploratory question because it explores the extent and methods of adapting teaching strategies through the use of digital storytelling to create more positive mathematical learning experiences for Foundation Phase learners. Exploratory research questions are used to gain more insight into a certain known phenomenon (Fouché & De Vos, 2005: 106). In this study I explore the effectiveness of digital storytelling by equipping teachers with the necessary skills and aids to create digital stories which can be used as teaching methods for Mathematics in Foundation Phase classrooms.

1.5.2 Secondary research questions

The secondary research questions were:

- 1) What do Foundation Phase teachers think, feel, and know about teaching Mathematics?
- 2) How can digital storytelling be used as a teaching strategy to create more positive learning experiences in the Mathematics classroom?

- 3) How effective did the teachers experience digital storytelling to be, as mathematical teaching strategy in the Foundation Phase classroom?
- 4) What guidelines can be created to help teachers to use digital storytelling in Foundation Phase classrooms?

1.6 Clarification of concepts

The following concepts comprise the focus of this study and are clarified below:

- Positive engagement towards Mathematics
- Negative attitude towards Mathematics
- Foundation Phase
- Teaching strategies
- Digital storytelling

1.6.1 Positive engagement towards Mathematics

Positive engagement towards Mathematics refers to a classroom situation where learners show high rates of engaging and having positive feelings about the learning activities. Ideally, it is a classroom where instruction is effective and encouraging. Learners depict such instruction and classroom circumstances (Oliver & Reschly, 2007: 4-6), as characterised by:

- learning material that is educationally relevant
- good planning and lessons on the level of the learners' understanding
- lessons that are logically and sequentially organised
- activities that give learners the opportunity to respond to theoretical tasks and observe learning from each other
- practical tasks done under the guidance of a facilitator, and
- immediate feedback and correction/guidance in errors.

Where learners do not experience engaging environments of this nature, it is inevitable that they will start to distance themselves and avoid engagement (Oliver & Reschly, 2007: 5).

1.6.2 Negative attitude towards Mathematics

Finlayson (2014: 100) describes a person with a negative attitude towards Mathematics as someone who usually refuses to participate in activities, who tends to avoid mathematical encounters, and shows signs of anxiousness towards any operation - even general daily activities regarding Mathematics. Ashcraft & Moore (2009: 1097) support this description and add that this

leads to the development of Mathematics anxiety. Maloney *et al.* (2013:115) argue that Mathematics anxiety is the fear for being embarrassed due to the demand for accuracy.

For the purposes of this study, a negative attitude towards Mathematics refers to all the aspects mentioned above, including the development and manifestations associated with Mathematics anxiety.

1.6.3 Foundation Phase

The Department of Basic Education (2011: 10) defines Foundation Phase as learners in Grades R-3 of the South-African school curriculum. This phase aims to lay the foundational skills and knowledge necessary to advance to the Intermediate Phase. According to the National Qualification Framework (NQF) the Foundation Phase is part of the General Education and Training band (GET). Learners in the Foundation Phase begin their formal education when they enter Grade 1.

1.6.4 Teaching strategies

Teaching strategies are techniques teachers use to facilitate learning and to help learners become independent and strategic in utilising their skills and knowledge. Teaching strategies can help learners to focus their attention, organise information, and monitor and assess learning. Teaching strategies also refer to the structures, systems, procedures, and processes that teachers use in their classrooms (Sarkar, 2009), or ways to communicate ideas (Alsup, 2004: 14), and to instruct.

For the purposes of this study teaching strategies will refer to the preferred methods teachers use to communicate ideas and skills to learners, whether verbal, visual, or tactile.

1.6.5 Digital storytelling

Based on the research of Robin (2008: 222) I developed the following description of digital storytelling for the purposes of this study:

Digital storytelling is a modern approach to incorporate technology in the classroom on various levels of education. It especially supports teachers to overcome some of the challenges in using technology productively in the classroom. It is a teaching strategy where computers are used to gain learners' input on a certain topic. Research is conducted and a script is written. It is the combination of audio, video, and written text to make video clips that tell a story. These clips are then played on a computer, uploaded to the internet, or burned on a DVD.

1.7 Theoretical framework

A theoretical framework is a map or a travel plan (Sinclair, 2007) that guides your study and is the frame of reference you will rely on when you develop a research design. For this particular study, two theories and a model are used.

1.7.1 Cognitive theory of multimedia learning (CTML)

The cognitive theory of multimedia learning (CTML) was first researched and formulated by Richard Mayer in the late 1990s (Mayer & Moreno, 2003: 14). It posits that a person learns and engages better in a learning environment that contains more than one form of media (Mayer & Moreno, 2003: 12; Sorden, 2005: 274). It is based on the assumption that when information is presented in a visual and audible way, the receiver of the information is more likely to respond positively to the information (Sorden, 2005: 278), and to form an understanding of the information more easily than when just one form of media is used.

This theory is paramount in this study because it supports the idea of using a digital platform to create visual images, text, and audio recordings to explain difficult and complex mathematical content.

1.7.2 Sociocultural theory of learning

Lev Vygotsky is one of the most well-known social theorists of all time. He developed the sociocultural learning theory in the early 1960s and since then it has been applied in academic discussions on how humans learn from their social surroundings and what significance scaffolding has on the cognitive development of the mind (Newman & Holzman, 2007: 4). I draw on this theory in my study because it focuses on the zone of proximal development (ZPD), the acquisition of knowledge by means of social interaction, and scaffolding as a way of learning in a constructive way (Ormrod & McDevitt, 2004: 240; Brewer, 2007: 11-14). The ZPD describes what learners can accomplish with support and what they can do independently (Brewer, 2007:12). I argue that, similar to language which is language acquired through social interaction, mathematical concepts can be acquired by using digital storytelling as teaching strategy. Scaffolding can form part of utilising the ZPD and focusing on reducing the gap between what learners can do with support and what they can do independently (Brewer, 2007: 14). I believe that it is in the ZPD that most learners are left behind because they have not yet mastered the knowledge and skills before the next level is introduced, mainly due to poor teaching strategies.

1.7.3 The ABC-model of attitudes

This theory explains how attitudes are formed and changed (Educational Portal, 2013:1):

An attitude object is the phenomenon which elicits certain reactions; in the case of this study, it will be reactions to Mathematics. The reaction can be affective, behavioural, and cognitive in nature.

- **Affective:** This is the emotional reaction towards a certain attitude object. The affective domain usually arises from one's morals, values, or beliefs.
- **Behavioural:** This is the way one acts in response to actual or anticipated exposure to an attitude object. Behavioural reactions can include avoidance and anxiousness.
- **Cognitive:** The cognitive component of the ABC-model of attitudes denotes the thoughts and ideas towards an attitude object. Cognitive reactions may result in affective reactions like frustration which then manifest behaviourally but are rooted in the thoughts one has towards an attitude object.

These reactions are separated for theoretical purposes; in practice they are mutually reciprocal. Many researchers have contributed to the development of this model for a long period of time (Bodur *et al.*, 2000: 17). Some of the constructing ideas of this model have been debated by Fishbein and Middlestadt who argued in the mid-1990s that non-cognitive factors are not linked to the formation of attitude while other researchers such as Breckler, Crites, Fabrigar, Petty, Haugtvedt, Herr, Miniard, Barone and Schwarz argued that an affective domain influences behaviour (Bodur *et al.*, 2000:17). As early as 1975, Fishbein and Azjen reasoned that the cognitive domain of a human will have an effect on behaviour (Bodur *et al.*, 2000: 17).

The reason why I chose this theoretical framework, is because I believe that a teacher's behaviour (teaching strategy and approach to learners) has an influence on a learner's behaviour, affective reaction, and cognition (understanding, willingness to learn, and attitude) towards a subject; in this particular study, Mathematics. I believe this model and theory to be valuable for the study because both focus on teaching learners by taking into account the learning environment plus factors that influence the learning environment.

1.8 Research design

A research design consists of the paradigm informing a study, and the methodology used in the study including participant recruitment, data-generation, and data-analysis strategies (Nieuwenhuis, 2007b: 70).

1.8.1 Paradigm informing the study

The paradigm that informs this study is critical theory which seeks to understand, change, and critique society (De Vos, Schulze & Patel, 2005: 7). This implies that I will not only try to make sense of the problem identified, but will also try to research solutions for the problem, influence

the participants to make epistemological and ontological shifts, and improve their teaching on a practical level. Nieuwenhuis (2007a:61) explains that critical theory is related to radical humanism and radical functionalism, but it is also influenced by critical hermeneutics and structuralism. I make use of the characteristics of critical theory which Nieuwenhuis (2007a: 62) outlines. Its characteristics are the following:

- Social reality is created historically. It is produced and reproduced from one generation to the next. A critical researcher should focus on eliminating the causes of alienation and domination caused by contest, conflict, and contradictions in communities.
- Understanding a particular phenomenon depends on the context in which it is encountered plus our own understanding and interpretation thereof.
- The perspectives, world-views, values, and intelligence of a community should be disclosed and critiqued by the researcher.
- Critical theorists aim to raise awareness of people's specific needs and challenges. The needs (of Foundation Phase teachers using digital storytelling as teaching strategy to improve their teaching of Mathematics) will be identified by exploring, trying to make sense of, and interpreting the strategies they choose.

The above characteristics are discussed in more detail in Chapter 4.

1.8.2 Qualitative research approach

As is usual in participatory action research (PAR) designs, I followed a qualitative approach in the data-generation and analysis. Qualitative research is based on the principle that words instead of numbers carry meaning (Nieuwenhuis, 2007a:47). This implies that for a qualitative researcher finding meaning in words is more valuable than numerical and statistical data. Using qualitative research for this study is suitable because it enabled me to gain a deeper understanding and get to the root of the problem, namely the teaching strategies that are required to develop a positive attitude towards Mathematics in Foundation Phase learners.

1.8.3 Methodology: participatory action research (PAR) design

The design that led this research is participatory action research (PAR); a research design in the social sciences which aim to generate social transformation. It is grounded in liberation theology and a neo-Marxist approach that enables community development; it is also embedded in the liberal origins of human rights activism (Kemmis & McTaggart, 2007: 273). This implies that social transformation is one of the outputs that participatory research aims to generate. Strydom (2005: 59) reports that the researcher and participants join forces in PAR in order to find a solution for a specific problem which a community faces. Nieuwenhuis (2007b:74) describes this type of

research collaborative and participatory; conducted to enable the researcher to seek practical solutions for practical problems.

Kemmis and McTaggart (2007:274-275) describe the attributes of participatory action research as:

- a sense of shared ownership between the researcher and community that is part of the research
- collaborative data generation and analysis to improve the identified problem, and
- taking action to improve the situation.

Participatory action research is furthermore my design of choice because it focuses on the relationship between social and educational theory in practice rather than just being a research technique (Strydom, 2005: 59). As researcher I was part of the process for change with the Foundation Phase teachers, through inquiring into and exploring via digital storytelling in the classroom how to improve the teaching of Mathematics to young learners.

Action research is a cyclical process of planning, implementing, and reflecting (Ebersöhn, Eloff & Ferreira, 2007: 125). Strydom (2005: 57) emphasises the importance of collaboration between the researcher and the participants to create practical emancipatory changes in a community. This implies that through this research the community could generate theory to overcome their challenges by means of cost-effective and feasible remedial action plans.

1.8.4 Research methods

A PAR study is an empirical study that makes use of primary data-generation. It is focused on the participants and their world-views and is inductive in nature (Mouton, 2013:150-151). For this reason, the data-generation, data-analysis and participant recruitment discussed in the sections below, were carefully considered.

1.8.5 Participant recruitment

Qualitative studies are usually embedded in non-probable and purposeful sampling (Nieuwenhuis, 2007b:79). In this study I made use of purposeful sampling and selected the participants because they had the necessary knowledge for me to gather appropriate data (Nieuwenhuis, 2007b: 79).

The criteria established to help me identify suitable participants for the study were that the participants had to be Grade 3 Foundation Phase teachers with a minimum of five years teaching experience. Participants from a public school in a town in the North-West province were selected.

To ensure an energetic and collaborative research process, a relationship with the participants was established before the field work was undertaken. To establish the relationship, I met the teachers in an environment removed from their school context.

Besides the abovementioned criteria, additional aspects were considered when I selected the school. They were: the geographical location of the school, the academic and extramural programme of the school, the time and availability of the teachers, and the need for remedial action plan at the school. More detail regarding this is discussed in Chapter 4.

I invited the Grade 2 and 3 teachers to participate in the research; a total of five teachers, two Grade 2 teachers and three Grade 3 teachers. The principal was keen to support the study.

1.8.6 Data-generation

Qualitative data-generation and data-analysis is described as a circular and simultaneous process (Nieuwenhuis, 2007b: 81-82). Action research entails continual cycles of planning, action, and evaluation, since one cycle informs the next (Ebersöhn, Eloff & Ferreira, 2007: 128).

For this study transcriptions (Annexure D) of audio taped meetings with the teachers in the form of an action learning set, was the main tool for data generation. Action learning sets are regular and planned gatherings between small groups of people whose goal it is to work together to discuss challenges and find solutions to the challenges (Wood & Zuber-Skerritt, 2013: 8). Reflecting on the problem or challenges is a very important aspect of action learning sets. Garret (2012: 33) argues that the value of action learning is that the researcher becomes part of the research and learns with the participants. Participants are enabled to share their perceptions, ideas, concerns, and experiences in a safe and secure environment facilitated by the researcher. The researcher negotiates the topic of the discussion and facilitates it. Draw-and-talk was also used as a data-generation method in this study. This is a visual method to acquire data and emphasises the value of drawing and explaining one's own drawings (Theron, Mitchell, Smith, & Stuart, 2011: 19). The participants are encouraged to talk about the meaning of their drawings while they are drawing it, to explain the contexts, and to use colour and method in their drawings (Theron *et al.*, 2011: 19). The researcher analyses the drawings and explanations collected from the participants (Theron *et al.*, 2011: 20). The participants were made aware that it is not the quality of the drawings that is important, but the message it conveys (Theron *et al.*, 2011: 24).

Storyboards are a component of digital storytelling and this data-generation method was used by the teachers in their classrooms and in the action learning sets. Ridley and Rogers (2010:7)

defines storyboards as visual materials used to communicate ideas. It has exceptional value for subjects in the STEM-sector (Ridley & Rogers, 2010:6).

Field notes, as generation technique, were part of this study. The process of making field notes is described as witnessing what happens at a research site and writing down what you see (Wolfinger, 2002: 85). I kept a reflective journal of critical notes about my experience and what I observed during and after meetings with the participants. According to Jasper (2005: 244), reflective journals are a common data-generation method used amongst critical researchers.

For this study, the data-generation comprised a two-cycle process. These cycles are briefly discussed below.

Cycle 1: I performed a desktop study of teaching strategies involving digital storytelling and how to design these media tools for Foundation Phase Mathematics lessons. I formed an action learning set with teachers to help them reflect on the perceptions they have about Mathematics, about teaching Mathematics, and about the teaching strategies which they believe contribute towards the general negative attitudes learners develop towards Mathematics. Draw-and-talk was used to gather the insights of the participants as well as transcriptions of the action learning sets in the form of discussions amongst the participants and myself. The participants and I kept reflective diaries at this point of the data-generation which assisted in documenting their experiences as they happened, and categorising critical thoughts of the events that took place.

Cycle 2: During this cycle the data generated in cycle one was used to plan how the teachers could use digital stories in the classroom. The participants and I designed these remedial action plans in a collaborative way. The next step was the implementation of the remedial action plans in their classrooms. Storyboards were used by the participants and the researcher. The teachers were encouraged to make field notes or take videos of the changes they witness in learners' attitudes towards Mathematics. The field notes and videos of the participants and discussions were used as methods to evaluate the strategy we wanted to implement to aim to address the challenge we identified.

The cycles and methods followed is discussed in more detail in Chapter 4 of, the above being an overview.

All the meetings with the participants were recorded with a recording device and transcribed for the data-analysis process that followed. The data collection included notes made during the discussions and draw-and-talk sessions, the participant-teachers' field notes, and other

documents they gathered in the classroom. The recordings and notes were used with the participants' consent (Annexure C).

I made use of electronic back-ups on Google Drive and on my laptop to store the data. To ensure the safety of the data, my laptop and the Google Drive-account are password protected; I can choose with whom I share the information, with controlled restrictions. For safe-keeping, a hard copy of the transcriptions are kept in a sealed box, together with the consent forms of the participants, all original notes, and verbatim recordings of the data.

1.8.7 Data-analysis

De Vos, *et al.* (2005: 333) define data-analysis as a process of sifting through raw data, where the researcher aims to identify significant patterns and to construct a framework of what the data reveals. It also entails bringing order, structure, and meaning to the data gathered.

For this study I made use of content analysis. Content analysis is an inductive process where the researcher makes a comparison of the data generated (Nieuwenhuis, 2007c: 101-102). The aim of this type of analysis is to generate findings that are based on the participants' insights, knowledge, attitudes, standards, sentiments, and capabilities (Nieuwenhuis, 2007c: 99).

Strydom (2005:62) argues that the aim of data-analysis of group discussions is to "identify trends and patterns that reappear..." in these discussions. Themes are derived from the trends and from the themes, findings are made

Due to the active role I had in this PAR-study, I was aware of the influence my own bias may have had on the study (Nieuwenhuis, 2007b: 79). Qualitative researchers have pre-determined views of the topics they are researching (Lichtman, 2013:21), hence the motivation for doing the research in the first place. Bracketing can be used as a method to control bias (Lichtman, 2013:22). This is when a researcher writes their own thoughts in brackets alongside the thoughts of the other participants (Lichtman, 2013:321) and I did this during data analysis, as well as by means of my reflective journal.

The coding of the data is an important aspect of analysis. Nieuwenhuis (2007c:105) defines coding as the process where transcriptions are critically read and then divided into meaningful segments. This entails that data with similarities are grouped into themes. Once the themes are identified, colour-coding is used to distinguish between the themes in the transcripts. To help prevent researcher bias, I consulted independent coders to assist in the analysis of the data and checked the findings with the participants.

1.9 Quality criteria (trustworthiness)

Aspects relevant to this study for measuring the trustworthiness of participatory action research suggested by Creswell (2005) as referenced by Ebersöhn, Eloff and Ferreira (2007:133-134) are: credibility, transferability, dependability and conformability.

These aspects are discussed in more detail in Chapter 4 of this study.

1.10 Ethical considerations

Ethics are defined as the rules or standards predetermining the proper conduct of participants in a profession (O'Neill & Norris, 2006: 184). Moral misconduct is a measure of ethics that could lead to the researcher being guilty of illegal misconduct. Falsifying results or data, and fragmented reporting are ways of acting morally unprofessional when doing research (O'Neill & Norris, 2006: 184).

1.11 Chapter summary

In this chapter the background and rationale for this study was discussed. The study was introduced by my personal negative experience with Mathematics teaching when I was in school and how that affected my own beliefs to do Mathematics.

The implications of learners' developing negative feelings towards Mathematics, like avoidance, math anxiety, the shortage of students entering STEM-career paths and the implications for the national and international STEM-sector were discussed.

International scholars' remedial action plans were presented and motivated why it won't work in the South-African context. The need and ideas for remedial action plans to suit our socio-economic circumstances were discussed. This provided an overview and rationale for the study. This discussion led to the formation of the research question and research aims for this study. It was justified in this chapter. To provide clarity in terms of this study, I also clarified the concepts of this study to ensure that the reader can interpret the statements with more ease.

Theories that underpinned this study and the methodology followed in this study were briefly discussed and why it is suitable for this study. The ethical considerations and measures for trustworthiness were also set out in this chapter. In the next chapter of the theoretical framework that underpinned this study will be discussed in detail.

CHAPTER 2

A CRITICAL DISCUSSION OF THE MAJOR THEORIES AND MODELS UNDERPINNING THIS STUDY

2.1 Introduction

According to Boote and Beile (2005:7) a good body of scholarship contains coverage, synthesis, methodology, relevance, and rhetoric. A body of scholarship should be more than just a list of the available literature on the topic; it should be a critical discussion, comparing and justifying current literature to the research question of the study. Chapters 2 and 3 of this dissertation will cover the body of scholarship, starting off with placing the study in a theoretical framework.

In this chapter I critically discuss the sociocultural theory of learning, the cognitive theory of multimedia learning (CTML), and the ABC-model of attitudes. The purpose of a theoretical framework is to force the researcher to think about their data before starting field work, and to motivate for certain theories which are important for the study (de Vos *et al.*, 2005: 203). I discuss the relevance of each theory and how it can be drawn on to help me to make sense of the knowledge which emerged from the empirical investigation.

2.2 Sociocultural theory of learning

Learning is the construction of knowledge and skills within social contexts, as Vygotsky claimed in 1978 (Brewer, 2007). He believed that learning cannot be separated from the social structures of humans and that learning leads to the development of various cognitive skills (Chaiklin, 2004; Brewer, 2007). According to Vygotsky learners are active participants in their own learning, constructing learning experiences from the environment, rather than being passive recipients of information. The term scaffolding has become synonymous with Vygotsky's sociocultural theory of learning (Van de Pol, Volman & Beishuizen, 2010: 271). In its simplest form, scaffolding is used to support construction workers when building. When applied to learning, scaffolding refers to the temporary support given to learners in different stages of learning (Van de Pol *et al.*, 2010: 272) implying that great emphasis should be placed on effective social interaction between teacher and learner. This implies that when a person finds him- or herself in a social environment, the things that are said, observed, and experienced become learning experiences, constructs of knowledge, and triggers for concepts that are not yet understood. Thus the interactions between the mediator of knowledge (the teacher) and the learner become an important determinant of what and how learning takes place. Vygotsky averred that the social structure (scaffold) in which young learners finds themselves, influences the way they acquire language and other learning skills (Brewer, 2007:30). This highlights the importance of the role of teachers, parents, classroom

practices, peers and environments in which learners are cognitively developed; learners acquire important skills and knowledge through scaffolding activities. Scaffolding activities include: theoretical explanations by teachers, group activities where learners apply new skills with practical problems such as word problems that can be solved using physical aids and drawing to understand, solving problems by using steps, individual help from a teacher or peers, and many more class activities that can help the learner to visualise, or understand, the problem (Chaiklin, 2004:11). Learners learn together, from each other, with each other, and for each other. The term collaboration is evident in Vygotsky's theory and should be interpreted as interactions between not only learners and a teacher but also between learners and their peers (Chaiklin, 2004: 11).

Vygotsky argued that "intersubjectivity" is paramount in learning (Brewer, 2007:29). It is the process where two or more people are involved in a task and start off with different understandings thereof, but through interaction with one another, come to a shared understanding. Support structures include various stakeholders in the learning experience; these stakeholders can be human, consist of materials, or be the environment learners find themselves in (Brewer, 2007:29). Scaffolding also requires that as the learner becomes more skilled, less help should be offered, assisting the learner in becoming an independent thinker (Brewer, 2007: 30).

Scaffolding and social interaction was evident in the learning experiences that took place in the classrooms of the teachers in this study. The participant-teachers will provide learners with scaffolds by first introducing them to the theoretical concept that is being taught; in groups, learners discussed the theoretical content (social interaction) and then made digital stories to illustrate their interpretation of the theoretical content. During this entire process, the value of social interaction and scaffolding was paramount and learners were enabled to acquire new knowledge and construct it into logical components by participating in and observing their social environment. This social interaction lead to intersubjectivity, as discussed above (Brewer, 2007: 29) and it determined the scaffolding-process and changing role of the teacher in the process of scaffolding (Van de Pol, 2010: 272).

A very important aspect of Vygotsky's theory is the zone of proximal development (ZPD) which indicates the area for optimal learning and development for individuals (Van de Pol *et al.*, 2010: 272; Brewer, 2007: 10; & Chaiklin, 2004: 3). At the lowest level in the illustration below (Figure 1) are the things which learners can accomplish with support from others, and at the top level the cognitive tasks learners can accomplish independently; the area in between is therefore the ZPD (Brewer, 2007:10). In the following figure, the Zone of Proximal Development is represented visually:

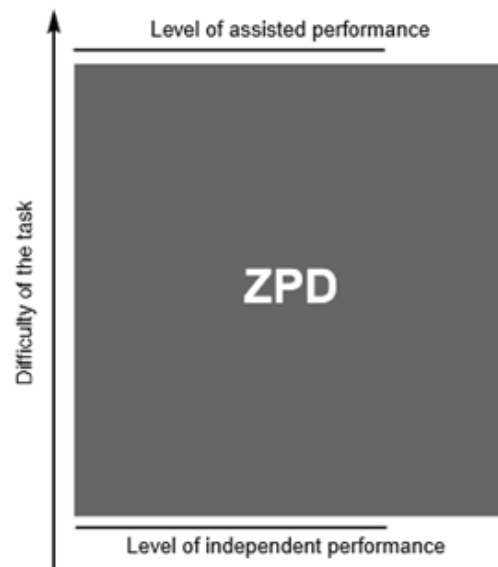


Figure 2-1: The Zone of Proximal Development. (Bodrova & Leong, 1998: 2)

Interpreting the available literature and the content of Figure 2-1, the following illustration is my view of the ZPD; the green area is the area where the teacher/peers should provide scaffolds and social interaction to support learning.

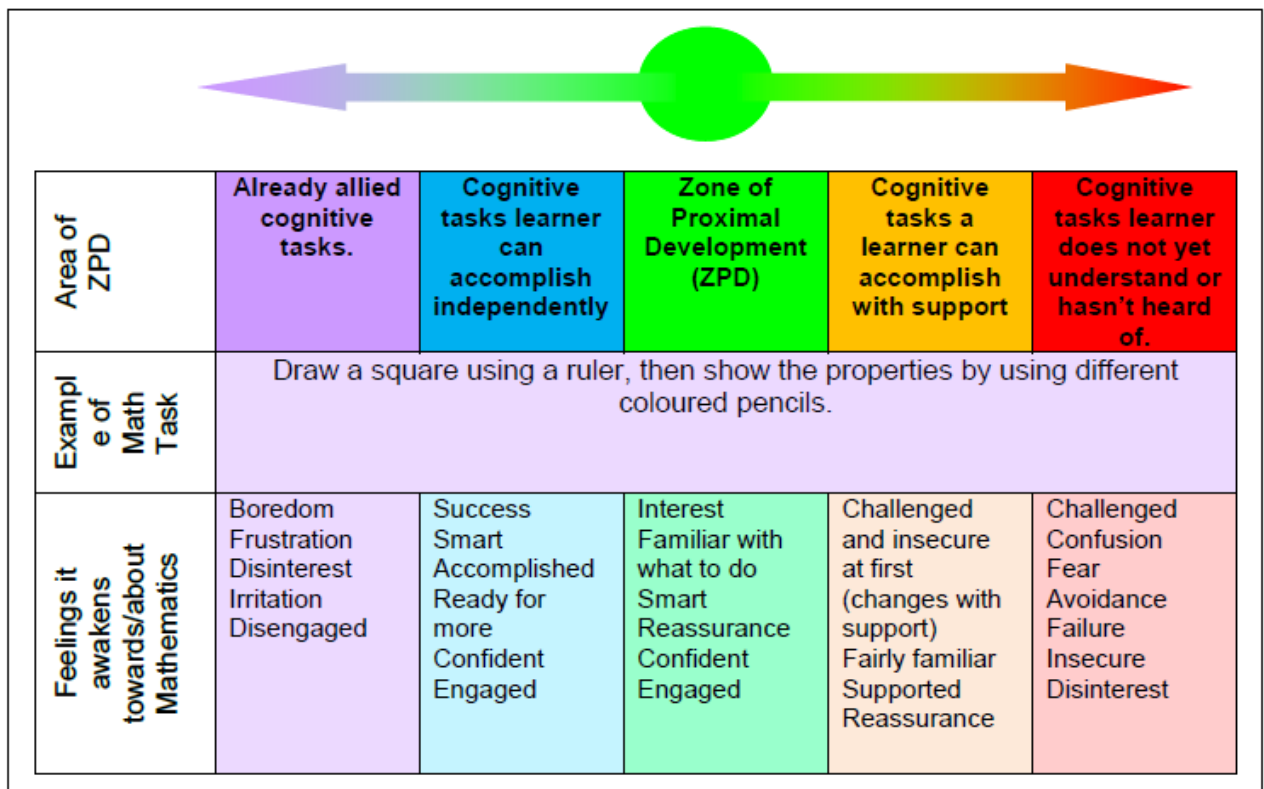


Figure 2-2: My interpretation of the Zone of Proximal Development

The ZPD is an ever-changing area; as soon as learners are able to accomplish a cognitive task without the scaffold of support, their ZPD changes (Brewer, 2007: 10). Each individual has their

own ZPD, influenced by the sociocultural environment in which they find themselves. The feelings learners experience as mentioned in Figure 2, will have a great influence on how they experience Mathematics as a subject. Support at an early stage, like using digital media, can alleviate feelings of being challenged, insecure, confused, afraid, and destined for failure. When learners feel engaged they participate in classroom activities. The danger at the other extreme is that learners already acquired the concepts and may feel bored, frustrated, and disengaged with the teaching, thus becoming uninvolved in classroom activities. Neither of the two extremes will enhance positive learner engagement.

In this study, the ZPD featured as one of the most important guiding aspects. As teachers used scaffolds to guide learners to acquire new skills, the gap between what learners know and can apply with support, closed and became what learners know and can apply independently. Through social interaction and scaffolding as argued above, learners were enabled to construct more concepts and apply newly acquired knowledge more independently, leading to a feeling of success and a positive attitude towards Mathematics.

Critique of the implementation of the ZPD is that in many instances, it is implemented too broadly and that some educators do not do the necessary preparation to expose the learners to well-structured scaffolding activities, thereby diminishing the enhancement of the ZPD (Van de Pol *et al.*, 2010: 272). In this study, the ZPD will be approached by individual teachers in individual classrooms. Learners will work in groups (which are divided into differentiated groups), lending structure to the activities, and the individual attention be provided by participant-teachers to ensure that all learners are supported on their individual levels of understanding and accomplishment.

In the South-African context, the sociocultural theory of learning is embedded in the curriculum, as elements of the theory are discernible in the principles of the Curriculum and Assessment Policy Statement (CAPS) followed in South-African public schools. The principles include progression¹ from grade to grade plus active and critical learning where learners are engaged in the learning environment (Department of Education, 2011: 4). Learning content progresses from grade to grade, relating to scaffolding and the ZPD. Learners themselves progress from grade to grade if they meet the required content criteria and show adequate levels of understanding. Active and critical learning takes place when learners become active in the learning environment, and learn from the social environment rather than being passive recipients of knowledge.

¹Progression: The DBE (2011: 4) defines progression as content and contexts that become more difficult from grade to grade. This implies that content will become more complex, deepening the insight of the specific topic. The other denotation of progression is that certain skills and knowledge must first be met before a learner can advance to a next grade or level of instruction.

Internationally, the ZPD has been accepted as a significant aspect of teaching in various subjects, including Mathematics (Chaiklin, 2004: 1). The importance of teaching children concepts that they can understand and be able to apply, cannot be stressed enough. The content should be appropriate and suitable for the cognitive levels of the learners. Jean Piaget specified four stages of cognitive development, namely sensory-motoric, pre-operational, concrete-operational, and operational (Brewer, 2007:8-29; McDermott & Rakgokong, 2006:5-6). The developmental stages that are applicable for Foundation Phase learners are pre-operational and concrete-operational.

Learners in the pre-operational stage of cognitive development are usually between the ages of two and seven; they observe and learn through sensory activities and find it difficult to absorb and understand abstract ideas. During this stage, learners develop a sense of conservation and acquire language at a rapid tempo (Brewer, 2007: 14-17; McDermott & Rakgokong, 2006:5-6). The fact that learners learn through sensory experiences during this stage is significant for this study because it supports the motivation for digital stories that use images and sound, rather than hearing verbal messages without visual clues.

Learners in the concrete-operational phase of cognitive development, between the ages seven and nine, experience the environment around them in a concrete way. Concrete lessons consist of physical apparatus used as teaching aids to increase the understanding of content. This also implies practical real-life application of content, as for example using measuring cups to explain to learners that 500ml is half a litre. Learners use a logical way of reasoning and a concrete frame of reference to do so. The conservation of length, time, volume, and area develop during this stage, making it critical for these concepts to be taught with precision in the Foundation Phase. Learners also develop skills for classification during this cognitive stage, implying that they start to see certain characteristics in objects and organising them into categories according to their properties, also a vital mathematical skill. Exposure to digital stories will develop this skill because learners will be able to see the properties as they are explained both verbally and visually, and interpreted when they create their own stories.

There are similarities between Vygotsky's theory and Jean Piaget's theories of cognitive development (Brewer, 2007: 30). These include observation of the environment which contributes to learning, and using one's senses to learn and make sense of the world by interpreting and reasoning what we see, hear, and do. The work of Vygotsky (socio-cultural theory of learning) and Piaget (cognitive stages of development) as discussed above, is combined to form the constructivist or developmentalist theory (Brewer, 2007: 8). This is a method of ensuring that learners in classrooms are exposed to constructive learning experiences by using different forms of media along with teaching, as proposed by the cognitive theory of multimedia learning (CTML) that will be discussed in the next section.

2.3 Cognitive theory of multimedia learning (CTML)

The cognitive theory of multimedia learning was first espoused by Richard Mayer in 1997. Mayer developed this theory based on the assumption of Thomas Edison (1922) that motion pictures would revolutionise education systems (Mayer & Moreno, 2003: 1). According to this theory of learning, the working memory of the brain has visual and audio channels and learning is enhanced when both of these channels are simultaneously activated (Mayer & Moreno, 2003: 14; Sorden, 2005: 271; Clark & Feldon, 2005: 12). In Figure 2, the working memory and other channels of the brain involved in learning are explained:

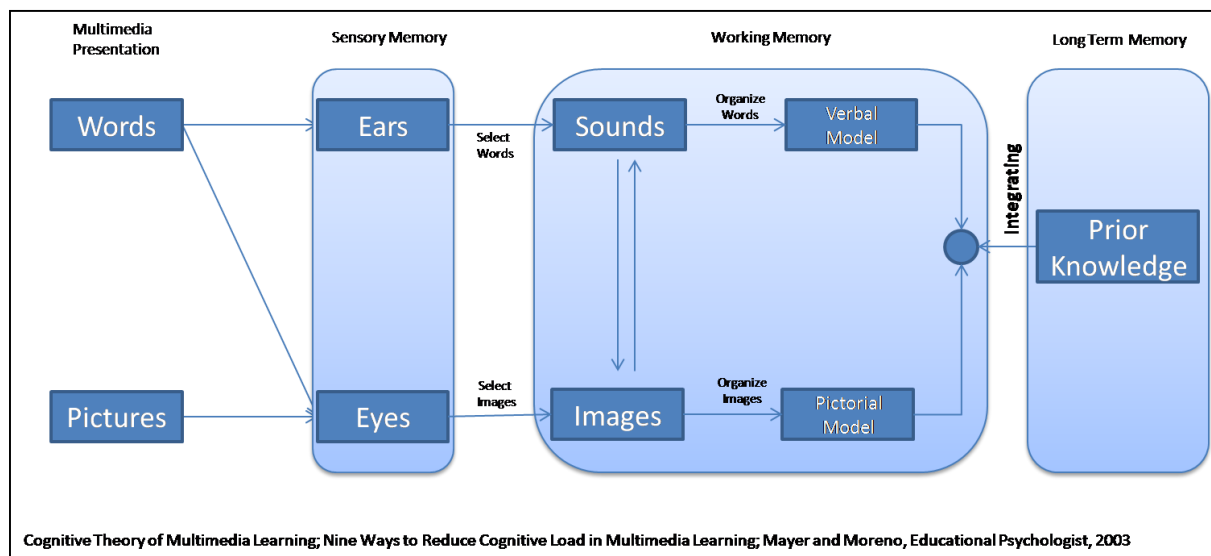


Figure 2-3: Cognitive Theory of Multimedia Learning (Mayer & Moreno, 2003: 44)

Starting from the left side, multimedia presentations include words and pictures; it is the way in which learners or receivers of knowledge acquire information (Mayer & Moreno, 2003: 44). The sensory memory (in this case the ears and eyes) transfers information to the working memory, which consists of images (visual) and sound (audio) channels. Learners organise the newly acquired information as they interpret it and from the working memory the information is stored in the long term memory where it is integrated with existing knowledge. When learners receive information while both channels are active, it reduces the cognitive load for both channels and learning becomes more effective. (Mayer and Moreno, 2003: 44-45). To reduce cognitive overload from images and audio channels, Mayer and Moreno (2003: 46) argue that the word-channel is better utilised when words are received in narrated form together with pictures.

The use of multimedia in learning induces three very important cognitive processes, namely, selecting, organising, and integrating (Mayer & Moreno, 2003: 3, Mayer & Moreno, 2003: 44) as seen in Figure 2. Selecting implies a process of manipulating visual and verbal messages, organising explains the verbal and visual messages and integrating refers to the ability to make

connections between verbal and visual messages and prior knowledge (Mayer & Moreno, 2003: 3-4).

What this implies for using digital stories is that the stories should contain pictures, words, and a textual narrative. Learners who watch the stories and hear the narrative will have a greater chance of experiencing successful learning. When learners select images to illustrate their thoughts, and write a narrative of the meaning of the images, they are busy selecting and organising their ideas. Integration takes place when they start to make connections with prior knowledge about the specific topic, for example when learning the properties of shapes, the new content might identify the properties while prior knowledge refers to knowing what a square looks like, recalling an image, and making a connection between the words (name of shape) and picture (how it looks).

Over the past two decades Mayer has identified several principles for his theory, resulting in the publication in 2011 of the following twelve (Sorden, 2012:8-9 & Sorden, 2005: 272-274). These principles are divided into the three types of cognitive load as identified by Mayer (2009: 57). Cognitive load can be explained as the way learners' cognitive resources focus during a learning or problem solving experience (Sorden, 2005:265).

Type of cognitive load	Principle of the CMTL
Reducing extraneous processing: Factors that are not the central focus of the material. It can include presentation methods. These should be minimised as far as possible.	• <i>Signalling Principle:</i> Learning is enhanced when the most significant content is cued to be highlighted with voice techniques. • <i>Redundancy Principle:</i> It is better to show graphics and a narration than graphics, narration and the narrated text along with the narration. • <i>Coherence principle:</i> Using the correct amount of verbal and visual messages is paramount. It should be enough to explain the concept but not too much for the observers to process. • <i>Spatial Contiguity Principle:</i> It is better when, if texts is used, that the words and corresponding text are placed closely to each other. • <i>Temporal contiguity principle:</i> When content is presented the verbal message and visual message should be shown simultaneously, rather than showing one or the other after each other.
Managing essential processing: The nature of the material studied and the knowledge of the learner.	• <i>Segmenting Principal:</i> Learning takes place effectively when the learning pace is controlled by the learners. • <i>Pre-training Principle:</i> If the name sand characteristics of the key components of the content is pre-trained, learning is more effective. • <i>Modality Principle:</i> People learn with more success from narration and graphics than from text and graphics.

Type of cognitive load	Principle of the CMTL
Fostering generative processing: Action of interpreting and organizing information in the learner's working memory	• <i>Personalization Principle:</i> Narrations will be more meaningful with the use of colloquial language rather than formal language. • <i>Voice Principle:</i> The multimedia message (narration) is more successful if a friendly human voice narrates it rather than a computerised voice. • <i>Image Principle:</i> The image of the narration do not necessarily have to be on the screen for learning to be successful, although it would be beneficial if learners do not have prior-knowledge of the topic. • <i>Multimedia principle:</i> This refers to the value of explaining concepts verbally and visually rather than solely with words or pictures.

**Table 2-1: The principles of the cognitive theory of multimedia learning (CTML).
(Adapted from Sorden 2012: 8-9 & Mayer 2009:57)**

The principles of Mayer's theory indicate that learning takes place in an environment where learners are able to interact with the material they study. Using multimedia in the classroom can induce anticipation, motivation, and excitement for learning (Sorden, 2005: 273; Antonietti & Giorgetti, 2006:270). Inducing learner anticipation keeps them interested in the subject, and interest is a motivator for learning. Being motivated also helps learners to conquer initial fears and staying motivated induces excitement and willingness to experiment, which leads to learning. This highlights the value of incorporating multimedia in education. Using digital stories as in this study, learners will feel motivated to learn because they can organise the learning content as they understand it. Learners with new ideas will anticipate their turn to write a story about how they see the content which will induce excitement because they witness via digital media, how their ideas come to life. Using digital stories may increase positive feelings because it assists learners to experience Mathematics in a fun and interactive way.

In this study, I work with teachers in an experiential manner (Kolb, Boyatzis & Mainemelis, 1999: 26) so that they are capacitated to use multimedia in the Mathematics classroom. I modelled with the teachers what I expected them to do in the classroom. To create the digital stories, learners will be divided into groups (social interaction) and make use of tablets with a pre-loaded application installed on it. The application that will be used is ComPhone™ and can be used without internet connection and can record sounds, text, images, or videos (Community Media Toolkit, 2012). The learners will be encouraged to create digital stories by using drawings or photos, voice files or sounds, and text that represents their interpretation of the theoretical content presented to them. These learning experiences will be an application of CTML because the learners will be exposed to multimedia to create, interpret, and apply newly acquired content (Mayer & Moreno, 2003: 3-4). By using this method to teach, anticipation and excitement will be

heightened, creating a fun space for learning that is expressive and in accordance with the ZPD of individual learners (Brewer, 2007: 29; Sorden, 2005: 273; Antonietti & Giorgetti, 2006: 270). Creating and planning this digital stories will also enable learners to organise, select, and integrate learning content into logical groupings of the three cognitive processes that are very important in learning (Mayer & Moreno, 2003:3).

CTML has the following limitations:

- Giving extraneous information causes confusion among learners. Ibrahim (2012: 84) argues that when extraneous information is given as part of a multimedia representation, it can cause confusion among learners because there is the danger that they will use their full capacity of working memory to interpret the extraneous information. Mayer and Moreno (2003: 34) supports this limitation. Educators should be cautious to just add the core content to the multimedia representations; for example when a digital story is made about counting in threes, the properties of each of the multiples are extraneous and should be omitted from the story.
- When the learning material is too complex to explain with multimedia, but cannot be left out for example long division (Ibrahim, 2012:84), the segmentation-principle gives a solution by suggesting that content be divided into smaller segments to be understood.
- Multimedia learning requires costly resources (Klopper, 2008: 169) and this might be a limitation for educators who cannot afford the resources, or for schools who cannot provide educators with the required resources.
- Betrancourt, Dillenbourg and Montarnal (2003:153) also found that a limitation of the CTML is the educators' attitude towards multimedia learning. If educators seem demotivated or uninterested in multimedia, learners' attitudes towards it will also be dulled.
- Another limitation of applying the CTML in the classroom is that it is time-consuming and takes a lot of preparation for the teacher (Sorden, 2012: 14). Contradicting Sorden (2012: 14), Mayer (2004: 5) argues that one of the benefits of CTML is that although it takes time to make the learning materials, it saves time for the educator because the material can be repeated without the educator having to re-teach it; the material can simply be viewed again by the learners.

CTML offers the following advantages:

- All the material is readily available and can be used on more than one occasion without any of the content being omitted (Mayer & Moreno, 2003: 51).
- Educators that apply the CTML in their classroom enjoy the benefit of enhanced learner engagement in teaching and learning experiences because multimedia enables learners to learn visually as well as audibly (Mayer & Moreno, 2003: 47). In South-Africa, CTML has

formed the basis of various programmes introduced into schools and tertiary education institutions in teacher education programmes (Klopper, 2008: 236; Steyn, 2007:11).

- Integrating different types of media in education makes it easier for educators to integrate various types of knowledge and skills (Collins, 2008: 23).
- Multimedia lessons can be presented anywhere as long as the educators and learners have multimedia devices such as tablets, cell phones, pocket projectors, laptops, or computers available to them (Collins, 2008: 25).
- From a personal point of view, CTML-learning material provides space for inclusive education because learners with hearing disabilities can also participate in the lessons where digital stories (as in this study) are used; they can see the images and are able to follow the narrative by reading the text that forms part of the story. Visually impaired learners can listen to the narrative and feel included in the class activity.

From the advantages and limitations of CTML discussed above, it becomes clear that there are certain aspects that need to be considered before lessons are presented using multimedia teaching methods. In this study, the advantages of using CTML overshadow the limitations and making digital stories to enhance learner engagement in Mathematics classes can be beneficial for both the educators and learners. This can lead to a change in attitude towards Mathematics. In the next section the focus is on the ABC-model of attitudes that supports the beneficial use of CTML in the classroom.

2.4 ABC-model of attitudes

The ABC-model of attitudes explains how affect (A), behaviour (B), and cognition (C) influence a person's attitude, and how each of these factors influences the other (Educational Portal, 2013: 1). A person's attitude is an affective, behavioural, cognitive, or combined reaction to an experienced phenomenon (D'Mello & Graesser, 2012: 145). Affective reactions are reactions that can be linked to emotions and feelings, and cognitive reactions are rooted in thoughts and behavioural reactions. Cognition, affect, and behaviour are linked together; for example a cognitive reaction can lead to an affect or feeling, like frustration, that will lead to an irritated behaviour, influencing one's attitude towards a specific phenomenon (D'Mello & Graesser, 2012: 145; Bodur *et al.*, 2000:17).

Learners may have a negative attitude towards Mathematics due to past experiences of failure (cognition), making them feel frustrated or anxious towards the subject (affect), and leading to avoidance (behaviour) of doing Mathematics (Willis, 2010: 32). In this study, using digital storytelling to enhance positive learner engagement in Mathematics, learners may experience the teaching method as fun and interactive (affect), motivating them to participate (behaviour), and

inspiring them to think differently about participating and sharing their thoughts with their peers (cognitive).

In this study, the participant teachers also share their thoughts about their own feelings towards Mathematics, reflecting on past experiences with the subject. During these discussions the teachers reflect on the impact of their own negative or positive experiences with Mathematics may have on the way they teach the subject to learners. For the participant teachers, talking about their feelings (affect) that they have towards Mathematics due to past experiences, might help them discover why they have certain attitudes towards the subject and how these attitudes determines how they think about (cognitive) and teach (behaviour) Mathematics. The teachers will in turn be able to hold such discussions with their learners, thus exposing any negative feelings among the children and allowing them to address it.

2.5 Integrating the theoretical framework of this study with digital storytelling

Each of the theories and the model discussed above will be applied in this study, linking to one another and focusing on the strengths of the theories and model to determine if digital storytelling can be used as a teaching method in the Foundation Phase to enhance positive learner engagement.

In Vygotsky's theory of sociocultural learning and the ZPD, aspects like social interaction and scaffolding stood out as key aspects of this study. The role of social interaction becomes prominent in when learners create their digital stories in groups. When they share their ideas and explain them to each other, they become more confident to share their thoughts in the process of constructing new knowledge, something that would not necessarily have happened in a direct learning experience (Brewer, 2007: 29-30; Van de Pol *et al.*, 2010: 272 & Chaiklin, 2004: 3). Scaffolding will take place throughout the learning experiences.

The sociocultural theory of learning will be integrated with the CTML to be applied when the learners, through social interaction, create the digital stories by interacting with one another to organise, select, and integrate their ideas about the content and their interpretation of the content (Mayer & Moreno, 2003:3). This activity is also linked to scaffolding (Brewer, 2007:29) where support is given to learners to close the gap of the ZPD. D'Mello and Graesser (2012:154) found that the direct method of teaching where content is presented in an environment where learners are passive, discourages learners to feel motivated and challenged (affect), and installs passiveness in their attitudes towards learning. Social interaction (behaviour) is thus very important when learning experiences take place; learners feel motivated (affect) to participate and share their ideas (cognitive). The learning experience is also more effective because learners use

both audio and visual channels for creating and learning new content (Mayer & Moreno, 2003: 14; Sorden, 2005: 271), as in this study.

I therefore argue that applying the sociocultural theory of learning, CTML and the ABC-model of attitudes in using digital storytelling as Foundation Phase Mathematics teaching method, can deliver positive results and positive learner engagement in Mathematics learning experiences.

2.6 Chapter summary

This chapter focused on defining the theoretical framework of the study. I discussed two theories and one model forming the framework, namely the CTML of Richard Mayer and Vygotsky's socio-cultural theory of learning, together with the ABC-model of attitudes. The principles of the theories and model were integrated to describe the framework which convinced me that using digital storytelling in Foundation Phase Mathematics classrooms can indeed enhance positive learner engagement.

In the following chapter the concepts that guided this study will be discussed. What Foundation Phase Mathematics is, how it differs from other subjects, why learners develop fears towards it, what positive learner engagement entails, and what storytelling is, will be discussed and linked to the theoretical framework to form the conceptual framework of the study.

CHAPTER 3

THE CONCEPTUAL FRAMEWORK THAT UNDERPINNED THIS STUDY

3.1 Introduction

Linking to the theoretical framework and how it supports the research question of this study, are the following concepts: Mathematics in the Foundation Phase; the nature of Mathematics and what distinguishes it from other subjects; learners' negative feelings towards Mathematics; making the Mathematics classroom an enjoyable place and how to use stories to accomplish this. These will be critically discussed in the following chapter.

3.2 What is Foundation Phase Mathematics and Foundation Phase Mathematics teaching

From a South-African perspective Davin and van Staden (2005: 133) describe Mathematics in the Early Childhood Education (ECE) years as a hands-on interaction with numbers, shapes, positions, and objects in everyday-life. They argue that Mathematics is not a paper-and-pencil subject and that young learners should experience Mathematics through play and movement (Troutman & Lichtenberg, 2003: 18; Davin & van Staden, 2005: 133).

Harel (2008: 894) defines Mathematics in two parts; firstly as a “union” of the collection of structures that consist of statements, definitions of phenomena, formulas, verifications of calculations, problems, and solutions to problems. The second part of Mathematics is reasoning and “ways of thinking” that lead to solutions to any of the structures mentioned above.

The DBE (2011a: 8) defines Mathematics as a “language” that consists of numbers, notations, and symbols to describe numeric, geometric, and graphic representations and relationships. Emphasis is placed on observing, representing, and investigation patterns in physical and social phenomena (DBE, 2011a: 8). Mathematical learning experiences enhance the development of critical and logical thinking skills.

The definitions provided by Davin and van Staden (2005:111), Harel (2008: 894) and the DBE (2011a: 8) indicate that Mathematics is a way of thinking and reasoning out problems that involves numbers and symbols which are represented in various ways.

I interpreted the above-mentioned references in the literature to my understanding, thus developing the following definition of Foundation Phase Mathematics:

Foundation Phase Mathematics is a subject where young learners are actively involved in learning experiences that develop critical and logical thinking skills about understanding and solving number and symbol problems. It is the process of constructing one's own ideas about numeric, geometric, and graphical relationships through observing, investigating and representing these phenomena.

The Curriculum and Assessment Policy Statement (CAPS) framework for Mathematics in the Foundation Phase, indicates five content areas to be taught at different difficulty levels in the school curriculum Grades R-12 in South-African public schools (DBE, 2011a:18). They are:

- Numbers, Operations and Relationships
- Patterns, Functions and Algebra
- Space and Shape (Geometry)
- Measurement
- Data Handling

The progression of learning content in the different grades of the Foundation Phase is an important aspect to keep in mind. The five content areas remain as they are over the four Foundation Phase grades, but the content becomes more complex in progression from grade to grade. For this study I focused on the content areas that the participating teachers selected according to their planning, to ensure that the school did not deviate from the curriculum as set out in the CAPS-document (DBE, 2011a).

Mathematical teaching in the Foundation Phase entails that teachers will challenge learners by asking them creative questions, plan activities that encourage learners to engage in mathematical learning experiences, allow learners to communicate their reasoning in various ways, see the value in incorrect approaches, guide learners to the correct reasoning and most prominently, expose learners to concrete, kinaesthetic, graphic, and hands-on activities with Mathematics (Davin & van Staden, 2005:135; DBE, 2011:16). This implies that Mathematics teaching in the Foundation Phase is an interactive activity that places emphasis on the learner being actively involved and experiencing content in a very concrete way.

3.3 What makes Mathematics different from other subjects

The definition of Mathematics distinguishes the subject from other subjects itself, “accuracy” and “calculations” that Harel (2008: 894) refers to, already indicates that Mathematics is a different way of thinking from Language that states the obvious. According to Davin and van Staden

(2005:135) “[m]Mathematics is a way of thinking” and “reasoning” which indicates the procedural nature of the subject.

From a personal point of view, I think the abstractness of Mathematics, especially in ECE is what distinguishes Mathematics from other subjects. I am convinced that some learners enjoy the fact that in Mathematics you have ways to test accuracy, whereas in Life Orientation and Art, correctness is determined by the observer’s frame of reference. This can also be a fearful aspect of Mathematics for the individual who does not want to be measured in terms of accuracy.

From a South-African perspective the diagnostic report of the ANA’s of 2013 (DBE, 2014: 9) highlighted that Mathematics is different from other subjects because it contains numbers, symbols, and words, and that learners struggle to keep up with this “mathematical language”, with special mention of the phenomenon in the Foundation Phase.

Mathematics requires people to react by doing calculations based on what they read, varying from easy calculations that are straightforward to complex calculations which require multiple processes.

Troutman and Lichtenberg (2003: 2) argue that Mathematics is universal in the sense that symbols mean the same thing in all languages. Mathematics requires higher order thinking and allows people to approach problem solving in different ways, and requires preferred ways of thinking. This is the reason why Vygotsky’s theory, CMTL, and the ABC-model of Attitudes informs this study; children learn when they are actively involved, use their senses, and make internal connections when theory is explained and illustrated (Troutman & Lichtenberg, 2003: 18).

Researchers have found that STEM-subjects are more difficult than subjects in the non-sciences because subjects in the sciences require constant proof of how and why learners think and reason the way they do (Coe, Searle, Barmby, Jones & Higgins, 2008: 4). Subjects in the STEM-sector require learners to think critically, logically, and abstractly simultaneously, which requires higher order thinking. We have become dependent on doing things correctly and procedurally, knowing we are accurate when we do it, and in Mathematics, although there is only one correct answer, and there are many ways to solve an initial problem. To be dependent on their own thoughts, and getting used to the fact that “there is more than one way to solve this,” causes anxiety in people.

Mathematics is perceived as a very isolated subject and is difficult for teachers to incorporate with other subjects; mathematicians in fact, like to place it in a superior position (Dorier, 2011: 140). This superior position Mathematics is placed in, sends out a message that only an exclusive group of people can grasp and understand it, leading to a lot of preconceived ideas about Mathematics and its level of difficulty.

From a personal point of view, I believe success in Mathematics also depends on a person's ability to visualise. When reading the symbols, a person must visualise the problem.

Curtis (1993: 4) argues that there is no "big picture" to cover Mathematics as a whole; Mathematics is different from other subjects because not every aspect of Mathematics is related to another aspect, some concepts just stand alone. From a Foundation Phase Mathematics point of view, I would like to use the example of fractions to contradict Curtis's argument.

When doing fractions, which has to do with parts of parts, one divides one whole into many equal parts. If, for instance learners do fractions with shapes, at that exact moment, they are using two other content areas namely numbers, operations and relationships and patterns, functions and algebra; together with geometry to solve the fraction equation. I agree with Curtis that "big picture" Mathematics is impossible to visualise, due to the complexity of the subject.

These differences from other subjects make Mathematics a complex and difficult subject for learners who struggle to think in an abstract way which can induce negative feelings, or feelings of failure. In the next section the reason why learners develop negative feelings towards Mathematics will be discussed.

3.4 Why learners develop negative feelings towards Mathematics

Learners who refuse to partake in Mathematic activities or learners who tend to avoid these activities and show anxious behaviours when doing Mathematics or everyday activities involving Mathematics (e.g. calculating the total on a grocery slip), can be described as learners who have developed negative feelings towards Mathematics (Finlayson, 2014: 100) due to the demand for accuracy and fast performance (Maloney *et al.*, 2013:115).

Negative feelings towards Mathematics is a very important issue to address as soon as it is witnessed in learners (Ashcraft, 2002: 84), as it can lead to the development of Mathematics anxiety. Due to the curious natures of Foundation Phase learners, they are willing to experiment, but also very sensitive to negative remarks and critique (Willis, 2010: 50). This means that Foundation Phase learners will try to experiment with mathematical problems because of their curiosity, but educators should be very sensitive with comments because learners are very sensitive and not able to handle criticism very well yet. Learners who experience the Mathematics classroom as a negative space where their attempts are criticised, are more likely to be demotivated and unwilling to participate, leading to the development of negative attitudes towards Mathematics and subsequent avoidance of the subject (Mji & Makgato, 2006: 256; Ashcraft & Moore, 2009: 201). When teachers make assumptions, comment that learners cannot do Mathematics or struggle with it, learners can be influenced negatively and feelings of failure are most likely to be instilled in them (Perry, 2004).

Negative experiences in Mathematics have a cyclical nature once they become manifest (Jameson, 2010: 48-49);, learners who experience negative connotations towards Mathematics can encounter poor teaching of the subject or teaching that is negative towards their feelings towards the subject. This leads to frustration and avoidance of the subject or subsequent development of Mathematics anxiety. Research shows that the lack of educators who enjoy teaching Mathematics can also contribute to why learners develop fear and negative feelings towards Mathematics (Jackson, 2008: 37).

In the TIMMS-report of 2011, learners showed international adequacy in content-knowledge of Mathematics but big problems when they needed to reason and solve problems using the content. This could be because learners find it difficult to trust their own reasoning, because they do not know how to support their reasoning with content, or because they struggle to visualise how the content can be applied in everyday situations. Learners also struggle with geometry and spatial visualisation. Being able to visualise is one of the most important skills involved in Mathematics. Learners who struggle in this regard can easily become lost in the classroom, falling behind in the development of skills and knowledge (Troutman & Lichtenberg, 2003: 23).

Troutman and Lichtenburg (2003: 563) highlight the general assumption in society that some people are born with exceptional mathematical skills and that people who are not born with these skills are not able to perform well. These researchers argue that this general assumption becomes part of the way parents, teachers, and learners themselves talk and think about Mathematics which leads to a negative attitude even before learners get to actually do Mathematics. Pre-acquired ideas about performance are dangerous and teachers, parents, and learners should avoid judging themselves by general assumptions.

The research of Willis (2010: 6) supports all the causes of negative feelings towards Mathematics as argued above, averring that the manifestation of negative feelings and fear towards Mathematics can be linked to both learners and educators. Some of the causes can also be linked to the curriculum, teaching aids, and learning environment as well (Willis, 2010:6). The causes of negative feelings towards Mathematics are summarised in the table below:

Causes of negative feelings and fear towards Mathematics related to learners	Causes of negative feelings and fear towards Mathematics related to educators	Causes of negative feelings and fear towards Mathematics related to other stakeholders
Pre-acquired negative feelings towards Mathematics.	Scolding learners for unsuccessful attempts.	Overcrowded or multi grade classrooms.
Previous negative experience towards Mathematics.	Demotivated to teach Mathematics.	Pressure to perform from parents.

Causes of negative feelings and fear towards Mathematics related to learners	Causes of negative feelings and fear towards Mathematics related to educators	Causes of negative feelings and fear towards Mathematics related to other stakeholders
Inability to visualise theory.	Insufficient planning to accommodate learners who needs more teaching.	Inadequate teaching and learning materials.
Low expectations to perform in the subject.	Impatient and only brief teaching of concepts.	High progression-rate of the curriculum
Fear to make mistakes.	Learners being inactive in classroom	The extent of the accuracy the subject requires.

Table 3-1: Summary of the causes of negative feelings and fear towards Mathematics. (Willis, 2010: 6; Finlayson, 2014: 100; Maloney *et al.*, 2013:115; Ashcraft, 2002: 84; Mji and Makgato, 2006: 256; Perry, 2004; Jameson, 2010: 48-49, Troutman & Lichtenberg, 2003: 563; Jackson, 2008: 37)

It is clear that learners can develop negative feelings towards Mathematics for various reasons and that the causes can be very widespread. Using digital storytelling, as in this study, can contribute to decreasing some of these causes. Digital storytelling will help learners to be active in the classroom, help them to visualise theories and concepts, to think critically about concepts, and to understand the concepts in their own way. In overcrowded classrooms learners will be enabled to learn from one another. In short, digital storytelling is an effective teaching aid and can induce positive attitudes towards learning Mathematics concepts because learners can interpret the concepts according to their understanding.

It is important to remember that learners with negative attitudes towards Mathematics, do not necessarily perform poorly in the subject; it only means that learners will tend to avoid participating in mathematical tasks and show symptoms of stress and anxiety when they do the tasks (Maloney *et al.*, 2013: 119). This implies that learners can have very good mathematical abilities, but due to a past negative experiences, or parents pressuring them to perform, can have negative pre-acquired feelings towards it, resulting in lower achievement in the subject. Ashcraft (2002:182) contrasts this statement by arguing that learners who have negative feelings towards Mathematics are more likely to achieve lower in the subject because they tend to avoid doing Mathematics, resulting in insufficient knowledge and understanding. I think both these researchers have valid arguments. Negative feelings towards Mathematics do not hinder learners' abilities but stop learners from wanting to pursue and enjoying lessons in this subject.

In this study, I aim to achieve the goal of making the Mathematics classroom an enjoyable space for all learners, using digital storytelling that will allow learners to be creative, to interact with each other, to visualise concepts, and to experience the classroom as a more relaxed environment where their thoughts and ideas are appreciated and valued. Changing the environment in which learners learn can change their attitudes, as the ABC-model of attitudes clearly demonstrates,

and a change in attitude can evoke a change in feelings making Mathematics a positive experience for learners.

The abovementioned attitude changes bring me to my next argument, as reported by Ashcraft (2002: 182-183), namely that behavioural remedial action plans are made with the aim to reduce Mathematics anxiety and the general negative attitudes and fears which learners have towards Mathematics. Many remedial action plans have proven to be successful, reducing highly anxious learners to levels of low anxiety. Surprisingly, none of the remedial action plans involve teaching or practising Mathematics concepts; behavioural remedial action plans expose learners to positive experiences with Mathematics.

Positive learning experiences are vital for learners to feel motivated to learn (Troutman & Lichtenberg, 2003: 564). In the next section, positive engagement in the classroom will be discussed.

3.5 Positive engagement in classrooms and making learning enjoyable

Learners in the Foundation Phase are very curious and like to experiment and try to find solutions to problems (Jameson, 2010: 50). This curiosity can become motivations for learning and interacting with learning material. Erikson distinguishes various stages of emotional development as illustrated in Figure 3-1 below.

Stage	Psychosocial Crisis	Basic Virtue	Age
1	Trust vs. mistrust	Hope	Infancy (0 to 1 ½)
2	Autonomy vs. shame	Will	Early Childhood (1 ½ to 3)
3	Initiative vs. guilt	Purpose	Play Age (3 to 5)
4	Industry vs. inferiority	Competency	School Age (5 to 12)
5	Ego identity vs. Role Confusion	Fidelity	Adolescence (12 to 18)
6	Intimacy vs. isolation	Love	Young Adult (18 to 40)
7	Generativity vs. stagnation	Care	Adult hood(40 to 65)
8	Ego integrity vs. despair	Wisdom	Maturity (65+)

Figure 3-1: Erikson's stages of emotional development. (McCleod, 2008).

Learners in the Foundation Phase are in stage four (industry vs. inferiority) where learners define themselves as competent at tasks in relation to their peers. Learners in this stage are very conscious of what their peers think about them and how they interact with their peers, gaining social status (McCleod, 2008; Brewer, 2008: 21). Exposing learners to positive learning experiences which make them feel they can accomplish given tasks is vitally important in this stage of emotional development (Brewer, 2008: 22). Through the use of digital storytelling

learners can interact with their peers and design the content to their own understanding, increasing their feelings of competence. Learners who are not on adequate levels of understanding will also benefit from these activities because interactive learning reduces the risk of the learners embarrassing themselves in individual attempts in front of their peers. This method of learning boosts learner self-confidence and induces feeling of success and positive learning in the Mathematics classroom.

Rob Long (2009:13) highlights the importance of using concrete material in lessons to increase learner understanding and learner engagement in lessons. Educators who provide learners with concrete physical resources will increase learner engagement in the classroom and make them feel part of the lesson because they get to interact with the materials and make internal connections between the content and practical applications. An example of concrete material used in lessons are counters which are typically used in one-to-one correspondence activities. The educator will ask the learners to pack out a number sentence (sum) like $4 + 2 = ?$, and the learners use counters to pack out the number sentence to get to the answer (Troutman & Lichtenberg (2003:226).

Classrooms which are child-centred, as Vygotsky's theory avers, will increase the positive experience of learners in elementary classrooms (Lerkkanen, Kiuru, Pakarinen, Viljaranta, Poikkeus, Rasku-Puttonen, Siekkinen & Nurmi. 2012: 267). This implies that in a classroom where learners feel that learning is about gaining and developing their own knowledge, in a way that they understand it, will create positive connotations to the class. In this study, learners are given the opportunity to experiment with learning content to write stories and choose images that suit their individual understanding and learning tempo. Lerkkanen *et al.* (2012: 267) also stress that classroom activities which are developmentally appropriate is very important to ensure that learners experience classrooms as inviting and safe spaces. In the research of Lerkkanen *et al.* (2012: 275) their findings showed that increasing child-centred activities in elementary Mathematics classrooms induced learner interest in the subject. It goes without saying that during child-centred activities it does not mean that learners will not make any mistakes, but it is a more compassionate system that and mistakes can be corrected without embarrassing individuals or making them anxious about their attempts.

A trio of researchers who focused their study on learner engagement in Mathematics classes, recently found that the intensity and quality of learner engagement in mathematical activities are paramount for learning (Azevedo, diSessa & Sherin, 2012: 270). This implies that educators should ensure that the child-centred activities they select will increase the quality of learning, resulting in learners critically discussing, analysing, and giving meaning to the concepts. To increase the intensity of learner engagement in the activities, educators should assume a largely facilitating role, only helping where help is needed and giving guidance in the structure of the

activities. This description fits well into a framework of learners making digital stories as a teaching method. The learners take control over their own learning, critically discuss and make sense of the content, and take on the responsibility of presenting the learning content, increasing their intensity of their participation, with the educator standing by to provide help and guidance if the need arises.

In summary, learner-centred classrooms make learning a positive experience. Learners need to be enabled to take control over their own learning in order to really achieve success in understanding and knowledge in Foundation Phase Mathematics classrooms. When learners are given the opportunity to incorporate their own creative ideas and thoughts into understanding and interpreting the content, it increases their engagement and makes the learning space a positive area, setting learners at ease for learning. This brings me to the next section, storytelling. Learners' creative ideas and the stories they tell about the learning content is valuable for their own and their fellow learners' learning. This will be discussed in the next section.

3.6 What is storytelling and its use

Storytelling is one of the oldest ways for information to be carried over from one generation to the next. It has been part of human civilisation since prehistoric days. Storytelling is a way for a person to express their thoughts to others by using imaginative expressions (Soares de Lima, Feijó, Barbosa, Furtado, Ciarlini & Pozzer, 2013: 33) and gives a person the opportunity to experience and make sense of the world around them. The value of stories and storytelling should never be undermined (Joubert, Bester & Meyer, 2006: 40). Brand and Donato (2001: 3) as quoted by Joubert *et al.* (2006:40) argue that reading to young children and telling them stories develops their conceptual skills. Thomson (2005: 16) identifies the following values of stories:

- It increases the frame of reference of learners.
- Learners become involved emotionally and this induces social development.
- Learners are exposed to real-life situations.
- Stories stimulate learners' imaginations.
- It is an enjoyable learning experience.
- Stories lend learners the opportunity to think critically.
- Learners acquire evaluation skills.

I agree with these values and in this study, storytelling is presented in a digital way which contributed to the values even more, because learners became active storytellers in presenting their own ideas in digital ways. Soares de Lima *et al.* (2014:33) highlight the importance of drawings or visual representations that assists in storytelling to give meaning to narratives. Joubert *et al.* (2006: 150) support this statement and place emphasis on pictures as cues for

narratives, telling observers what is happening. This notion supports CMTL, as discussed in Chapter 2, people will benefit more from receiving information through visual and audio channels simultaneously. For the purposes of this study, storytelling is done by learners and educators, creating digital stories with a narrative, images, and text that run simultaneously in a short video using the ComPhone™ application.

Digital storytelling is a method of storytelling focused on using digital media to create and view stories. The digital media used in this study were tablets. The learners planned their own stories about learning content in Mathematics, searched for images, and wrote narratives to tell their stories. The educators also made digital stories of their own with the researcher and then modelled how to make digital stories with the learners in their classrooms. These stories from the learners and educators were then used as learning content for specific content areas in Foundation Phase Mathematics.

Digital stories have been used in education for some time now (Robin, 2008: 2) and have delivered very successful results regarding learner engagement and learner participation, subsequently increasing learner performance.

3.7 Chapter summary

Foundation Phase Mathematics is a very complex subject that entails learners to think abstractly, react accurately, and do fast calculations. Mathematics has to do with numbers, shapes, data-handling, calculations, visualisation, measuring and algebra, this makes Mathematics different from other subjects. It is a language on its own, giving the person interpreting it not too much room for error.

Learners develop negative feelings towards Mathematics because of influences from other learners, educators, curriculum demands, learning environments, and social pressure from society, peers, and parents. Changing this through the use of digital storytelling might relieve some of the stressors and make learning Mathematics enjoyable and interactive for learners. Educators should ideally expose learners to child-centred activities in Mathematics such as digital storytelling in this study aims to do, to increase learner involvement and to create positive experiences in a very demanding curriculum in the Foundation Phase. Digital storytelling as used in this study is of great value for teaching because it stimulates the audio and visual channels of learners, allows them to interact with learning materials, and leaves room for creative development and the understanding of difficult Mathematics concepts. The next chapter focuses on the methodology followed in this study.

CHAPTER 4

THEORETICAL DISCUSSION OF THE RESEARCH DESIGN

4.1 Introduction

As the title of this study suggests, the aim was to explore the use of digital storytelling as teaching method in Foundation Phase Mathematics classrooms to enhance learner engagement. In Chapter 2 I discussed the theoretical framework that underpins the study, and how each of the models or theories structure the study. In Chapter 3 I discussed the conceptual framework, focusing on the nature of Mathematics, how Mathematics is taught in classrooms, why learners develop negative feelings towards Mathematics, and the possible value of digital storytelling to enhance learner engagement in Foundation Phase Mathematics classrooms.

I placed my study in a research design that supports the initial research question which guided this study. A research design is the blueprint of a study (Mouton, 2013:56) and defines how the researcher intends to conduct the enquiry (Mouton, 2013; Nieuwenhuis, 2007b). The choice of a research design is related to the epistemological and ontological paradigms that the researcher ascribes to (Creswell, 2005) and outlines the research methodology and methods (selection of participants, data-generation, and data-analysis) (Mouton, 2013). In this chapter I explain my choice of design as being the most appropriate to answer the research questions that guided this study. Thereafter I discuss the measures I took to ensure trustworthiness, quality, and ethical research.

4.2 Research paradigm

Lichtman (2013: 324) defines a paradigm as the way we see the world. It represents interrelated assumptions about the world leading to a specific philosophy about life and one's role in it. For this study I decided on a critical transformative paradigm which not only aims to understand knowledge, but encourages action for change by finding solutions to the problems in a collaborative way (De Vos, Schulze & Patel, 2005: 7). To emphasise finding solutions to social problems in a community, Lichtman (2013:114) highlights that a study led by critical theory aims to bring change in the social context of a community; it is informed by postmodernist principles of social justice. Lichtman further emphasises that critical theory means knowledge is socially constructed and that different groups hold knowledge differently from others. For this particular study, new knowledge regarding digital storytelling as teaching method for Foundation Phase Mathematics to enhance positive learner engagement was co-created with the participants via them sharing their own experiences of teaching Mathematics, their feelings about Mathematics,

and how using digital storytelling as teaching method has affected the level of learners' engagement in their classrooms.

The characteristics that determine critical theory, as outlined by Nieuwenhuis (2007a: 62) and are applicable to this study are:

Social reality is historically created and reproduced from one generation to the next. A critical researcher focuses on eliminating the causes of domination and alienation that causes conflicts in communities.

In this study, I aimed to eliminate the negative feelings Foundation Phase learners develop towards Mathematics, and to make learner engagement positive through the use of digital storytelling as teaching method. The aim was to at least change one source of Mathematics anxiety and the development of negative feelings towards Mathematics: the teaching methods. Subsequently, experiential learning was encouraged.

The understanding of a particular phenomenon depends on the context in which it is encountered and our own understanding and interpretation that influences it.

I encouraged the participant teachers to explore their own feelings and to learn in an experiential way so that they could use their knowledge to empathise with learners and adapt their teaching accordingly, making their classrooms places where learners feel positive about engaging in the learning process.

The perspectives, world-views, values, and definitions of intelligence of a community should be disclosed and critiqued by the researcher.

Mathematics and other STEM-subjects are typically viewed as the more important and more difficult subjects in society. This perspective was one of the challenging aspects of the study. The teachers themselves held this perspective and it became evident in their teaching that this was part of how they feel towards teaching Mathematics; it is a subject that requires more skills than teaching language and life skills. For this study, we had to go back to the root of this perspective: why does society make assumptions like this? How can we change the way people see Mathematics, and teach Mathematics? In this study I explored the use of digital storytelling as teaching method to reveal a different approach for teachers to teach Mathematics; a teaching method that made them feel excited to teach. Critical theorists aim to raise awareness of specific needs and challenges of people.

This study aimed to identify the need for a critical remedial action plan in Foundation Phase Mathematics classrooms for learners to experience an engaging atmosphere in which they can

participate without fear. The lack of enjoyment can also be due to teaching methods that requires abstract thinking for the concrete-operating brains of young learners. I aimed to address this challenge and find a plausible solutions.

4.3 Participatory Action Research (PAR) Design

As mentioned earlier, the design which I chose for this study is participatory action research (PAR). My reason for choosing this design is because it is embedded in the social sciences and generally aims to generate social transformation in the communities it serves (Nieuwenhuis, 2007b: 74). PAR design originates from human rights activism, liberation theology, and a neo-Marxist approach that ultimately leads to community development (Kemmis & McTaggart, 2007: 273). Researchers conduct PAR studies to investigate real social challenges, to understand the root of the challenges, and to find solutions for the problems by working with people to change the way they think and do things (Powers & Allaman, 2012: 1). Since social transformation was one of the outcomes of the PAR (Strydom, 2005: 67), the teachers and I joined forces to find a solution for a specific problem, namely using digital storytelling as Foundation Phase Mathematics teaching method to encourage positive learner engagement. Nieuwenhuis (2007b: 74) supports this description and adds that practical solutions are tested to resolve a problem when following a PAR design.

Lichtman (2013: 107) reasons that PAR studies aim to empower participants. This links to the attributes typical in PAR studies that Kemmis and McTaggart (2007: 274-275) identify, namely a shared sense of ownership between the researcher and the community involved, collaboration between all parties which leads to data that focuses on improvement of the specific problem, and action taken to improve the particular problem. Zuber-Skerritt (2001: 7) explains that action research in general, and PAR in particular, results in sustainable change because the participants are part of the research process, working together with the researcher to find solutions for the challenges they face.

What distinguishes PAR studies from other designs, is that PAR focuses on the relationships between educational and social theory in practice, rather than just being an instrument of research (Strydom, 2005: 55), implying that the solutions sought must be plausible and must improve the situation faced by the community involved. In this study, I am part of the research process in helping Foundation Phase teachers to talk about their own negative attitudes towards Mathematics and teaching it, as well as in developing digital stories to use as teaching method to enhance learner engagement in Foundation Phase classrooms.

Zuber-Skerritt (2001: 18) stresses that knowledge is created in the action research process by means of conceptualising, critical discussion, and reflecting. This can be seen as the first cycle of a PAR-study, as PAR studies take the form of cyclical processes (Ebersöhn, Eloff & Ferreira, 2007: 125). After the first cycle, comes the implementation of new knowledge, the testing of possible solutions, and reflection on the effectiveness of the solution. During these cycles, the researcher and participants collaborate (Strydom, 2005: 55) to generate theory (reaching the epistemological outcome) to overcome the identified challenge (emancipatory outcome) by means of cost-effective and achievable remedial action plans (the practical outcome). See Figure 4.1 for a diagram of this.

In this study, the participant teachers and I collaborated in critical discussions regarding their own fears, ideas, and perceptions about Mathematics, about teaching Mathematics, and about why learners develop negative attitudes towards Mathematics. The teachers and I formed an action learning set (Wood & Zuber-Skerritt, 2013: 8) which met regularly to critically reflect on our progress and learning.

After we discussed and established the knowledge and attitudes of the teachers about Mathematics, how they teach it, and how they feel about teaching it, we moved on to the action part of the study, namely an inquiry into the use of digital storytelling as teaching method to determine if it could help the educators to enhance learner engagement in the Mathematics classroom.

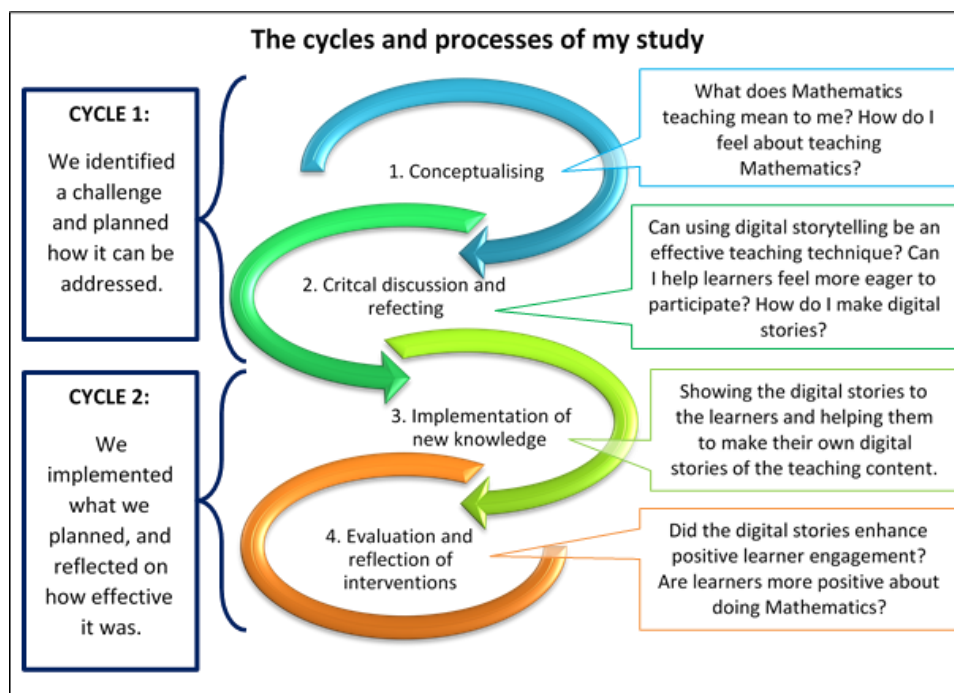


Figure 4-1: The research process of this study.

Strydom (2005:58-61) distinguishes between the advantages and disadvantages of PAR, as argued by various researchers.

Advantages of PAR relevant to this study	Disadvantages of PAR relevant to this study
It is a motivator for participants to take action	It is a time consuming research approach
It is a hands-on approach and is practice orientated	
The process of the research will effect transformation and change that is part of the solution	Sometimes in PAR-studies there can be difficulties in power sharing between the researcher and the participants. The impression might be that the researcher is only there to give information, not for the participants to participate in the research process. In this study, there were no issues regarding power sharing, all the participants collaborated for a shared vision.
The transformations can be self-generating and self-maintaining	
The researcher and community gain valuable knowledge and experiences from PAR	Researchers must be aware that their bias can influence their study. To prevent bias, I used bracketing in the data collection and made use of independent coders.
It is a collaborative approach	
It helps developing countries with their immediate need for change and improvement	
It highlights the bridge between theory and practice; and	The possible negative impact of the researcher removing themselves from the community once the research had been conducted
It contributes to the researcher feeling motivated, encouraged, inspired and rejuvenated.	

Table 4-1: The advantages and disadvantages of PAR relevant to this study. (Bless & Higson-Smith, 2000: 60–61; Cousins & Earl, 1995: 155; Holman, 1987: 681; McNicoll, 1999: 52; Morse, 1997: 288; Van Rooyen, 1998: 80–89; Weyers, 2001: 113; Whyte, 1989: 515; 536–537; 550 as quoted by Strydom, 2005: 58-61; Nieuwenhuis, 2007b:75).

What these advantages and disadvantages imply, is that as the researcher, I had to be careful during the study not to let my bias affect the action learning sets, the results I focused on, and on how I interpreted what the participants said during meetings. The advantages were that all participants in the study (including myself) were assisted in thinking about Mathematics and the negative feelings attached to teaching and doing it, from another perspective. It also helped us to address problems that are unique to the community in which the research took place.

I aimed to minimise the disadvantages listed in the above table by planning the action learning sets (see paragraph 4.4.2) to the minute, to ensure that the time I had with the participants were effectively used. I always went to the school or venue we chose early to set up the equipment beforehand, so that we could start our sessions immediately. Furthermore, to ensure that all the participants felt equal, I introduced myself as a participant, not as a researcher. When we completed data-generation activities, such as draw-and-talk and making digital stories, we completed it in groups and I participated as well. To avoid the disadvantage of me only giving them information, I tried to speak very seldom, only presenting the plan of the action learning set and then moving on to the research activities. Lastly, to ensure that change continues after the data-generation is done, I ensured that the participant teachers knew how to work with the application, and provided them with my contact details so that they can contact me if they need help again. I also asked sponsors to provide the school with tablets and the necessary technology for the video-making process.

From the above discussion, it became clear that I had to perform a qualitative study because statistical data would not have brought change to the community. In the following section I discuss how I placed my study in a qualitative research approach.

4.4 Action research using a qualitative approach

Before I can define the research design of this study, it is important to define the research approach. A researcher can choose between adopting a qualitative, quantitative, or mixed research approach (Nieuwenhuis, 2007b: 70; Mouton, 2013: 55). Qualitative research is defined as an approach that focuses on words and their meaning, understanding and interpreting data (Nieuwenhuis, 2007b: 47; Lichtman, 2013: 5). Quantitative data, in contrast, can be described as research that makes meaning from statistical and scientific analysis of data and from testing hypotheses (Lichtman, 2013: 5). Mixed research is when qualitative and quantitative research methods are combined to perform a study (Lichtman, 2013: 15).

This study is underpinned by qualitative research. Lichtman highlights that qualitative research is very valuable in the social and human sciences because it focuses on giving the research participants a voice, and the researcher then gives meaning to the voice of the participants, interpreting it through his or her own lens (Lichtman, 2013: 9). Lichtman (2013: 11) avers that qualitative research in the social sciences, with a specific focus in education, stems from anthropology, giving answers to questions in a subjective manner.

Qualitative research has certain characteristics, as identified by Lichtman (2013, 14-15), Mouton (2013: 55-57) and Nieuwenhuis (2007b: 50). Each characteristic is discussed and the link to this study is described in the right column of Table 4.-2:

CHARACTERISTIC	LINK TO MY STUDY
Qualitative research has an ontology that has multiple realities.	Each participant came with their own reality about the topic of the study. They shared it from their perspective and the data were analysed from a specific paradigm: critical theory.
The researcher is central to the study and the data is interpreted based on the researchers' experiences and their background.	I, as the researcher, first interpreted the data based on my own experience and background, according to my own and the participant teachers' view of reality. I then checked this with participants
There is no interest in cause and effect or generalising, as in quantitative research.	For this study, the voices of the participant teachers was important, and the aim of the research could in no way be met using statistical data or testing hypothesis.
Learning can be done in various ways.	Various methods to data-generation was used in this study: draw-and-talk, action learning sets, reflective journals and storyboarding.
The aim is for social interactions to be interpreted and understood.	I interpreted the data that was generated from the action learning sets and tried to understand what and why the participant teachers said and felt during our interactions.
Selecting a non-random and smaller sample is very common, the researcher build a relationship with the smaller sample.	The study only had four participants. We worked closely together, the relationship was personal, intimate and voluntary.
There is a strong emphasis on words and visual data as data-generation methods.	The data is dependent on the words and visual interpretations that the participant educators had about using digital storytelling as Foundation Phase Mathematics teaching method.
Themes and coding are very common methods to analyse qualitative data	For this study, the data was analysed by means of content analysis. Themes were identified by the use of coding the transcripts and interpretations of other data that were collected.
The writing style of qualitative studies are very personal and less formal.	During the whole study, I write in the first person, because I'm writing from my point of view, I was part of the research, not just an onlooker.

Table 4-2: Characteristics of qualitative research applicable to this study.

The abovementioned description and characteristics of qualitative research formed the most beneficial approach for this study. The study focused on gaining insight from Foundation Phase educators about how using digital stories in the Mathematics classroom could enhance positive learner engagement.

4.5 Research methods

In the previous sections, this study was defined as a PAR-study informed by a critical paradigm. A PAR-study can be described as an empirical study that makes use of personal data-generation (Mouton, 2013: 150). This implies that as the researcher, I had to carefully consider the data-generation, data-analysis, and participant recruitment for the study to ensure that it correlates with what a PAR-study entails. In the sections that follow, this will be discussed.

4.5.1 Participant recruitment

It is impossible for an entire population to be included in a study (Maree & Pietersen, 2007: 172) and for this reason researchers make use of sampling. Sampling is when a few people of a population are selected to be representative of the entire population (Maree & Pietersen, 2007: 172). There are various ways to select a sample for a study (Nieuwenhuis, 2007b: 79), and for this study purposeful sampling was considered the most suitable method.

When using purposeful sampling, the researcher selects participants because they hold the necessary knowledge for the researcher to gather suitable and rich data (Nieuwenhuis, 2007b: 79). The researcher has to establish criteria according to which the participants are selected to result in the collection of accurate, appropriate, and meaningful data (Maree & Pietersen, 2007: 178).

For this study, the following criteria had to be met in order for a member of the community to be a suitable participant to the study:

- The participants had to be a Grade 2 or Grade 3 Foundation Phase teachers.
- The participants had to have a minimum of three years teaching experience. The reason for this was that teachers who have been teaching for three years are likely to have encountered learners with negative attitudes towards Mathematics.
- The participants had to be educators at a public school in a specific town in the North-West province.
- The participants had to teach at the same school. The reasons for these criteria were that participants would already have established relationships of trust, and that it was convenient.

When choosing the participants, I also took the following aspects into consideration:

- **The geographical location of the school:** The school I chose is within a fifty kilometre radius from my hometown.
- **The academic and extramural programme of the school:** The school does not have an extensive extra-mural time table, thus the study did not strain the extramural-activities hosted by the school.

- **Time and availability of the teachers:** The meetings were held at times suitable to the teachers and our meetings took place at the school, avoiding transportation problems.
- **Need for remedial action plan:** The benefit of the remedial action plan might help learners and teachers who face troublesome socio-economic circumstances; parents or caregivers can also not afford expensive behavioural therapy or extra classes.

Six teachers at this school complied with the criteria: three Grade 2 teachers and three Grade 3 teachers. I invited all six to participate in the research because they could do the planning together, minimising the possibility of interfering with their academic programmes. The more participants, the more insight and knowledge could also be shared and generated. The principal was keen to support the study. In the end one Grade 2 teacher and three Grade 3 teachers participated throughout, making the active participants a total of four. The table below is a summary of the biographic data of the participants.

Participant	Gender	Race	Home Language	Years Teaching Experience	Grade they teach
1	Female	White	Afrikaans	3	2
2	Female	White	Afrikaans	6	3
3	Female	White	Afrikaans	18	3
4	Female	White	Afrikaans	14	3
5	Female	White	Afrikaans	25	2

Table 4-3: Geographical data of participants in study

In order to ensure an energetic and collaborative research process, a relationship was established with the participants before the field work was conducted. The description of this relationship building will be discussed in the following section where the data-generation process that was followed is also investigated.

4.5.2 Data-generation

After I determined how the participants would be selected, it was important to determine what type of data-generation strategies would be suitable for a PAR-study that would be effective for my study. Nieuwenhuis (2007b: 74), emphasises that in action research the data-generation process consists of a variety of data-generation techniques. For this study, I used action learning sets, draw-and-talk, storyboards, field notes, and reflective journals.

4.5.2.1 Action learning sets

Wood and Zuber-Skerritt (2013: 8) define action learning sets as regular and scheduled gatherings of people for a specific purpose; in this case, the participant teachers and I to work together to discuss challenges to collaboratively experiment with possible solutions to the challenges they are facing. This was the main data-generation technique which informed my study. When using action learning sets, it is inevitable that the researcher becomes part of the research, learning together with the participants (Garret 2012: 33). The participants on the other hand are enabled to share their perceptions, ideas, concerns, and experiences in a safe and secure environment facilitated by the researcher. The researcher conveys the topic of the discussion and facilitates it. With PAR-studies, the researcher's participation is not a threat to the data-analysis process because the research is very interactive and the researcher's participation plays an essential role in the research (De Vos *et al.*, 2005: 335). For this study, each action learning set had a specific goal that led me in the preparation for each meeting with the educators, and each session had to be carefully planned due to the availability of the participant teachers.

Table 4-4 summarises the dates the action learning set met and the aim of the specific meeting.

Date of meeting	Aim of meeting
5 September 2014	Introduction, identifying the problem and talking about own feelings towards Mathematics and teaching Foundation Phase Mathematics.
17 November 2014	Introducing digital storytelling as a possible teaching method for Mathematics and familiarising oneself with the tablets and applications to make digital stories.
5 December 2014	Workshop: Planning and producing our own digital stories for Mathematics.
4 February 2015	Reflecting on using digital stories as a teaching strategy as introduction to lessons.
28 July 2015	Exploring with digital storytelling as classroom activity with Grade 2 learners and reflecting on its success.

Table 4-4: Meeting dates of action learning set of this study

4.5.2.2 Draw-and-talk

Another method used during the data-generation was draw-and-talk. Theron *et al.* (2011: 19) define draw-and-talk as a visual method to acquire data. They emphasise the value of drawing, even for adults, in expressing themselves in situations that are hard to put into words. The participants were encouraged to talk about the meaning of their drawings as they were busy drawing it, explaining the contexts, the use of colour, and the method of their drawings (Theron *et al.*, 2011: 19). The value of using draw-and-talk is its contribution to the PAR-design because it does more than just engage participants in research but also allows the researcher to analyse

the data collected from the participants (Theron *et al.*, 2011: 20). What is important to bring to the attention of the participants, is that it is not the quality of their drawing that is important, but the message it conveys (Theron *et al.*, 2011: 24). For this study, the participant teachers drew a picture of how they felt about teaching Foundation Phase Mathematics and afterwards explained to the group what their drawings conveyed. I believe it was a very important exercise because it helped the participant teachers to realise some of their own hidden emotions and explained why they sometimes felt frustrated in teaching Mathematics. This technique was used as part of an action learning set as indicated in Table 4.3 above.

4.5.2.3 Storyboards

In the planning of the digital stories during our action learning sets and in the classrooms, the participant teachers used storyboards. Ridley and Rogers (2010: 7) define storyboards as visual materials used to communicate ideas. They emphasise the value of using storyboards for education in subjects that form part of the STEM-sector (Ridley & Rogers, 2010: 6). In this study the storyboards were helpful to clarify for the participant teachers and learners what to do next, and to make sense of their own ideas. It also helped me because I could observe the method of thinking of the participant teachers.

4.5.2.4 Field notes

To ensure that all the observations and highlights of the action learning sets that were not part of the data-generation techniques were captured, I made use of field notes. The process of making field notes is described as witnessing what happens at a research site and writing down what you see (Wolfinger, 2002: 85). A reflective journal is a data-generation method generally used by critical theorists and is compiled by researchers who make critical notes about what they experience and the things they observe during a study (Jasper, 2005: 244). I make use of a reflective journal during this study. The participant teachers also kept reflective journals of what they witnessed in their classrooms and experiences they had of the study.

The reason why I chose these data-generation methods is because they enabled the participant teachers to interact with one another and share their challenges, successes, and ideas while still having their own voices in the research process, both visually and verbally. It enabled me to make valuable findings from detailed experiences of the teaching strategies that the participants use to teach Mathematics in the Foundation Phase. Using action learning sets, the participants could also give immediate feedback on the strategies they found to reduce negative attitudes which

helped the other participants to gather their own ideas about how they could use the strategies themselves.

All the meetings with the participants was recorded with a recording device and transcribed for the data-analysis process that followed. For storing of the data, I made use of electronic back-ups on Google Drive and on my laptop. To further ensure the safety of the data, my laptop is password protected and the e-mail account linked to the Google Drive account as well. I can choose with whom to share the information and have controlled restrictions. For safe-keeping, a hard copy of the transcriptions will be kept in a sealed box, together with the consent forms of the participants and all the original notes and verbatim recordings of the data.

Figure 4.1 describes the two main cycles of the study. During the data-generation, I used the cycles to guide. The data-generation strategies study led me to consider how they would be used for the findings of the research. In the next section I discuss the data-analysis strategies.

4.5.3 Data-analysis

De Vos (2005: 333) describes data-analysis as a process of sifting through raw data, identifying significant patterns, and constructing a framework of what the data reveals. It also entails bringing order, structure, and meaning to the data gathered. For the purposes of this study, carefully looking at the data through the lens of a critical theorist and understanding and finding possible solutions to the challenges experienced. As the principles of action research suggests, the data was analysed together with the participants to ensure that their voices were not lost. It is very important that participants should give their input in this part of the study (Ebersöhn, Eloff & Ferreira, 2007: 140).

The data-analysis strategy used in this study was content analysis. Content analysis is an inductive process where the researcher investigates differences and similarities in the data generated (Nieuwenhuis, 2007c: 101-102). The main objective of this type of analysis is to generate research findings based on the participants' perceptions, knowledge, attitudes, values, emotions, and experiences (Nieuwenhuis, 2007c: 99).

Strydom (2005: 59) argues that the aim of data-analysis of group discussions is to “identify trends and patterns that reappear...” in the discussions. The trends lead to the themes that come from the focus groups and then lead to the findings. . Action learning set transcripts should also be analysed differently from individual interview transcripts because the researcher has to take the following into account:

“...the words, the context, the internal consistency, frequency of comments, extensiveness of comments, specificity of comments, and what was not said, as well as finding the “big idea”..” (Strydom, 2005: 60).

Due to the active role I played in this PAR-study, I had to be aware of the influence my own bias might have on the study (Nieuwenhuis, 2007b: 79). According to Lichtman (2013:21) qualitative researchers have pre-determined views of the topics they are researching, from whence the motivation for doing the research in the first place. Lichtman suggests bracketing as a method to control bias (Lichtman, 2013:22). Bracketing is when a researcher writes their own thoughts in brackets alongside the thoughts of the other participants (Lichtman, 2013:321) and I used this during the data analysis, as well as in my reflective diary.

The coding of data is an important aspect of analysis. Nieuwenhuis (2007c: 105) defines coding as the process in which transcriptions are critically read and then divided into meaningful segments. This entails that data with similarities becomes grouped into themes. Once the themes in this study were identified, colour-coding was used to make a distinction between the themes in the transcripts. Using independent coder(s) helps to counter researcher bias.

An important aspect I considered when analysing the data, was that the analysis had to reflect on the research question of this study. It was important to answer the research question and not to get deterred while analysing the generated data. Identifying certain themes also helped me to stay on track and to answer the research question of the study. In the following section, aspects of quality and trustworthiness which guided this study and lend credibility to it, will be discussed.

4.6 Quality criteria and trustworthiness

Trustworthiness is a paramount aspect of the research process. Lichtman (2013: 293) describes trustworthiness in PAR studies as transparency. Evaluating what we read is one of the most controversial aspects of trustworthiness in PAR studies as Lichtman (2013:293) points out. This means that I had to be sure from what lens the study would be looked at, and to evaluate the data according to this lens while aiming to control my own bias. To ensure this, I used coding in the study. Nieuwenhuis (2007c: 115-116) suggests that data coding is a way of ensuring that research bias is eliminated. To avoid a tendency to positivistic fuzzy and naturalistic generalisation, the responses of participants were also analysed with consideration of context, consistency, frequency, and specificity of what was said, as suggested by Strydom (2005: 68), the transcriptions of our action learning sets lent this analysis to be carried out.

To further increase the trustworthiness of the study I used the work of Creswell (2005) to measure the trustworthiness in this participatory action research. The aspects relevant to this study and suggested by Creswell are credibility, transferability, dependability, and conformability.

Credibility refers to prolonged engagement in a field, member validation, and controlled bias of the participant researcher. I visited the site on several occasions, validated the data alongside the participants and became a participant in the research. Transferability refers to making detailed and rich descriptions of the setting, the process of data generation, analysis, and the use of bracketing to keep the participants' viewpoints separate from my own. To insure dependability there was a transparent chain of evidence, comprehensive field notes, and all the research partners were present at all the meetings. Lastly, to insure conformability verbatim accounts were made of the meetings between the participant teachers and myself.

I also undertook measures to increase the trustworthiness of the study. Not only should a researcher aim to ensure quality and trustworthiness, but there are ethical guidelines that need to be followed to improve trustworthiness. These considerations will be discussed in the following section.

4.7 Ethical considerations

According to O'Neill and Norris (2006: 184) ethics are defined as the rules or standards governing the proper conduct of the members of a profession. Moral misconduct is a part of ethics that could lead to a researcher being guilty of illegal misconduct as well. Fabricating results, falsifying data, and fragmented reporting are ways of acting immorally and unprofessionally during research (O'Neill & Norris, 2006: 184).

To avoid unethical research in this study, the following ethical considerations, as set out by Maree and Van der Westhuizen (2007: 41-42) were followed:

- Ethical clearance was sought from the Ethics Committee.
- The Department of Basic Education was contacted to seek permission to perform research at the chosen school.
- The participants signed a letter of informed consent to participate in the research, explaining all the details of the research, their roles, and my role in detail. This was presented to the participants at the first meeting and explained to them where necessary.
- The participants' identities were kept anonymous throughout the research process.
- Participation in the research was voluntary and the participants knew that they could withdraw from the process at any time.

These ethical considerations and measures of trustworthiness formed an important part of the study as I aimed to produce findings that are accurate and that I can account for.

4.8 Chapter summary

This chapter discussed the methodology of the study. It described the paradigm that guided this study which is embedded in critical theory, a neo-Marxist paradigm that focuses on understanding the challenges a community face, and collaborating with community members to find possible solutions for these challenges. Critical theory is a very common paradigm in the social sciences.

Next the design was discussed. The study is underpinned by a PAR design; a design for research that focuses on social challenges, exploring sustainable change, and making the members of a community the participants of the study, working together with the researcher to find solutions for the challenges they face. As that name suggests, the research design entails active participation by all stakeholders and taking action in seeking plausible solutions for challenges. .

Very commonly used in the social sciences, I followed a qualitative approach for the study. Qualitative research focuses on giving participants a voice, and understanding the cosmology, ontology, and epistemology of a research problem. It is not merely asking “why” and “how” questions, but aiming to understand them. In this study, I investigated digital storytelling as a Mathematics teaching strategy in Foundation Phase classrooms, through a qualitative lens.

The selection of participants and the criteria for selecting the participants, through purposeful sampling, was next discussed. Four participants comprised the study, and the necessary ethical guidelines namely informed consent, anonymous and voluntary participation, were followed.

Next, the data-generation process was discussed in detail, justifying the significance of the selected techniques. For this study, action learning sets, draw-and-talk, field notes, reflective journals and storyboards were used as data-generation techniques. An outline of the planned sessions was provided. Since the data analysis and data-generation in PAR studies happen simultaneously, due to its cyclical nature, the cycles of this study were also discussed. The first cycle of the study focussed on identifying the challenges the community face and we planned how these challenges could be addressed. Cycle 1 was thus the conceptualising, discussion, and reflecting cycle. Cycle 2 consisted of the implementation and evaluation of the new knowledge gained in Cycle 1. We implemented our plans and remedial action plans and reflected on the success thereof. The challenges the community faced can briefly be described as negative learner attitudes towards Mathematics. We explored the use of digital storytelling as teaching

strategy to enhance positive learner engagement in Foundation Phase Mathematics classrooms as remedial action plan. The next chapter reports on the findings of this remedial action plan.

The data analysis strategy used in this study is content analysis. Themes were identified and verified from the gathered data and transcriptions. To control research bias, bracketing was used as a control measure.

To ensure quality and trustworthiness, credibility, transferability, dependability, and conformability were considered along with the coding of the data. To ensure that the study was ethical seeking permission from the faculty, school, and Department of Basic Education was obtained, the participants gave informed consent to participate in the study, and the identity of all the participants and the school were to be kept anonymous at all times. In the next chapter, the data generated during this study is discussed and analysed.

CHAPTER 5

DISCUSSION OF FINDINGS

5.1 Introduction

In the preceding chapter, the research methodology for this study was critically discussed and justified. I discussed the critical theory philosophy that orientated this study and I discussed how a PAR-approach informed this study. Further, I justified the choice of participants, the generation of data and how the data was analysed to ensure valid findings. The ethical considerations and trustworthiness measures of this study were also discussed.

In this chapter I will critically discuss each of the themes identified by referring to direct quotations from the data, the artefacts generated during the fieldwork and my reflective journal. The data were analysed through the theoretical lenses of this study namely the social-cultural theory of learning, CTML and the ABC model of attitudes as discussed in Chapter 3.

The purpose of the study was to determine how Foundation Phase teachers can use digital storytelling as a teaching strategy to enhance learner engagement in the Mathematics classroom, as the research question that guided this study states:

How can Foundation Phase teachers use digital storytelling as a teaching strategy for Mathematics to create more positive encounters for learners?

The secondary research questions of this study were:

- 1) *What do Foundation Phase teachers think, feel, and know about teaching Mathematics?*
- 2) *How can digital storytelling be used as a teaching strategy to create more positive learning experiences in the Mathematics classroom?*
- 3) *How effective did the teachers experience digital storytelling to be, as mathematical teaching strategy in the Foundation Phase classroom?*
- 4) *What guidelines can be created to help teachers to use digital storytelling in Foundation Phase classrooms?*

To address and answer the research questions, I will discuss the findings according to the two cycles of PAR that guided the data generation of this study. The following figure explains the cycles as previously discussed:

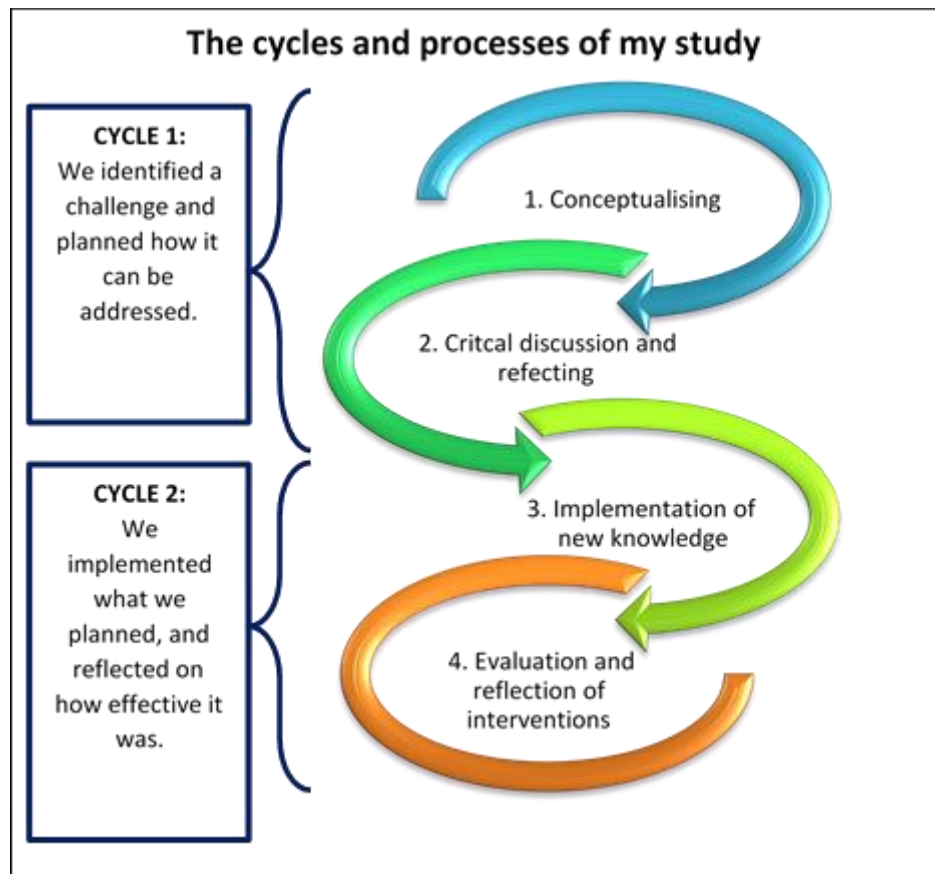


Figure 5-1: PAR cycles that were used to guide the data-generation phase of this study

Figure 5-1 depicts the two PAR cycles that were followed in this study. Cycle one consisted of the identification of the research problem and planning how to overcome the challenges faced and cycle two consisted of the implementation of the remedial action plan and reflection on the results of our remedial action plans.

5.2 Discussion of themes

Five main themes emerged from the data. Each of these themes will be discussed with supporting evidence from the data and then justified with a theoretical underpinning. I will highlight how each theme corresponds to the PAR cycles, to further clarify how the study truly focused on finding a possible solution for the challenges the teachers faced in engaging learners in Mathematics. Table 5-1 illustrates each of the findings and in which cycle of the research it emerged.

Themes that emerged	Cycle of PAR-study
Teachers' feelings and attitudes regarding Mathematics and Mathematics teaching in the Foundation Phase	Cycle 1
Factors impacting on the teaching of Mathematics in the Foundation Phase	Cycle 1
Teachers' experience of digital storytelling as a teaching strategy	Cycle 2
Digital storytelling: promoting active learning	Cycle 2
Challenges and potential barriers teachers are faced with when using digital storytelling as teaching strategy for Mathematics	Cycle 2

Table 5-1: Research themes of this study and PAR-cycle they are linked to.

In the sections to follow, each of the findings will be reported and discussed with relevant evidence and supporting literature.

5.2.1 CYCLE 1: IDENTIFYING THE ISSUES AND NEEDS OF TEACHERS

5.2.1.1 Theme 1: Teachers' feelings and attitudes regarding Mathematics and Mathematics teaching in the Foundation Phase

This theme focuses on the feelings that the participant teachers have towards Mathematics and feelings regarding teaching Foundation Phase Mathematics. The way they feel about the subject and the teaching of it can positively or negatively influence their teaching.

The participants had different feelings about Mathematics as a subject, stemming from their own experiences, as Participant 3 (P3) stated:

"it [Mathematics] became difficult for me in high school when the teacher tried to explain more difficult concepts to us and they were some of the concepts that I just couldn't understand or maybe it is that she didn't explain it well enough to me... It forced me to move from higher-grade Mathematics to standard grade Mathematics..."(P3)

Participant 5 (P5) said that she liked Mathematics and that she

"finds it the same as other subjects like Afrikaans." (P5)

In contrast Participant 2 (P2) thought that

“Maths isn’t straightforward” (P2)

and Participant 1 (P1) said that she

“didn’t like maths but teaching grade 3 maths, that’s not difficult.” (P1)

There were thus mixed feelings and experiences from the participants’ own interaction with Mathematics; some of them did not think of it as anything other than a language with definite rules and one correct way of doing it, but most of them had some sort of negative connotation towards Mathematics. Their own feelings towards Mathematics could have a strong influence on how they present it to learners (Aslan, Ogul & Tas, 2013: 45; Stuart, 2000). Hembree (1990) found that when teachers feel negative or anxious about doing Mathematics, they will most likely expose learners to negative Mathematics learning experiences as well, highlighting the importance of teachers feeling positive about Mathematics even though they may have had negative experiences with it in the past.

It was clear that the participants experienced frustration in teaching Mathematics and with the learners’ reactions to it.

“I feel that there is a lot that is expected from a teacher when teaching Mathematics.” (P2)

“I feel that I must just go on, I can’t get frustrated or angry I must just teach. What can we do, learn they must learn.” (P1)

“I am fine when learners say that they don’t understand what I’m saying, but learners who use the “I don’t know” makes me feel demotivated. When they don’t want to work it makes me angry because they are throwing away opportunities. They really are children who has potential and don’t use it. Take for example a learner in my class, he’s known to be stupid but I really think that he is lazy and not stupid as he has been labelled.” (P5)

Figure 5-2 below illustrates the frustration that P1 felt about teaching Foundation Phase Mathematics:

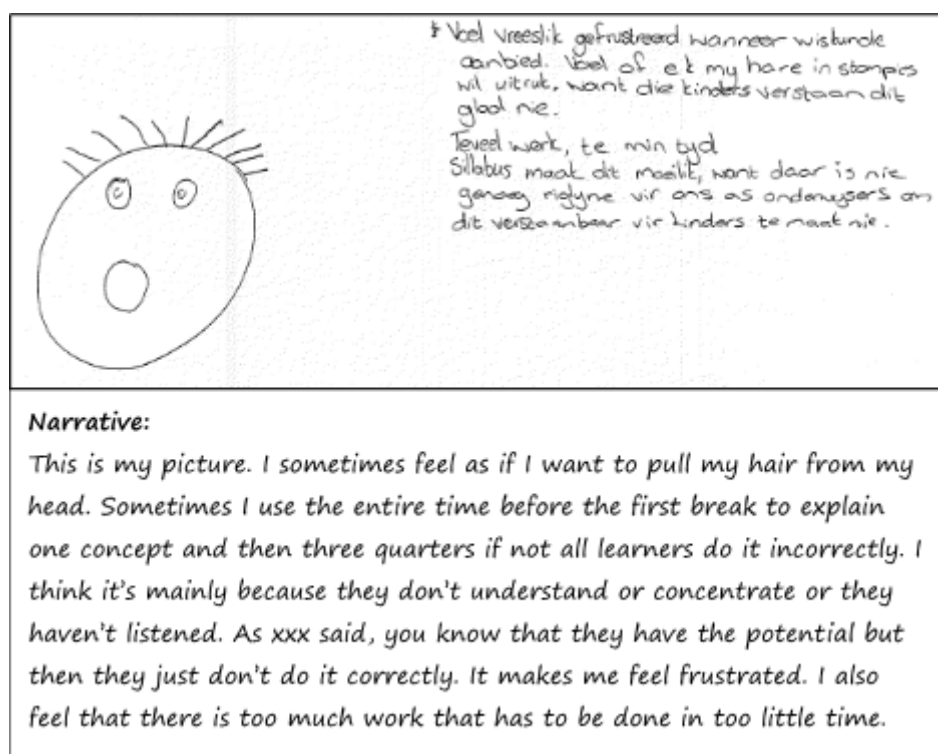


Figure 5-2: Draw-and-talk activity: Feeling frustrated about teaching Mathematics², P1 (Session 1, September 2014).

From the illustration, one can see that the participant feels frustrated, helpless and overwhelmed. As she explains in her narrative, although she tries to explain the content, the learners sometimes do not grasp it. She also feels frustrated when learners who can achieve success do not understand the work correctly. Vygotsky's ZPD informs us that the area between what learners can do with support and what they can do independently is the area where learning takes place (Brewer, 2007:12). This implies that learners should be given the opportunity to first construct new learning content before moving on to the next learning content (Ormrod & McDevitt, 2004: 240), something that the demand of the syllabus does not take into account according to the participant teachers.

From the feelings that surfaced, it is clear that the teachers feel frustrated towards teaching Mathematics and that past experience has an influence on attitude, which affects behaviour and cognition. As the ABC model informs us, past experience has an influence on one's attitude, which affects one's behaviour (Bodur *et al.*, 2000: 17 & Ertmer & Newby 2013:48).

² Translation of Afrikaans-caption in illustration: Feel very frustrated when presenting Mathematics. Feel as if I can pull out my hair from my head because the children do not understand it at all. Too much work, too little time. Syllabus makes it difficult because there are not enough guidelines for us as teachers to make it understandable to the children.

The participant teachers explained that they had tried to change their teaching to better meet the needs of learners. For example, P5 said that when a learner struggles

“you just try another method and it gives the learners another perspective.” (P5)

From this discussion it was evident that the participant teachers were already thinking about changing the way they teach in order to help them to teach Mathematics better, but that they were struggling to do so.

In the next section, the factors that have an impact on the teaching of Mathematics in the Foundation Phase will be discussed. These factors help to explain why teachers feel frustrated with teaching Mathematics.

5.2.1.2 Theme 2: Factors impacting on the teaching of Mathematics in the Foundation Phase

Few of the challenges teachers face in teaching Mathematics in the Foundation Phase have to do with the content of the subject; rather they have to do with the workload, the intensity and the abstractness of the prescribed curriculum, namely the CAPS (DBE, 2011a: iv). P5 emphasized that there are so many calculations that learners need to do that teaching Mathematics has become a system of learners memorizing the steps that you show them rather than developing an understanding of the concepts

“you don’t get the chance to really lay a foundation of the basics. This leads to the learners adapting your way of doing things; they memorize that although they sometimes really don’t understand what they are doing...if you ask that question in another way they don’t understand what you are asking them.” (P5)

Participant 4 (P4) agreed to this by saying

“the pace in the Foundation Phase is far too hasty.” (P4)

One of the challenges that the participants face for teaching Foundation Phase Mathematics is that the *syllabus* is simply too crammed for the teachers to really get time in the class to practice the concepts that they teach the learners; the learners do not get the opportunity to construct new knowledge vital to their understanding. The teachers have little time to practice basic calculations before moving on to the next type of calculation, and struggle to find time to illustrate the concepts in a concrete manner, suited to the cognitive development stage of the learners (Brewer, 2007: 14-17; McDermott & Rakgokong, 2006:5-6). As P1 pointed out:

“you don’t have time to use concrete materials to support your lessons....” (P1)

This overload of content, leads to learners being force-fed new concepts, rather than their being able to slowly work from the concrete to the abstract (Brewer, 2007: 12). Teachers find it difficult to scaffold learning and work according to the learners' ZPD (Brewer, 2007: 11). Learners need to interact with concepts to acquire an understanding of them (Ormrod and McDevitt (2004: 240). When there is an overload in content, as the teachers claim, there is no time for concrete explanations and the learners cannot think abstractly about concepts they have not yet constructed.

The teachers felt overwhelmed by the CAPS document that prescribes the learning outcomes for Mathematics in the Foundation Phase. As P5 stated:

"...our syllabus. It is outrageous." (P5)

"It is not very clear, there is no demarcation of up to which number the calculations should be done..." (P4)

"If you look at the workbooks and textbooks...it's not always relevant to what you are teaching. Sometimes the themes and worksheets...do not correlate...." (P3)

The participants experience a lack of support and guidance regarding the operationalisation of the syllabus. One can almost say that the curriculum policy makers and implementers are not on the same page. This raises red flags because the teachers feel disempowered by the syllabus. According to the ABC-model of attitudes, the teachers' feelings (e.g. frustration) influence their behaviour (demotivation, impatience) and cognition (e.g. negative thinking about learners) during the teaching of Mathematics (Bodur *et al.*, 2000: 17). The lack of alignment between the workbooks and content contradicts the CTML theory (Mayer, 2009:57) that the visual, written and auditory aids should be coherent and relevant to each other and to the learners (Sorden 2012: 8; Mayer, 2009:57). Another important finding was highlighted by P1 who had the following to say about the need for adjustments to the prescribed curriculum:

"[a curriculum] drawn up by someone...who has teaching experience and knows the challenges we face in the classroom." (P1)

This further highlights how the teachers feel disempowered by the syllabus. According to them, the syllabus is not feasible or based in a realistic scholastic context. The participants think that the curriculum designers did not take into consideration the real-life challenges teachers face in the classroom. This renders the Foundation Phase Mathematics CAPS not only ineffective, but also contributes to creating a negative attitude towards Mathematics at this young age.

Figure 5-3 illustrates factors that negatively influence teaching³ (P2):

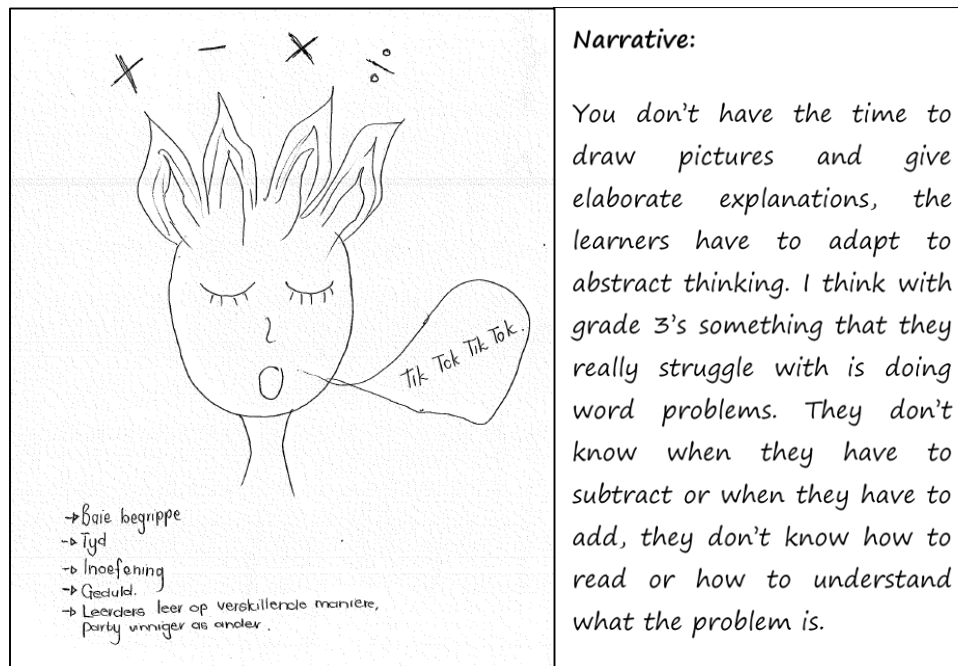


Figure 5-3: Draw-and-talk activity - Mathematics sets my head on fire, P2. (Session 2, September 2014)

From the figure, it is clear that P2 struggles with *time allocation*. The flames coming from her head and the “tick-tock” of the clock indicates that she feels pressurised to cram all the content into the time frame provided. The participant teachers identified the *gap* between grades as another factor that influences their teaching of Foundation Phase Mathematics:

“in grade 1 they do basic calculations of plus and minus, division and multiplication. They do basic doubling and halving and BOOM!, when they get to grade 2 it’s suddenly calculations up to number 200! It’s terrible really.” (P5)

According to Vygotsky’s theory regarding the ZPD of a learner, there should not be learning gaps or gaps in learner understanding for optimal learning to take place (Brewer, 2007: 12). The teachers in this study were not feeling very competent to teach Mathematics in the short time allowed for learners to grasp concepts for which they had not been prepared. According to the ABC model, this negative feeling could result in them becoming demotivated in their teaching and even lead to negative behaviour towards learners (Bodur *et al.*, 2000:17).

³ Translation from Afrikaans-caption in illustration: A lot of concepts, time, practicing, patience, and learners’ different learning styles, some acquire knowledge faster than others.

From the evidence presented and the above discussions, I identified the *overcrowded syllabus*, *time allocation* and the *gap between grades and learner understanding* as the main factors that have a negative impact on the participant teachers' presentation of Foundation Phase Mathematics to the learners.

5.2.1.3 Reflection on my learning in cycle 1

Once I identified the main factors that negatively influenced the participant teachers' presentation of Mathematics and the feelings they have towards Mathematics, we focused on their willingness but also lack of capacity to adapt their teaching successfully to suit the learners' ZPD and still help the learners to be positive about Mathematics. I introduced the idea of using digital stories as a teaching method to assist the teachers in their lesson presentation. I thought it would be suitable because of all the benefits it has for Mathematics presentation (as discussed in chapter 3). The findings of this study also indicated the possible benefits of digital storytelling that the participant teachers identified - this is discussed at a later stage in this chapter.

What I learned during this cycle of my study was that the teachers struggle to talk about the feelings they have towards Mathematics. Initially they were very cautious to admit that they had negative feelings towards Mathematics and the teaching of it, but once they realised that they were not the only ones who felt this way a very collaborative and trusting collegial relationship formed amongst the participants. As facilitator this made me feel positive because I could sense that the teachers realised that they needed to change their perspectives regarding teaching Mathematics because they realised it was influencing their attitude towards the learners in the classroom.

When the participant teachers started to open up about how they felt and how this had an influence on their teaching, I learned the value of the PAR-process, because the participant teachers realised through this that they had to come up with a solution to decrease the occurrence of the factors that influenced their teaching.

I sensed that they were positive about attempting a new strategy in teaching, even though they were aware of some challenges that could arise (refer to section 5.2.2.3). I thought that the participant teachers needed to be exposed to a positive teaching strategy that could help them address some of the challenges that they face with teaching Foundation Phase Mathematics. This is when I introduced the participant teachers to digital storytelling as a teaching method. I felt this could be a successful strategy because it is collaborative and will help learners with visualisation of abstract thoughts. Since I had learnt that they associated the classroom setting as stressful, I decided to take them away from their school for them to be able to focus their

complete attention on making the digital stories. The findings of these action learning set meetings will now be discussed as cycle 2 of the data-generation process in the following sections.

5.2.2 CYCLE 2: IMPLEMENTATION AND EVALUATION OF DIGITAL STORYTELLING AS A STRATEGY FOR TEACHING MATHEMATICS IN THE FOUNDATION PHASE

5.2.2.1 Theme 3: Teachers' experience of digital storytelling as a teaching strategy

In this section I will progress to discussing the next cycle of the PAR-study: implementing and reflecting on action taken to resolve the challenges identified in the first cycle.

Initially, the participants did not feel competent to create and use the digital stories (See Annexure F), as P5 mentioned during our digital storytelling workshop:

"...I am really struggling with this, I don't think I will master the technology. I am trying to follow but have no idea what I am doing." (P5)

The technology can and will be overwhelming for users who are not used to teaching and planning lessons with it. This reaction also influenced my thinking:

"Although the participants showed up, I got the feeling that some of the participants felt overwhelmed with what we were doing. I think some teachers might be scared to use the new technology." (Researcher reflective journal, 28 November 2014)

I hoped that the participants would be more positive towards the technology once they understood how to operate it, as Bentracourt *et al.* (2003:151) identified that the attitude of the educator towards multimedia will dull the experience for the learners if it is negative.

However, I was excited to see during the workshop the participants' negative feelings improved as they started to experiment taking photos with the tablets and making voice recordings. I found it valuable that we were a small group working in pairs, to experiment together. P3 highlighted the change in attitude perfectly when she said

"Initially I felt sceptical, but later I enjoyed it!" (P3)

At the end of the workshop the teachers informally discussed the method and the change in attitude was evident:

"When we integrate these videos with the theme, it can really work... [chuckles] I just don't want to be the one making the videos." (P5)

I experienced that the participant teachers started to feel motivated and positive about making the digital stories. The participant teachers' change in feelings towards using digital stories as a teaching strategy subsequently changed their behaviour and influenced their cognition in a positive way, as the ABC-model of attitudes suggests (Ertmer and Newby, 2013: 48).

The participant teachers were of the opinion that the digital storytelling strategy forced learners to *engage more of their senses* while learning, as opposed to the more traditional forms of teaching where learners only look at the board/textbook and listen to their teacher. During the workshop where we planned and produced digital stories for the teachers to use, they mentioned the following:

"the more senses the learners use to learn, the more effective it will be." (P1)

What turned out to be very positive is that some of the participants decided to use their own private-use devices for making the videos, even though they were for school. P3 said:

"Luckily we all have laptops...if you really want to use the videos in the class...you can show the learners the videos on your computer." (P3)

This showed that the participants were keen to use digital storytelling as a Mathematics teaching method, but due to the social economic circumstances of the school and its learners, provision of the necessary teaching aids was a major concern. When the participant teachers suggested using their own private media devices to produce digital stories in the classroom, it indicated that they were motivated to use this strategy in their classrooms. Hopefully this positive attitude will expose the learners to positive learning experiences, which will subsequently increase the learners' engagement in the classroom (Willis, 2010: 32).

When the teachers reflected on using the digital stories in their classroom, I could really see a change of attitude. When asked how it felt to make the videos, responses were:

"Excited. I was looking forward to see the final product!" (P1),

"Curious...I enjoyed the process a lot!" (P2),

"It gives you a new type of excitement about teaching again." (P3).

The excitement was visible amongst the participants, the atmosphere was light-hearted and I felt that the teachers were speaking as a team. The participants viewed the visual and audio stimulation as one of the biggest assets of using digital storytelling in the classroom, as P3 stated:

"It makes the work attractive to the learners; it interests all of their senses" (P3)

"The visual as well as audible inputs from the learners." (P4)

The participants were starting to see the educational value of digital stories and how they could have a positive influence on their teaching. The value of the stimulus of the visual and audible senses is indispensable for effective teaching, as the CTML suggests (Sorden, 2005: 271).

During the digital storytelling workshop there was a *sense of collaboration* amongst the educators, as they worked together to create the stories and lessons. This helped to overcome the fears of those who were not so confident in using the technology. The opportunity to combine their knowledge and skills made them feel empowered, as P2 stated:

"We can make the videos together and just use it in our classrooms." (P2)

The participants felt excited about using their own videos as introductory lesson aids and they felt positive about being able to have group interaction to learn from each other.

After acquiring the skills to use digital storytelling in the classroom, the participant teachers felt motivated to use this strategy in their classrooms. When they were asked if using digital stories in their classrooms would make them more positive or more negative about teaching Mathematics, all of them answered that it would make them *feel more positive* about their responsibility to teach. P1 said that it makes her more positive because she is

"excited to show it to the learners" (P1) and P2 said:

"we as teachers and the learners enjoy it terribly!" (P2)

P3 stated that

"it [digital stories] makes the work easier for the learners." (P3)

When the teachers feel motivated, the learners are also motivated to participate changing the teaching atmosphere to a more positive learning environment, which is very important as Willis (2010:32) points out that the feelings one fosters towards Mathematics, will influence the behaviour one shows towards doing it.

The participant teachers found that using digital storytelling as a teaching strategy to present lessons was successful in the sense that it engaged the learners more positively and it increased their excitement. In the next section the experiences that the teachers had when they used digital storytelling as an activity for the learners to do in the classroom will be discussed.

5.2.2.2 Theme 4: Digital storytelling: promoting active learning

As part of cycle 2 of the PAR-study, we experimented with the use of digital storytelling as a classroom activity to enhance positive learner engagement in Foundation Phase Mathematics. This theme was derived from an analysis of the experiences that one participant teacher (P3) had when she experimented with learners making digital stories in the classroom. This teacher volunteered to try digital storytelling as an experimental teaching strategy in her classroom. I observed how she implemented the teaching strategy and assisted with helping the learners navigate the tablets. The participant teacher was very positive about using this strategy and she made the learners feel positive about trying it as well.

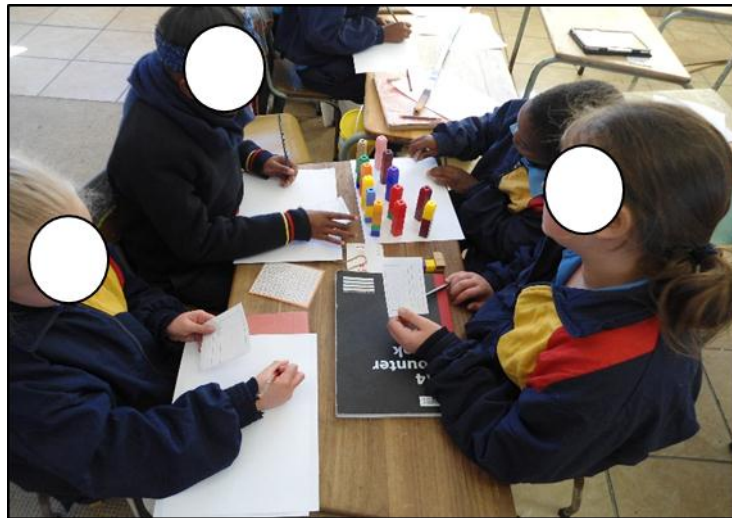


Figure 5-4: Learners participating in writing their storyboard - cooperative learning!

When learners made their own digital stories, there was evidence that they were positively engaged. The class was divided into two groups and each group made its own digital story using its own storyboard and tablet.

When showing the digital stories to the learners, the participants witnessed curiosity amongst the learners, but learners were also more engaged in the lessons, as P3 said:

“...they looked excited about what we were going to do next.” (P3)

“...it makes them curious about what they are learning.” (P4)

The learners were drawn into the lessons and they were attentive to what was happening around them, thus, learner engagement was enhanced. Lerkkanen *et al.* (2012: 275) suggests that adapting learning content to a level that will interest learners, will enhance their participation and level of excitement towards learning.

“Learners enjoy Mathematics more and they listen and they view attentively.”

When the working memory of a person's brain is stimulated through visual and audio media, as when using digital stories, it causes enhanced learning (Mayer & Moreno, 2003: 14; Sorden, 2005: 271; Clark & Feldon, 2005: 12).

As seen in Figure 5-4, the learners were all actively engaged in designing their storyboards. The learners chose to work in their preferred way of thinking as one can see some learners manipulating concrete material (blocks) to solve the given problem, which was $5 \times 13 = ?$. The learners understood that they had to use steps to complete the problem and here the participant teacher had to provide guidance to the learners, but only as a facilitator, as P3 reported back:

"...the learners needed much encouragement and guidance to plan the stories...it was challenging for them to think about what they should do next, this is where teacher guidance was very important." (P3)

The participant teacher guided the learners with prompts to think out a plan of what they should do next, helping the learners to think critically and creatively. The guidance the participant teacher provided supports the sociocultural learning theory of Vygostky, specifically the ZPD: what learners can accomplish with and without support (Brewer, 2007: 9). Stories are valuable for teaching (Joubert *et al.*, 2006:40) as they help to develop learners' conceptual skills. Using storyboards when planning digital stories, the learners could organise their thoughts, as guided by the teacher and select the information that was necessary to complete their story. Stories enhance creative thinking skills (Soares de Lima *et al.*, 2014:33).

Storyboarding is one of the processes of creating digital stories that required the learners to think critically about the content of their story and to think creatively about how they could represent the content. Vygotsky emphasised that the role of the social environment is vital for the development of critical thinking skills (Brewer, 2007: 9) and that learners should be exposed to environments that enable them to think for themselves using their perspective of a phenomenon. The participant teacher reported that her role to guide the learners was:

"...I prompted ideas for them to get them to think in the right direction." (P3)

This shows that the participant teacher facilitated critical thinking, rather than doing the thinking for the learners. It is very important that the learners are prompted to think for themselves. In this way, the learners could learn to trust their own thoughts and to focus on the main concepts when their thoughts deviated from the learning content. Figure 5-5 below is an example of the storyboard the learners planned to make their digital story (see Annexure E for full quality).

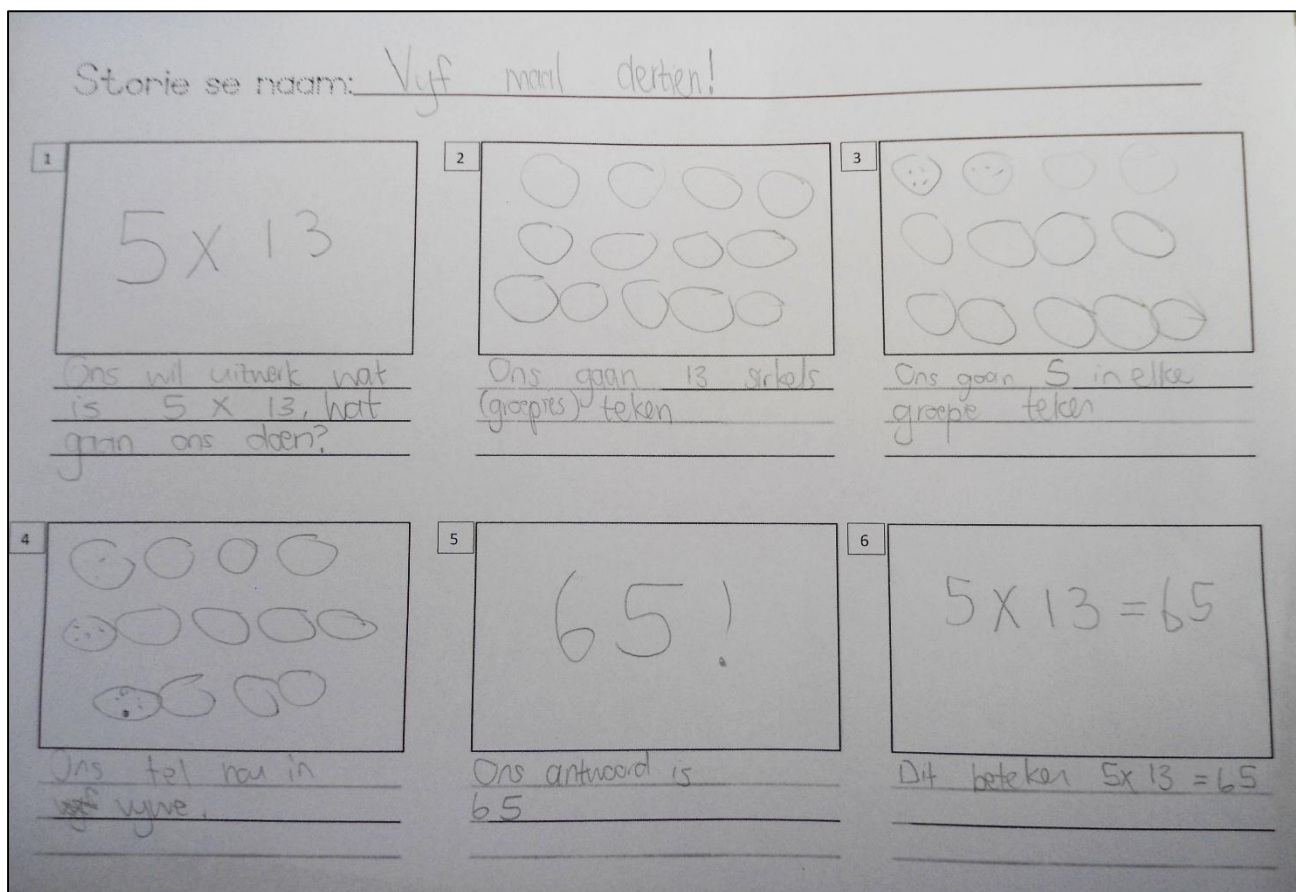


Figure 5-5: Example of storyboard the learners made - Writing our own content!⁴

Planning the story helped the learners to think critically about what content was relevant, what was a logical order for the frames and what text should be used.

Figure 5-6 is a step-by-step explanation of the production of a digital story as made by the learners; refer to video 5 on the data disc (Annexure F).

	Step 1: Planning of each of the frames (screens) for the digital story by using a storyboard. The storyboard must have a planned image, script and text that will be added to the frame (script and text must be the same). Number of frames and the length of the script is important. One sentence per frame.
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⁴ Translation of storyboard script from Afrikaans to English- **Frame 1:** We want to calculate 5×13 . What must we do? **Frame 2:** We are going to draw 13 groups. **Frame 3:** We are going to draw 5 [items] in each group. **Frame 4:** Now we are counting in fives! **Frame 5:** Our answer is 65! **Frame 6:** That means $5 \times 13 = 65$!

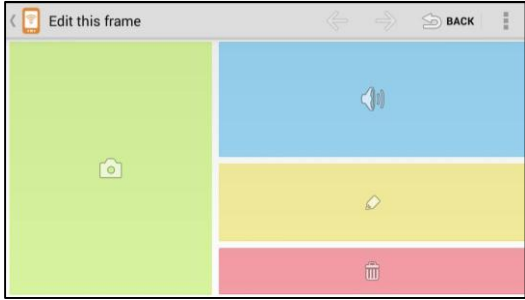
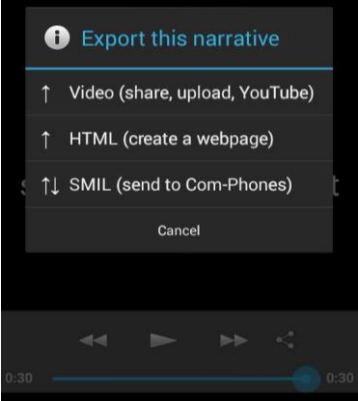
	Step 2: Taking photos or drawing the planned images for each of the frames
	Step 3: Open the ComPhone™-application on any Android-device. Each of the icons represent the part of the frame you want to add: • Camera icon- image • Microphone icon- Recording the script (narrative) for the specific frame with the built-in microphone of the device. You can add a second sound that will be background music. • Pencil icon: Where you type the narrative for the frame so that the viewer can see the narrative and hear it while they watch the digital story • → icon: adding the next frame • Dustbin-icon- delete frame
	Step 4: Record narrative and add images for each of the desired frames
	Step 5: Save the narrative and now the digital story can be played on the device or be put on a flash drive or be burnt to a DVD.

Figure 5-6: Step-by-step explanation of producing a digital story - Easy as one, two, three!

When the learners had finished planning their story, they went on to make the visuals for each frame, by drawing the images they wanted to use. The learners then took pictures of each of the picture frames and recorded the script for the frame. Each frame was made separately using the ComPhone™-application. After all the frames and voice recordings were captured, the participant teacher finalised the digital story by following the cues on the application. The creative thinkers used their skill to plan how the frames should be presented and what to use when. This activity engaged all the learners in the learning process, as the participant teacher said:

“There was a huge amount of excitement, in such a measure that learners who normally don’t participate...volunteered to be narrators of the story.” (P3)

This indicates that using digital storytelling as an interactive classroom activity indeed stimulated the learners’ learning, enhancing positive learner engagement.

The learners could see what the other learners were doing and could construct their own thinking and build an understanding of the content. Figure 5-7 illustrates the collaboration between the learners:



Figure 5-7: Learners supporting each other - Let’s do this together!

In Figure 5-7 it is evident that the learners worked collaboratively and they supported each other in making the storyboard for the video. The participant teacher said:

“in the groups they [the learners] could get another kind of support that they don’t usually get.” (P3)

This highlighted the importance of the group dynamics. The learners helped each other to understand the problem they were trying to solve, scaffolding each other’s learning. The group dynamic also provided the learners who had advanced critical thinking skills to provide ideas and mentorship to the learners who struggled with critical thinking, as the sociocultural theory of

learning suggests (Van de Pol *et al.*, 2010: 272). The participant teacher fulfilled the role of facilitator for learning, rather than using the direct method of teaching where the learners would be inactive.

Figure 5-8 illustrates how the learners were actively involved in the learning process with the teacher facilitating the learning.



Figure 5-8: Learners and participating teacher making the digital story - We learn together!

Figure 5-8 highlights the facilitation process that the participant teacher made use of and the level of engagement of the learners. They are drawn into the activity and they are focused on what is happening. The participant teacher stated:

“The engagement of the learners with this programme is ideal for the classroom...I hope to see this programme in all schools in the near future.”(P3)

This is a result of integrating the CTML and the sociocultural theory of learning to change the negative feelings learners foster towards Mathematics to positive feelings as the ABC-model of attitudes suggests. I observed how the excitement the teacher felt transferred into her teaching. She was engaged in the learners’ activity the entire time and her approach and body language were inviting and positive.

As previously discussed, using new technology in the classroom can be overwhelming for learners, but once they were used to it learning could take place. P3 highlighted this when she said:

“I think that when the learners watch the final product, the content will be understood better...I think the excitement of making a video and doing such an enjoyable activity did deviate their attention from the learning content...but as soon as they watch the video...the content sticks.” (P3)

When the learners watched the video, they could see the content *“coming alive”* and they organised it according to their own understanding of it, selected and integrated their ideas, the content and their interpretation of the content to enhance their learning (Meyer & Moreno, 2003:46). The learners organised the content by selecting the necessary information to understand the concept of multiplication. They could form their own understanding of multiplication by observing the multiplication process as it was explained in the digital story.

Learners tend to avoid Mathematics due to the accuracy and abstract thinking it requires (Mji and Makgato (2006:256). The participants also emphasised that the learners struggle with Mathematics. After being asked what the learners struggle with and tend to avoid, P1 said:

“Counting, they don’t want to count. They don’t understand that you have make grouping of numbers...” (P1)

P3 highlighted that learners struggle with:

“reading time...and visualisation.” (P3)

Due to the abstractness of Mathematics it is vital that learners should be able to visualise, and this is one benefit that the simultaneous stimulation of the audio and pictorial channels of the working memory definitely addresses, as indicated by research (Mayer & Moreno, 2003: 46).

The participants indicated that learners struggle with visualisation, but they found that when using digital stories in the classroom, the learners were helped with visualising abstract thoughts, as P1 stated:

“...the more senses the learners use to learn, the more effective it will be. With this [digital stories] they look, they listen and they recognise...the video is in childhood vocabulary...for them to understand it.” (P1)

Learners who struggle with visualization were exposed to visual and audio information playing simultaneously, helping the learners to organise their abstract thoughts, as the CTML (Mayer & Moreno, 2003:3) suggests. The fact that digital stories stimulate the learners’ senses definitely enhanced their participation in the activity, making them part of the learning process. For learning to be optimised, learners need to be able to use and expand their critical and creative thinking skills.

The learners also acquired mathematical vocabulary as they heard how the other learners explained their thoughts. The learners also acquired the new vocabulary by looking at the videos, as P1 explained:

“With this they look, they listen...it is half in childhood vocabulary...for them to understand it.” (P1)

Vygotsky’s sociocultural learning theory places great emphasis on the acquisition of language through the social environment (Brewer, 2007:22). Using digital stories in the classroom seems to assist with learners acquiring vocabulary in terms that they understand

Due to the challenging socio-economic circumstances the learners and school find themselves in, it was less likely that they would get exposure to this type of technological learning, as P3 said:

“[our school] is less privileged and not all the learners have access to computers or cell phones...” (P3)

Using digital storytelling as a classroom activity gave learners exposure to using technology and acquiring skills and knowledge about using technology efficiently.

The benefit of using digital storytelling as a teaching method and classroom activity was that it definitely enhanced positive learner engagement in the Mathematics class. Lessons were fun to participate in and the learners could enjoy acquiring new knowledge and skills.

In the next section the challenges and potential barriers faced regarding the use of digital storytelling in the classroom will be discussed.

5.2.2.3 Theme 5: Challenges and potential barriers teachers are faced with when using digital storytelling as a teaching strategy for Mathematics

As with every other classroom activity that is done for the first time, it was inevitable that at some stage challenges would arise. The participant teachers reported that:

“The learners sometimes deviated from the topic...” (P3)

Ibrahim (2012: 84) argues that deviating from the topic or giving extraneous information is one of the limitations of using multimedia in classrooms, as it can then consume too much of the learners’ attention, resulting in the learners losing focus from the main topic. In this case, the participant teacher fulfilled her role perfectly by praising the learners for their ideas but also providing guidance to help the learners select only relevant information. The participant teacher’s teaching experience might have helped her in this situation, as she knew how to handle this type of situation. The participant teacher handled this challenge very well as she still praised the learners’ efforts even when they deviated from the topic.

“Some learners were also very dominating and wanted to take over...” (P3)

The learners' stage of emotional development plays an important role regarding power-sharing. As Brewer (2007: 22) depicts on Erikson's stages of emotional development, learners in the elementary grades are still learning to co-operate with their peers in a social learning environment. According to McCleod (2008) the learners who form part of this study are at a stage of emotional development where they attempt to show their competence alongside their peers, making power-sharing a real issue.

The participant teacher handled the power-sharing issue very well, once again, as she said she

"...tried to minimize this by including all the learners in the activity and using as many possible ideas from all the learners" (P3)

and by dividing the learners:

"into smaller groups...each learner could contribute to the planning of the story and participate in making it."(P3)

The learners all had an active role to focus on and this helped to ensure that their contributions were valued. Research by Troutman & Lichtenberg (2003: 564) informs us that each learner wants to feel that what they know and their ideas are valued.

"I think it was effective that the learners could plan the stories ahead although the learners needed much encouragement and guidance..." (P3)

In my reflective journal I made a note that the learners initially:

"struggle with navigating and manipulating the tablets on their own, the teacher had to help them and in the end press the buttons for the learners." (Researcher reflective journal, 28 July 2015)

The participant teacher helped and facilitated learning when she provided guidance with the tasks, such as storyboarding, that the learners struggled with. Her role was to provide learners with scaffolds, as Vygotsky's ZPD suggests (Ormrod & McDevitt, 2004: 240). The participant teacher exclaimed that although there was room for error, the learners:

"were more relaxed because they were in an environment where it is okay to make mistakes. There is not as much pressure as when individual work is done."(P3)

The learners were exposed to a learning experience where they could explore and experienced the supporting role of their teacher and peers, enhancing their engagement in the classroom.

The above-mentioned challenges are not so much to do with digital stories, but are common to all collaborative forms of teaching, as Vygotsky's socio-cultural theory of learning informs us (Brewer, 2007: 12).

Some learners also struggled to navigate and manipulate the tablets.

"I think the technology was a bit too overwhelming for the learners...something they have to get used to."(P3)

Robin (2008:220) emphasises that using technology in the classroom is more than just adding a piece of software to a lesson. Although the application used (ComPhone™) is very basic with an easy interface, it was difficult for the learners to navigate the tablets themselves. This links to the ZPD of the learners as stipulated by Brewer (2007:9); the teacher must provide scaffolds to help the learners with what they cannot do independently. The fact that the participant teacher provided this scaffold of navigating the technology for the learners helped them to stay focused on what they were doing.

When asked if she thought that the learners would be able to complete the activity without teacher guidance she said:

"I think the making of the videos [digital stories] using the technology can be done independently."(P3)

Using digital storytelling and making the learners used to the technology will be a process. Simpler software can be another option to consider as well. This challenge was unique to the use of digital stories in the classroom, it is a vital skill that needs to be developed, and as Robin (2008:222) informs us, it is a challenge that can be overcome.

Another concern that arose continuously during the entire study was the socio-economic circumstances of the school. The school and educators do not have the funds to equip the learners with tablets and they only have access to one projector in the school hall, which makes it difficult to organise digital storytelling as a teaching strategy because it cannot really be done as a classroom activity if the learners need to move classrooms each time before doing digital storytelling as an activity. P1 and P4 identified the lack of the necessary equipment as the biggest threat of using digital storytelling when they said:

"Because we don't have projectors in the classroom we must go to the hall each time to view a video" (P1)

and

"We don't have sufficient technical technological equipment, without projectors it is very unpractical." (P4)

During the digital storytelling workshop P4 again highlighted that the school and the learners in the school do not have the necessary funds to buy the technological equipment needed when she said:

"The only thing I wonder is will it have any cost or implications like that for our learners. Because then it won't really work in our context" and later again she said *"The real question is the finances, will our school be able to afford it?" (P4)*

P3 also contributed by saying that:

"[our school] is less privileged and not all the learners have access to computers or cell phones..." (P3)

From this I could really see that the financial implication of using this technology raises concern amongst the participants. Klopper (2008:169) highlights costly equipment as one of the limitations of using CTML in the classroom. As we can see in this study the participants identified it as a major limitation for the socio-economic circumstances of their school and their community.

This concludes the discussion of findings. In the next section I reflect on the findings discussed in this chapter.

5.3 Reflection on my learning in cycle 2 of this study

This cycle of the study was hands-on and this is where I really felt excited as my study came "alive". I felt positive and nervous at the same time, as I wrote in my reflective journal:

"This session was both fun and concerning...I got the feeling that some of the participants felt overwhelmed with what we were doing." (Researcher reflective journal, 17 November 2014).

The initial attitude of the participant teachers concerned me at first, I felt as if it might be too much for them to handle, considering that they already had a lot of stress with factors such as the syllabus and learning gaps influencing their Mathematics teaching. In fact, I absorbed their stress, something that confirms how negative feelings can be transferred within a learning space. Therefore, I put my negative feelings aside and concentrated on the positive aspects of our interaction.

When we first started working collaboratively, it was thrilling to see how much the participant teachers enjoyed learning from each other and working together. They worked together to

improve their teaching. I could sense that the teachers were starting to build a collegial trust relationship.

“There was a really good spirit and sense of collaboration and trust amongst the participants.” (Researcher reflective journal, 17 November 2014).

It made me feel positive to think that the participants were starting to change their initial sceptical attitudes to more positive and collegial participation in using their newly acquired skills. In terms of ongoing improvement in teaching, the ability to support each other would have a very positive influence.

The participant teachers started to take control of the new teaching strategy and they were very positive about experimenting with digital storytelling as a Mathematics teaching strategy in their classrooms. The participant teachers enjoyed the process of making the digital storytelling and they were even more excited after they saw how the learners reacted to the digital stories they presented to them.

The PAR-process has helped the teachers to realise that they can learn together and work together to achieve their teaching goals. The process made them realise that they share the same feelings and ideas about Mathematics and teaching Mathematics. They started to think as one body moving forward and helping and supporting one another rather than each being on their “own island” and battling through the challenges alone. I learned that is valuable for the teachers to first feel that they are meeting on mutual ground and that it is necessary for them to speak about the challenges they face with each other before they aim to address challenges. Through the whole process I could see that the participant teachers were becoming confident about their teaching and they could focus on the positive aspects of teaching Mathematics rather than being overwhelmed with negative factors.

When observing how engaged the learners were in the classroom activity of making the digital stories, it made me excited about how effective this strategy is for engaging learners in Mathematics from their early years of formal education. I observed how the participant teacher could focus on just facilitating learning and helping the learners to think critically for themselves.

To me, this was an eye-opening learning experience. To observe the benefits of using digital storytelling from this experiment we did in the classroom made me realise that teachers want to be positive about teaching, that they are willing to try new strategies to improve their teaching and that exposing learners to a more relaxed learning environment engages them more, but also helps learners to become more self-regulated in their learning.

5.4 Summary of chapter

In this chapter the research findings from the study were reported. The findings aimed to answer the research question(s) of the study, which will be concluded in Chapter 6.

In the first cycle the participant teachers identified that they had some negative feelings towards Mathematics due to past negative experiences with the subject. Some contributing factors that influenced the teachers' Mathematics presentation to Foundation Phase learners include frustration regarding the syllabus, time allocation and the gaps between grades and learner understanding. The identification of feelings teachers had towards Mathematics and factors that have an impact on teaching of it answered sub-questions 1 and 2 of this study.

After introducing the idea of using digital stories as a teaching strategy for Mathematics to the participant teachers, we went on to cycle 2 where we implanted our action plan of using digital stories in the classroom. With the implementation of cycle 2 of the study the participants were shown how to produce digital stories and they made their own stories which they used as introductory teaching aids to present new learning content to the learners. When the teachers showed these stories to the learners, they were excited to incorporate digital storytelling into their teaching as it enhanced positive learner engagement. When the learners made their own digital stories as a classroom activity, the participant teachers experienced a level of learner engagement they had never experienced before. The learners were drawn into the learning activity and they wanted to participate. This answered sub-questions 2 and 3 of this study and in Chapter 6 the last sub-question of this study will be answered in full, although it was partially answered by determining how the PAR-process helped the participant teachers to work collaboratively and build collegial trust relationships. In the next concluding chapter the study will be summarised and recommendations for further studies will be discussed.

CHAPTER 6

RECOMMENDATIONS AND CONCLUSION OF STUDY

6.1 Introduction

The main aim of this PAR-study was to explore the use of digital storytelling as a Foundation Phase Mathematics teaching strategy to enhance positive learner engagement. This study took place at a school in the North West province and it included four teachers from the Foundation Phase who participated in the research process and generation of qualitative data.

When I first embarked on this study, I reflected on my own bad experiences with Mathematics and I reasoned that this past experience must have had an influence on my perception of my ability to do Mathematics. I became intrigued with the literature about the development of negative attitudes towards Mathematics and the possible influence it has on the attitude of teachers and learners of the subject. I felt the need to explore ways to solve this phenomenon, due to the impact it had on the STEM-sector and economy of our country.

Due to the socio-economic circumstances of communities in South-Africa, I came to realise that behavioural therapy to address learning barriers, which is a successful remedial action plan in more developed countries, was not feasible for our socio-economic circumstances. Hence, my thoughts were that the attitude of teachers in classrooms can be changed and that will subsequently change the attitudes of learners towards Mathematics in the Foundation Phase, making their future scholastic experience more positive and result in more positive engagement in the subject through their entire school and possibly university educational paths.

The findings of the planned remedial action plans were discussed in the previous chapter and in this chapter I will conclude the findings, revisit the research questions that guided this study, provide guidelines for using digital stories as a teaching strategy and make recommendations for teacher education and further studies.

6.2 Summary of chapters

A summary of the coverage of each of the chapters of this study is presented below:

6.2.1 Chapter 1: Introduction and background to the study

This chapter served to orientate the study by providing the rationale and the problem statement for this study. From the problem statement and rationale the research questions and aims for the study were determined. This chapter outlined the negative attitudes that teachers and learners

had towards Mathematics and the consequences of these attitudes on the economic structure of South-Africa and globally. This chapter also provided a short overview of the chosen research methodology and design followed during the course of this study and the justification of the methodology. The research paradigm and theoretical framework that underpinned this study was overviewed as well.

6.2.2 Chapter 2: A critical discussion of the major theories and models underpinning this study

The aim of this chapter was to define the theoretical framework that underpinned this study. The sociocultural theory of learning, the CTML and the ABC-model of Attitudes are the three theories that comprised the theoretical framework. Each of these theories was discussed and justified as to why it was significant for the study.

6.2.3 Chapter 3: The conceptual framework that underpinned this study

In this chapter I critically discussed the major concepts that informed this study. What Mathematics is, how it differs from other subjects, why teachers and learners develop negative feelings towards Mathematics, what teaching Mathematics entails, the value of storytelling and what digital storytelling is formed the topics for discussion in this chapter. This chapter helped me to organise my thoughts regarding the significance of the theoretical framework and it provided me with guidance to choose the appropriate methodology to generate and analyse data to support the rest of my study.

6.2.4 Chapter 4: Theoretical discussion of the research design

This chapter explained how I placed my study in a research design that ensured valid findings that would contribute to answering the research question that guided this study. I motivated why looking through a critical lens for my paradigm was suitable, why this study was a qualitative PAR-study. The selected data-generation methods, participant selection, sampling and data-analysis strategies were discussed. The two PAR-cycles followed in this study were described in this chapter and provided guidance in the data-generation and analysis of findings for this study. The ethical measures that were undertaken in this study were also discussed in this chapter to ensure the quality and trustworthiness of the results.

6.2.5 Chapter 5: Discussion of findings

This chapter was a report on the findings of this study concluding with an analysis of the findings. Five themes emerged from these findings, they were:

- *Teachers' feelings and attitudes regarding Mathematics and Mathematics teaching in the Foundation Phase*
- *Factors impacting on the teaching of Mathematics in the Foundation Phase*
- *Teachers' experience of digital storytelling as a teaching strategy*
- *Digital storytelling: promoting active learning*
- *Challenges and potential barriers teachers are faced with when using digital storytelling as a teaching strategy for Mathematics*

Each of these findings was discussed and justified with supporting literature. The findings were discussed according to the two PAR-cycles that were present in this study.

6.3 Revisiting the research questions

The aim of a research study is to answer the research questions. I present my final conclusions on each of the findings in the following discussion of the research questions that guided this study.

6.3.1 Sub-question 1: What do Foundation Phase teachers think, feel, and know about teaching Mathematics?

In the meetings we had as an action learning set teachers displayed mixed feelings towards Mathematics and their teaching of it. With the activities we did, I could see that some of the teachers felt overwhelmed when they started to participate and realized how they actually felt. The greater part of the action learning set had a negative past experience with Mathematics, making them doubt their own ability to do the subject. This led to the development of teaching barriers as the participant teachers were not confident about their ability to teach Mathematics successfully. The participant teachers were positive about the content that they had to teach to the Foundation Phase learners but they felt frustrated regarding *the overcrowded syllabus, gaps in grades and learner understanding and the time allocation* allotted to teach the prescribed learning content. These frustrations influenced them negatively about teaching Mathematics because they felt as if they were just force-feeding learners information without having time to expose learners to concrete and interactive learning experiences.

The action learning set allowed the teachers to form collaborative relationships and gave them a safe place for them to share their successes, frustrations and new ideas to engage the learners in their lessons. The participant teachers knew that they had to adapt their strategy of presenting Mathematics because they could identify that the learners struggled with thinking in an abstract way and that they needed visual stimulus to help them with their teaching.

6.3.2 Sub-question 2: How can digital storytelling be used as a teaching strategy to create more positive learning experiences in the Mathematics classroom?

The participant teachers were introduced to the use of digital stories as a teaching strategy for the Foundation Phase Mathematics classroom by collaboratively planning stories for the themes they were busy doing with the learners in their classrooms. The teachers made use of the digital stories as an introductory teaching aid for their lessons where the concepts they were teaching to the learners were explained. The teachers then played the digital stories to the learners to engage the learners in the lessons at the beginning of the lesson. The teachers referred back to the digital stories when they presented further content.

After the success of the digital stories being used as introductory teaching aids to lessons, one of the teachers volunteered to use digital storytelling as a classroom activity with the learners. The participant teacher divided the learners into groups and the learners planned and produced their own stories in the groups. This added to positive participation and enhanced engagement of the learners and the participant teacher could fulfil her role as learning facilitator as the learners created their own learning content. The participant teacher had to provide guidance with navigating the tablets that were used to produce the digital stories and she had to provide the learners with prompts when planning the stories to ensure they were heading in the right direction.

The learners were engaged positively and they could use their critical and creative thinking skills in a relaxed and cooperative social learning environment. When the learners viewed the digital stories they produced their visual and auditory senses were stimulated which also enhanced their learning and contributed to their visualisation skills development.

6.3.3 Sub-question 3: How effective did the teachers experience digital storytelling to be, as mathematical teaching strategy in the Foundation Phase classroom?

The participant teachers identified this teaching strategy as very effective, stating that the level of learner engagement with this strategy was ideal and that the learners enjoyed what they were doing. Learners who normally avoided Mathematics were positively engaged in this learning activity to such a measure that they volunteered to participate.

As with any other experimental strategy there were some challenges that arose. The learners deviating from the topic, having trouble with power-sharing and the learners who struggled to navigate the tablets were some of the challenges that were faced, but these were easily overcome when the participant teacher provided guidance to the learners.

The participant teachers did identify the socio-economic status of the school and the learners in the school as one of the major challenges with using this kind of technology in the classroom to teach Mathematics. Although this is a major concern, the participant teachers still measured this teaching strategy as effective in their classroom.

The first three sub-questions were answered in the findings reported. To summarise these findings, Figure 6-1 shows the overall benefits and limitations of digital storytelling for teaching and learning in the Foundation Phase Mathematics classroom.

How the use of digital stories benefits teaching	Limitations of digital storytelling as teaching method
• Teachers feel more motivated to present material. • Lessons can be made more interesting. • Lessons are supported with multimedia teaching aids. • Digital stories can be used more than once. • Digital stories lend a helping hand in teaching the learners the correct vocabulary. • Lessons can be made to be context-specific.	• The technology can be overwhelming to use. • Planning the digital stories can be time-consuming. • Financial implications: it is costly to buy all of the necessary equipment. • Availability of resources: the school and homes of learners must be equipped with projectors, smartphones and tablets.
How the use of digital stories benefits learning	Challenges of digital storytelling for learning
• Enhanced positive learner engagement. • Social environment relaxes the anxious learner. • Closes the gap between what learners can do with support and what they can do without support. • Promotes critical and creative thinking. • Smaller group interaction enhances whole-class participation.	• The technology can be more interesting than the content. • The learners struggle with navigating and manipulating the technological devices. • The learners can deviate from the topic. • At first the learners may struggle with group dynamics.

Table 6-1: Benefits and limitations of digital storytelling on teaching and learning aspects.

To answer the last sub-question that guided this study, recommendations and statements made by the participants during the study, as reported in the findings chapter, will be interpreted to form the guidelines to using digital stories as a Mathematics teaching strategy in the Foundation Phase. In the next section, this will be discussed.

6.3.4 Sub-question 4: What guidelines can be created to help teachers to use digital storytelling in Foundation Phase classrooms?

The following guidelines for using digital storytelling as a Mathematics teaching strategy in the Foundation Phase were formulated from the findings and input from the participating teachers to

- First be aware of your own feelings towards Mathematics and talk about them with your colleagues. This will help you to identify your feelings and to help you in identifying the factors that negatively impact your Mathematics teaching.
- Do not be afraid to use the technology, once you are used to working with the application it is easy to navigate and use the tablets.
- Work collaboratively to plan and produce the digital stories. Your colleagues have valuable ideas and can help you to provide clarity on your own ideas.
- Do not try to make the digital stories too complicated and focus on using child-centred vocabulary in the home language of the learners.
- The learners will benefit more from using digital stories when they are divided into groups of different abilities and different preferences in learning styles.
- Give enough prompts when the learners plan the stories on storyboards. Help them to select the relevant ideas and oversee the process so that some learners do not take over the activity.
- As a learning facilitator you have to provide guidance for the learners in navigating the tablets when they start to produce the digital stories. Do not do everything for the learners but help them until they know how to navigate the tablets themselves.
- If the learners seem confused while making the digital stories, do not worry, once they watch the final product, they will grasp the concepts.
- Remember that the aim is not to develop perfect videos but to provide the learners with more interactive learning experiences to enhance their participation in the Mathematics classroom.

The guidelines were constructed from the participant teachers' own experiences and should serve as a resource to help other teachers to plan engaging Mathematics lessons for their learners. With the guidelines the participant teachers provided, the teaching strategy can be improved to better suit the learning needs of the learners and teachers.

6.3.5 Answering the main research question

The main research question that guided this study was:

How can Foundation Phase teachers use digital storytelling as a teaching strategy for Mathematics to create more positive encounters for learners?

The discussion above, together with the guidelines generated from the findings, answers this question.

In the following section I will make recommendations for further studies and for teacher education, based on the findings of this study.

6.4 Recommendations

From my interpretation of the findings that came to light in this study, recommendations for further studies and teacher education will be discussed in the following sections.

6.4.1 Recommendations for further studies

- More research needs to be done on the effect of teachers' perceptions about Mathematics on their teacher education and how they can be helped to change their negative perceptions while being prepared for the workplace.
- More research needs to be done on the effect of teachers' attitudes towards young learners in their general attitude towards school and academic development.
- Based on the negative feelings of the teachers regarding the syllabus they must teach, I recommend further research on the feasibility of the prescribed CAPS-curriculum documents in the time frame of South-African schools in practice.
- Regarding the use of storytelling, I recommend further research on the value of storytelling for Mathematics teaching in assisting teachers in explaining abstract concepts to younger learners.

I believe these recommendations will be beneficial to the acquisition of scholarship in an area that has been ignored: the integration of creative and linguistic skills in the teaching of logic-orientated STEM-subjects and the value it has on learning success.

6.4.2 Recommendations for teacher education

- Aspiring teachers should be equipped with skills to effectively integrate technology usage by learners in the Foundation Phase level.
- Teachers and aspiring teachers should be exposed to collaborative teaching experiences, to experience the value of planning and working together, sharing their ideas and helping each other with challenges.
- Education students could have a module to help them cope with anxiety and negative attitudes that they have built up towards certain subjects and to be enabled to overcome the negative feelings in order to be effective in teaching the subject to young learners.
- Education students should be equipped with the necessary skills to not only have knowledge of the CAPS-document but to also be enabled to understand the implications of the syllabus and how they can plan to cover the syllabus in their year planning.

Based on these recommendations, I believe that aspiring teachers will be better prepared to present Mathematics to young learners, having already identified and resolved their own negative

connotations to the subject and being confident to use technology efficiently to support their teaching.

In the next section the limitations and contribution of this study will be discussed.

6.5 Limitations and contribution of the study

This study was explorative and focused on determining how the usage of digital stories in the Foundation Phase Mathematics classroom can enhance positive learner engagement. The **limitations** of this study are that although measures of trustworthiness were taken to ensure quality findings, the data generated in this study were based on the perception and experience of only four participant teachers. It could possibly be that the perception is very limited due to the similar circumstances of the participant teachers.

This study **contributes** to the available scholarship in the social sciences because it is focused on collaborative education research that is community based. It addresses a real issue that the education sector faces, and could lead to possible solutions to some extent of learner Mathematics anxiety that is transmitted through teaching strategies used in the Foundation Phase. This study can also inspire teachers globally to overcome their fear of using technology in the classroom and help them to be open to experimentation with new and engaging teaching strategies.

6.6 Concluding remarks

Negative feelings towards Mathematics can have an influence on the teaching and learning of Mathematics. This problem needs to be addressed in the Foundation Phase because in this phase learners acquire the fundamental skills to understand all the other mathematical concepts in their further education. The teaching strategy used in Foundation Phase classrooms needs to be engaging for all learners and it should interest them to actively and positively participate. Using digital stories as a teaching method is a possible strategy that has delivered effective results.

It remains the responsibility of teachers in the Foundation Phase to foster a love and positive attitude towards Mathematics in young learners, rather than a fear for the subject.

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ANNEXURES

ANNEXURE A: CERTIFICATE OF PROOFREADING

ANNEXURE B: ETHICS CERTIFICATE

ANNEXURE C: CONSENT LETTERS

ANNEXURE D: EXAMPLE OF TRANSCRIPTIONS

ANNEXURE E: VISUAL DATA COLLECTED

ANNEXURE F: DIGITAL STORIES (VIDEO LINKS)

ANNEXURE A: CERTIFICATE OF PROOFREADING

Janet Whelan

*87 Somerset Country Estate
450 Queen Elizabeth Avenue
Glenwood, Durban 4001*

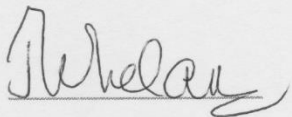
*Telephone 031-261 3079
Cell No 072 422 3233
Email: whelanj@telkomsa.net
skype: janet.whelan31*

19th October, 2015

To whom it may concern:

This is to certify that I completed a language edit for Andri Schoonen
on Chapters 5 and 6 of the dissertation entitled

"Digital storytelling as Mathematics teaching strategy to encourage
positive learner engagement in the Foundation Phase"



Janet Whelan

ANNEXURE B: ETHICS CERTIFICATE

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: (018) 299-4900
Faks: (018) 299-4910
Web: <http://www.nwu.ac.za>

Institutional Research Ethics Regulatory Committee

Tel +27 18 299 4849
Email Ethics@nwu.ac.za

ETHICS APPROVAL CERTIFICATE OF PROJECT

Based on approval by **Ethics Committee of the Faculty of Education Sciences**, the North-West University Institutional Research Ethics Regulatory Committee (NWU-IRERC) hereby approves your project as indicated below. This implies that the NWU-IRERC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

Project title: ACTION RESEARCH FOR COMMUNITY ENGAGEMENT BY TERTIARY INSTITUTIONS: BEYOND SERVICE LEARNING.															
Sub-project: Digital storytelling as Mathematics teaching strategy to encourage positive learner engagement in the Foundation Phase															
Project Leader: Prof L Wood															
Student: A Schoonen															
Ethics number:	N	W	U	-	0	0	0	2	2	-	1	3	-	A	2
	Institution				Project Number					Year			Status		
	Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation														
Approval date: 2014-09-18					Expiry date: 2018-03-06					Category N/A					

Special conditions of the approval (if any): None

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principle investigator) must report in the prescribed format to the NWU-IRERC:
 - annually (or as otherwise requested) on the progress of the project,
 - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-IRERC. Would there be deviated from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-IRERC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-IRERC retains the right to:
 - request access to any information or data at any time during the course or after completion of the project;
 - withdraw or postpone approval if:
 - any unethical principles or practices of the project are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the NWU-IRERC or that information has been false or misrepresented,
 - the required annual report and reporting of adverse events was not done timely and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.

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

Yours sincerely

Linda du Plessis
Digitally signed by Linda du Plessis
DN: cn=Linda du Plessis, o=NWU,
ou=Vaal Triangle Campus,
email=linda.duplessis@nwu.ac.za,
c=ZA
Date: 2015.10.22 12:55:20 +02'00'

Prof Linda du Plessis

Chair NWU Institutional Research Ethics Regulatory Committee (IRERC)

ANNEXURE C: CONSENT LETTERS

Informed Consent Letter

11 July 2014

Dear Sir/ Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN COLLABORATION WITH YOU

1. Project information

I hereby request your consent to participate in my research study. I am a master's student in Learner Support at the North-West University, Potchefstroom Campus. My aim with this project is to explore the use of digital storytelling as teaching method to encourage more positive engagements with Mathematics in the foundation phase classroom. The study will take place in the form of a Participatory Action Research (PAR) approach.

PAR requires democratic interaction, participation, and collaboration between the researcher and the participants. Therefore, you will be expected to meet once a week with other participants and the researcher for interaction. The meetings will not hinder the instructional time; they will take place after school hours. The research will commence in September until November 2014.

2. Your role in the study

Participation to this study is voluntary and you may withdraw at any time without any implications. As mentioned above, you will meet with other the other participants and researcher on a weekly basis. During the action learning sets, you will be expected to participate in working together to answer the following questions:

- What do you think, feel and know about teaching Mathematics?
- How can Foundation Phase teachers use digital storytelling as a teaching strategy for Mathematics to create more positive encounters for learners with the subject?
- How effective did you experience digital storytelling as Mathematical teaching method in the Foundation Phase classroom?

- What guidelines can be created to help teachers to use digital storytelling in Foundation Phase classrooms?

Following the above until the researcher and the participants are satisfied that effective change has been implemented will help the researcher and the participants to develop the practical guidelines to implement digital storytelling as a teaching method for Mathematics in the Foundation Phase.

All the data pertaining to this study will be obtained through action learning sets, discussions and other participatory methods. All discussions will be recorded. However all the information pertaining to this study will be handled confidentially, adhering to the ethical rules of research determined by the North-West University. As part of ethical measures, aspects like informed consent, voluntary participation and anonymity will be respected and adhered to. Lastly, you will be informed of the findings and be given a copy, if you wish to have it.

3. What you can expect from the me (the researcher)

As the researcher, I will:

- Keep your identity anonymous;
- Ensure that all data gathered is handled confidentially;
- Give you regular feedback on the progress of the study;
- At the end of the project, provide you with a copy of the research findings for your benefit;

4. Promoter contact details

I also include the promoter's contact details for use, if a need arise:

Professor Lesley Wood

Tel +27-18-299 4770

E-mail: lesley.wood@nwu.ac.za

Mobile: +27 082 296 9202

Fax+27-18-299 4788

Thank you for your time.

Kind regards,

Andri Lubbe

21616744@nwu.ac.za

0822544065

Informed Consent Letter

15 August 2014

Dear Sir/ Madam

I, the under signed, hereby declare that 'n am fully informed about the aim of Ms. Andri Lubbe's research project titled: *Digital storytelling as Mathematics teaching strategy to encourage positive learner engagement in the Foundation Phase*.

I declare furthermore that I am fully informed about the ethical guidelines that will be followed in this study, namely:

- My participation to the study is voluntary.
- I can withdraw yourself from the research at any given time without consequences.
- All data gathered will be handled confidentially and my identity or institution's identity will not be made public.
- I can request feedback on the project from Ms Lubbe if the need arises.

I further declare that I am participating in this study voluntary and I am willing to participate in action learning sets that will be recorder verbatim, that Ms Lubbe will gather my reflective journal entries as data and that Ms Lubbe will use the digital stories we create as data for her study.

Participant's initials and surname: _____

Participant's signature: _____

Date: _____



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Private Bag X6001,
Potchefstroom
South Africa
2520
Tel: 018 299-1111
Web: <http://www.nwu.ac.za>

Andri Lubbe
018 299 4775/ 0822544065
21616744@nwu.ac.za

20 June 2014

Dear Dr H Motara

Department of Education, North-West Province
Dr Kenneth Kaunda District
Potchefstroom

PERMISSION TO CONDUCT RESEARCH AT [REDACTED]

My name Andri Lubbe, student number: 21616744, ID-number: 9012200139083, and I am a MEd-student in Learner Support at the North West University (NWU). I am conducting my master's research under the supervision of Professor Lesley Wood (contact details provided).

The title of my dissertation is: *Exploring the use of digital storytelling to encourage positive engagement with Mathematics in Foundation Phase classrooms.*

My research proposal is in the process of being approved by the MEd and PhD Committee of the Faculty of Education Sciences and my research project falls under the authority of Prof Lesley Wood's main research project titled: **Action Research For Community Engagement By Tertiary Institutions: Beyond Service Learning.**

Ethical clearance has been granted to Prof Wood's project by the Research Ethics Committee of the NWU (Ethics Number: NWU-000 22-13-S2).

I hereby request your permission to conduct the research at [REDACTED] The research aims to explore and implement the use of digital storytelling as teaching method to help learners experience more positive encounters with Mathematics in the Foundation Phase.

This research will involve foundation phase teachers at [REDACTED] who will be invited to participate in the study on a voluntary basis. All sessions will take place after school hours, so teachers' participation in the research project will not have an effect on their teaching responsibilities in any way. To start off, I will invite the Grade 2 and Grade 3 teachers at [REDACTED] to an information session where I will inform them about my research project. After the information session, I will extend an invitation to the attendees to participate on a voluntary basis in the research project. Thereafter the voluntary participants and I will meet to have discussions about the teachers own perceptions of Mathematics and the education thereof, teaching strategies used and exploring how these teaching strategies can impact the attitude learners have towards Mathematics. Subsequent sessions will involve at the exploration and development of support strategies which teachers can use to enable learners to experience Mathematics in a positive way using innovative teaching strategies, like digital storytelling.

All our sessions will be interactive and these sessions will be audio recorded for the purposes of transcription and analysis. The research will adhere to the ethical prescriptions of the Research Ethics Committee of the NWU. All information collected will be treated in the strictest confidence. Neither the school nor individual teachers will be identifiable in any publications stemming from the research. The role of the participating teachers is voluntary and the participants may decide to withdraw at any time without any fear or penalty. In the unlikely event that a participant may require any type of psychological support as a result of their participation in the research project, the researcher will take the necessary professional action to support the teacher.

Should you need more information about the research you are very welcome to contact me at 082 254 4065 or Prof Lesley Wood at 018 299 4770.

Thank you very much for considering my request.

Yours sincerely,

Andri Lubbe
Med-student
North-West University

Private Bag X6001,
Potchefstroom
South Africa
2520
Tel: 018 299-1111
Web: <http://www.nwu.ac.za>

Andri Lubbe
018 299 4775/ 0822544065
21616744@nwu.ac.za

18 June 2014

The Principal of [REDACTED]

PERMISSION TO CONDUCT RESEARCH AT [REDACTED]

My name Andri Lubbe, student number: 21616744, ID-number: 9012200139083, and I am a MEd-student in Learner Support at the North West University (NWU). I am conducting my master's research under the supervision of Professor Lesley Wood (contact details provided).

The title of my dissertation is: *Exploring the use of digital storytelling to encourage positive engagement with Mathematics in Foundation Phase classrooms.*

I hereby request your permission to conduct the research at your school. The research aims to explore and implement the use of digital storytelling as teaching method to help learners experience more positive encounters with Mathematics in the Foundation Phase.

This research will involve foundation phase teachers who will be invited to participate in the study on a voluntary basis. All sessions will take place after school hours, so teachers' participation in the research project will not have an effect on their teaching responsibilities in any way. To start off, I will invite the Grade 2 and Grade 3 teachers to an information session where I will inform them about my research project. After the information session, I will extend an invitation to the attendees to participate on a voluntary basis in the research project. Thereafter the voluntary participants and I will meet to have discussions about the teachers own perceptions of Mathematics and the education thereof, teaching strategies used and exploring how these teaching strategies can impact the attitude learners have towards Mathematics. Subsequent sessions will involve at the exploration

and development of support strategies which teachers can use to enable learners to experience Mathematics in a positive way using innovative teaching strategies, like digital storytelling.

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Should you need more information about the research you are very welcome to contact me at 082 254 4065 or Prof Lesley Wood at 018 299 4770.

Thank you very much for considering my request and I look forward to hear from you.

Yours sincerely,

Andri Lubbe
MEd-student
North-West University

Private Bag X6001,
Potchefstroom
South Africa
2520
Tel: 018 299-1111
Web: <http://www.nwu.ac.za>

Andri Lubbe
018 299 4775/ 0822544065
21616744@nwu.ac.za

13 August 2014

The School Governing Body of [REDACTED]

PERMISSION TO CONDUCT RESEARCH AT [REDACTED]

My name Andri Lubbe, student number: 21616744, ID-number: 9012200139083, and I am a MEd-student in Learner Support at the North West University (NWU). I am conducting my master's research under the supervision of Professor Lesley Wood (contact details provided).

The title of my dissertation is: *Exploring the use of digital storytelling to encourage positive engagement with Mathematics in Foundation Phase classrooms.*

I hereby request your permission to conduct the research at the school you serve: [REDACTED]

[REDACTED] The research aims to explore and implement the use of digital storytelling as teaching method to help learners experience more positive encounters with Mathematics in the Foundation Phase.

This research will involve foundation phase teachers who will be invited to participate in the study on a voluntary basis. All sessions will take place after school hours, so teachers' participation in the research project will not have an effect on their teaching responsibilities in any way. To start off, I will invite the Grade 2 and Grade 3 teachers to an information session where I will inform them about my research project. After the information session, I will extend an invitation to the attendees to participate on a voluntary basis in the research project. Thereafter the voluntary participants and I will meet to have discussions about the teachers own perceptions of Mathematics and the education thereof, teaching strategies used and exploring how these teaching strategies can impact

the attitude learners have towards Mathematics. Subsequent sessions will involve at the exploration and development of support strategies which teachers can use to enable learners to experience Mathematics in a positive way using innovative teaching strategies, like digital storytelling.

All our sessions will be interactive and these sessions will be audio recorded for the purposes of transcription and analysis. The research will adhere to the ethical prescriptions of the Research Ethics Committee of the NWU. All information collected will be treated in the strictest confidence. Neither the school nor individual teachers will be identifiable in any publications stemming from the research. The role of the participating teachers is voluntary and the participants may decide to withdraw at any time without any fear or penalty. In the unlikely event that a participant may require any type of psychological support as a result of their participation in the research project, the researcher will take the necessary professional action to support the teacher.

Should you need more information about the research you are very welcome to contact me at 082 254 4065 or Prof Lesley Wood at 018 299 4770.

Thank you very much for considering my request and I look forward to hear from you.

Yours sincerely,

Andri Lubbe
MEd-student
North-West University



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Private Bag X6001,
Potchefstroom
South Africa
2520

Tel: 018 299-1111

Web: <http://www.nwu.ac.za>

Andri Lubbe

018 299 4775/ 0822544065

21616744@nwu.ac.za

18 August 2014

Dear Parent/Care giver

LETTER TO INFORM THE PARENTS OF [REDACTED] ABOUT MY RESEARCH PROJECT

My name is Andri Lubbe, student number: 21616744, ID-number: 9012200139083, and I am a MEd-student in Learner Support at the North West University (NWU). I am conducting my master's research under the supervision of Professor Lesley Wood (contact details provided).

The title of my dissertation is: *Digital storytelling as teaching method to encourage positive engagement with Mathematics in Foundation Phase classrooms.*

The research aims to explore and implement the use of digital storytelling as teaching method to help learners experience more positive encounters with Mathematics in the Foundation Phase.

This research will involve foundation phase teachers who will be invited to participate in the study on a voluntary basis. All sessions with the teachers will take place after school hours, so teachers' participation in the research project will not have an effect on their teaching responsibilities to the learners in any way.

To start off, I will invite the Grade 2 and Grade 3 teachers to an information session where I will inform them about my research project. After the information session, I will extend an invitation to the attendees to participate on a voluntary basis in the research project. Thereafter the voluntary participants and I will meet to have discussions about the teachers own perceptions of Mathematics and the education thereof, teaching strategies used and exploring how these teaching strategies can impact the attitude learners have towards Mathematics. Subsequent sessions will involve at the exploration and development of support strategies which teachers can use to enable learners to experience Mathematics in a positive way using innovative teaching strategies, like digital

storytelling. During the planned duration of my study (September-November 2014) I will meet with the participant educators and not with the learners in the participant educators' classes that they teach.

The research will adhere to the ethical prescriptions of the Research Ethics Committee of the NWU. All information collected will be treated in the strictest confidence. Neither the school nor individual teachers or learners will be identifiable in any publications stemming from the research. The role of the participating teachers is voluntary and the participants may decide to withdraw at any time without any fear or penalty. In the unlikely event that a participant may require any type of psychological support as a result of their participation in the research project, the researcher will take the necessary professional action to support the teacher.

Should you require more information about the research you are welcome to contact me at 082 254 4065 or Prof Lesley Wood at 018 299 4770.

Yours sincerely,

Andri Lubbe

MEd-student

North-West University

ANNEXURE D: EXAMPLE OF TRANSCRIPTIONS

Transcription of action learning set-meeting 1.

GETTING TO KNOW EACH OTHER, TALKING MATHS!

Date of meeting: 05/09/2014

Length: 27min 20 sec

Participants: 5

Speakers	Responses
Researcher	Good afternoon everyone. My name is Andri Lubbe. I am a master's student from the North-West University in Potchefstroom, uhm...I am doing my master's in Learner Support and I studied Foundation Phase education. My study focuses on Mathematics and how there can be outside influences that make that learners develop a fear or anxiety towards Mathematics. We all have an experience where we felt that "I am not good enough for this." Uhm, well, before we start, I have to ask you if it will be fine that I record our sessions and I am going to transcribe them do analyse the data for my studies. Is that fine with you? You can also withdraw at any point without any consequences. I will also not make your or the school's identity known. This is a safe space in which we can work together.
Participant 1 Participant 2 Other participants	I'm fine with it (chuckles) I just don't want to hear my own voice on a recording. Yes (Nods positive)
Researcher	Is there time in your life that usually lines that you might have a fear towards mathematics?
Participant 1	I guess it became difficult for me in high school, when the teacher tried to explain more difficult concepts to us and they some of the concepts that I just couldn't engross or maybe it's that I..uhm...that she didn't explain it well enough to me. I went part of the group who could choose if they want mathematics we had to have it and then it falls me to move from higher grade mathematics to standard grade mathematics or mathematics literacy because I just couldn't make it. If I had the choice I would choose not to take mathematics as the subject but as you know we didn't have a choice [chuckles].

Participant 5	No I like maths, I have never struggled with it. I find it the same is other subjects like Afrikaans.
Participant 2	On the other hand I find Afrikaans easier than maths. Maths isn't straightforward
Participant 3	I didn't like maths but teaching grade 3 maths that's not difficult. I like grade 3 maths it's easy.
Researcher	If I can give an example from my own when I was in grade 10 or 11, I can't really remember, my teacher explained trigonometry to us. She was explaining the use of sin, cos and tan, and I could just not grasp it. She was explaining a new concept to us and she asked if anyone would like to try to tell her what they anticipate should happen next. In my bravery I thought I'd give it a try. When I answered incorrectly she scolded at me "are you stupid why can't you do this?" From that day on I was scared to do trigonometry and really thought that I couldn't do it. This causes you to think that you really cannot do it and you tend to avoid it because you don't want to be scolded at again or don't want anyone to make you feel stupid. I now know that is not true but for that moment I believed it.
Participant 5	I can tell you what bothers me about mathematics, we just get so much calculations to do with the learners that you don't get the chance to really lay a foundation of the basics. This leads to the learners adapting your way of doing things they memorize that although they sometimes really don't understand why they are doing it the way that they are, because if you ask that question in another way they don't understand what you're asking them. The methods and the amount of work is what really causes the problem. In the foundation phase we don't get the chance to teach them the comprehension and the relations and when they get to the higher grades they have this gap.
Participants 4	The workload
Researcher	So does this make you feel frustrated? That you don't get the chance to do the work depth?
All participants	Yes!

Participant 5	In grade 2 there is a lot of new calculations that the learners have to master. In grade one they do the basic calculations of plus minus division and multiplication. They do basic doubling and halving and boom! When they get to grade 2 it's suddenly calculations up to the number 200! And suddenly they have to do calculations with brackets, it's terrible really.
Researcher	Do you feel that if they were more time allocated to mastering the basics...
Participant 5	...they would struggle least in the later grades.
Participant 4	The pace in the foundation phase is fall too hasty
Participant 3	It just goes too quick. You don't have time to use concrete materials to support your lessons, dream do you remember when we were in the foundation phase years ago, we packed out sums with objects, we approached the calculation from various points of view, we stood still and one type of calculation for very long, the basics were taught to us.
Participant 1	There just isn't time for that anymore
Participant 3	Yes, we just can't do it anymore.
Researcher	So the is too much expected from the teachers and the learners?
Participant 3	Yes.
Researcher	And you can't just give it for homework...
Participant 2	No! Because one parent explains like this, one teacher explains it like this and one explains it like that and it just confuses the learners in the end.
Researcher	Which resources would you say within support you in teaching?
Participant 3	Perhaps the new government... [Chuckles]
Participant 1	[As a joke] or just a realistic one!
Participant 3	On a serious may be a new curriculum, drawn up by someone from another perspective. One who has teaching experience and know the challenges we face in the classroom.
Participant 1	If you look at the workbooks and textbooks provided by the government it's not always relevant to what you are teaching. Sometimes the themes and the worksheets that are in the books do not even correlate with each other.

Researcher	From my personal opinion I think that when the curriculum planning is done, no time is allocated for extramural activities that takes up time in in the daily program of the school as per example school photo day, guest speakers visiting the school, extra holidays that are implemented. I don't think that when they do the planning that always take into account that these variables have an influence on your teaching time. Also when there is the national tests taking up time like the ANA's. It is teaching time that is lost.
Participant 5	That is all true yes. Another issue is our syllabus. It is outrageous.
Participant 4	It's not very clear, there is no demarcation of up to which number the calculations should be done. You can't possibly do calculations of each type up to the number hundred or 200.
Participant 2	In grade 3 our calculations should be up to number 900, that is insane!
Participant 3	I wouldn't necessarily say that it is incorrect, when you do hundreds, tens and thousands and you teach them place value I would say up to the number 1000 is fine but when you teach learner calculations it should be limited.
Researcher	Do you think that this frustration that you experience with the curriculum may have any influence on the way that you present your classes? Sometimes you feel the pressure and this may have an influence on your teaching method?
Participant 4	I have a way, she has a way, she has a way and the department has way the parents have a way as well, understand? So basically the learners are exposed to 3 ways of doing a calculation. Some of the parents don't have the necessary skills to teach the learners mathematics and all or to help them.
Participant 1	I agree, sometimes I parents asking me how they should explain something to their kid.
Researcher	So do you think that's if there is some sort of digital support that the learners can take home with them and watch the way the calculations are done in class it may be easier for them to do it?
Participant 5	If they have the privilege I think it will be easier.
Participant 1	I think it can work as long as they have something to watch it on all have access to something to watch it on. If the stories can be made into some form of a

	book. At most other schools in our town that's better off, the kids have their own computers or cell phone so that it will be easy for them to watch it but in our the case the learners don't have computers as we are less privileged and not all the learners have access to computers or cell phones at home.
Researcher	What is nice about the application that we use for this digital stories is that it can work on a cell phone, moat of the learners' parents at least have a cell phone. You don't need internet to run the application. In my experience the children of today going to eat that much anymore they are dependent on visual stimulation and audio stimulation to get the best results. That is why I thought this might be a good starting point where we look at how we can support learners with this need that they have for visual and audible stimulation in order to achieve better learning results. To be equipped with the basics in clause sway the educated teachers by being using stories and the digital stories to further explore the topic so that the learners can practice the concepts in their own time and from the own understanding as well. Thank you for sharing how you feel about teaching maths and how you feel about math in general I know it's not always the easiest task to share your feelings because we as humans are scared that we are the only one who feels that way. But I think what stood out clearly is that we do feel frustrated about the current status of mathematics in the foundation phase. The next activity that I want to introduce to you is draw and talk. Please excuse my own attempted drawing I'm not that good of an artist but it's not the core of the activity. The image I'm showing you is what I drew about how I feel about teaching mathematics. I'll explain to you what my picture means: When you look at the teacher you can see that she feels positive about it teaching and that she has a clock in the back that is ticking and may make you feel a bit nervous. While she's teaching she is constantly aware of this clock behind her that's why it's bigger than what a normal clock would be. In the in

	the description I gave you is that I feel that I do have a lot of off the lots of the because I'm passionate about teaching mathematics and I am passionate about mathematics but the is things that bother me about teaching mathematics things that I don't always understand and things that just wall it has an a bad influence on the way that I sometimes present myself in close and then this leads to the heart the confusion and the scene while I'm busy teaching I can see sometimes that these mixed expressions on the learners faces some of them all confused some of them are sleepy board been some of them are really terrified as you can see this little guy is really terrified and then some of them all playing happy. When I look at the colour I used blue because blue feels clear blue feels straightforward. OK, so much for my picture, now I've done a lot of talking. What I would like you to do is to draw your own picture about how you feel about teaching foundation phase mathematics. I just want to stress that it is not about the quality of your drawing it is when you explain what your drawing means that is valuable data. Year is some paper for you and some pens, koki's and colour pens which ever you feel like using.
	ACTIVITY TAKING PLACE.
	Participant 4 had to leave the meeting due to a prior engagement.
Researcher	Is there anyone who would like to explain the drawing to us please?
Participant 2	I feel that there is a lot that is expected from a teacher when teaching mathematics.
Participant 3	I feel that I must just go on, I can't get frustrated or angry I must just teach. What can we do, learn they must learn.
Participant 5	I'm very happy to teach mathematics. To use all my knowledge and all my skills to teach the learners what I know. I must teach the learners and I am fine when a learners says that they don't understand what I'm saying, but learners who use the "I don't know" makes me feel demotivated. When they don't want to work it makes me angry because they are throwing away opportunities. They really are children who has potential and I don't use it. I take for example in

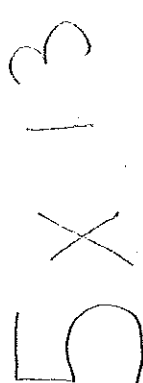
	learning my class, he's known to be stupid but I really think that he is lazy and not stupid as he has been labelled.
Participant 1	This is my picture. I sometimes feel as if I want to pull my hair from my head. Sometimes I use the entire time before the first break to explain one concept and then three quarters if not all learners do it incorrectly. I think it's mainly because they don't understand or concentrate or they haven't listened. As participant 5 said, you know that they have the potential but then they just don't do it correctly. It makes me feel frustrated. I also feel that there is too much work that has to be done in too little time.
Researcher	In general does this still make you feel positive about teaching mathematics?
Participant 5	In a way yes, you just try another method and its gives the learners another perspective. You give extra attention to the learners who you know struggle and let's try again. I can also sit and work with the learner agrees really really dumb, but also up to a point, then it frustrates as well. Especially with calculations concerning money.
Researcher	So you say that it is money is a calculation that the learners struggle with is, there anything else that you've picked up which the learners struggle with?
Participant 3	Counting, they don't want to count. They don't understand that you have to make groupings of numbers to sometimes calculate.
Participants 2	You don't have the time to draw pictures and give elaborate explanations, the learners have to adapt to abstract thinking. I think with a grade 3's something that they really struggle with is doing word problems. They don't know when they have to subtract or when they have to add, they don't know how to read or how to understand what the problem is
Participant 1	Something that they really struggle with his reading time as well. They struggle to know when to use which terminology.
Researcher	Concerning word problems, do you think that if the problem is broken up into steps as part of the video it will be easier for the learners to understand?
Participant 5	I think if it can be made into a picture, I always tell my learners to imagine a picture when they read it, it will be a lot easier for them to understand.
Researcher	So would you say that learners have a problem with visualization?

All participants	Yes
Participant 2	I think that today's kids are used to using technology, they all 4 years old and then they can use a tablet. So I think if these 2 minutes or so video with an explanation and afterwards the learners skate a chance to practice what they've just seen on the video it will work. But once again it depends on if the school can afford to buy technology like this. I think learners should also be interactive playing the video and pressing buttons, drawing pictures even on the computer. They should be part of the learning experience.
Researcher	Maybe like help planning the stories?
Participant 2	Yes.
Researcher	In our next session I'm going to bring along tablets so we can see how we use the application it's really a basic interface and it's very easy to use. If you can bring along a word problem that you would like to make a video of it will be helpful and we can maybe give it a try. I will show you how to make storyboards, which is planning a story and the frames that you want to use for your video. So our next session will basically be a workshop on using the application the tablets and how to go about making a digital story. Thank you for coming today and I look forward to us meeting again. I appreciate your time as my own mother is a teacher as well I know that the teachers time especially the free time is very limited so I really want to thank you for sharing your time with me.

ANNEXURE E: VISUAL DATA COLLECTED

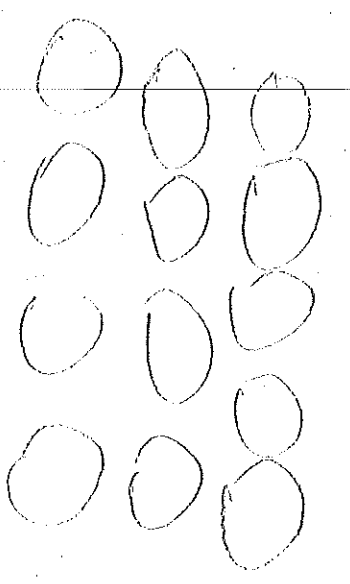
Storie se naam: Nuf maal dertien!

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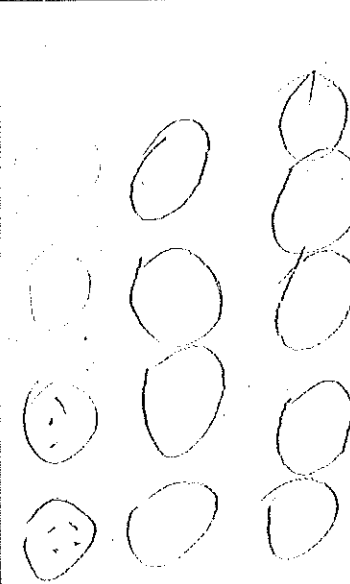
Ons wil uitreken wat
is 5×13 , wat
gaan ons doen?

2



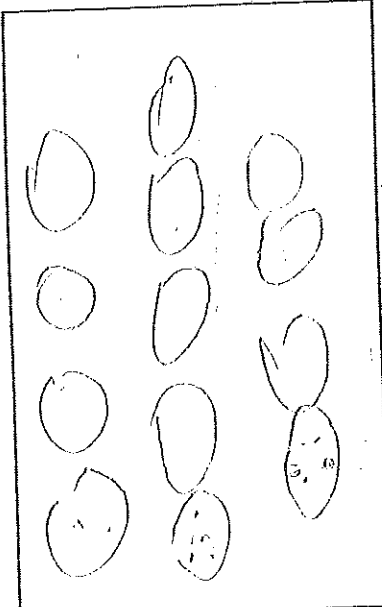
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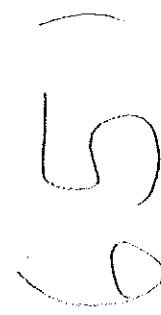
Ons gaan 5 in elke
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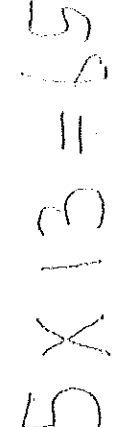
Ja, tel nou 13
vir elke groepe!

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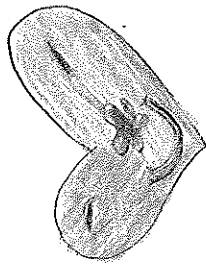


Ons antwoord is
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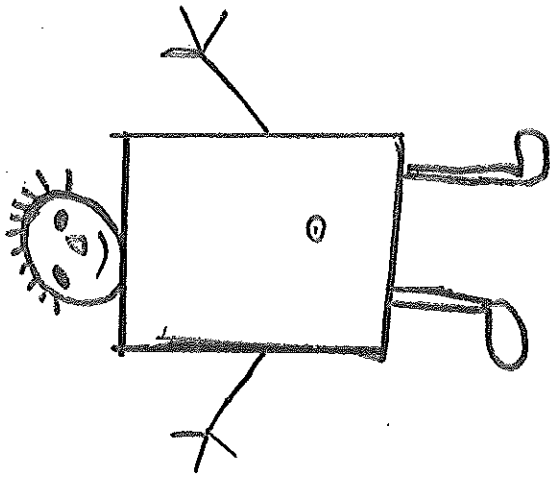
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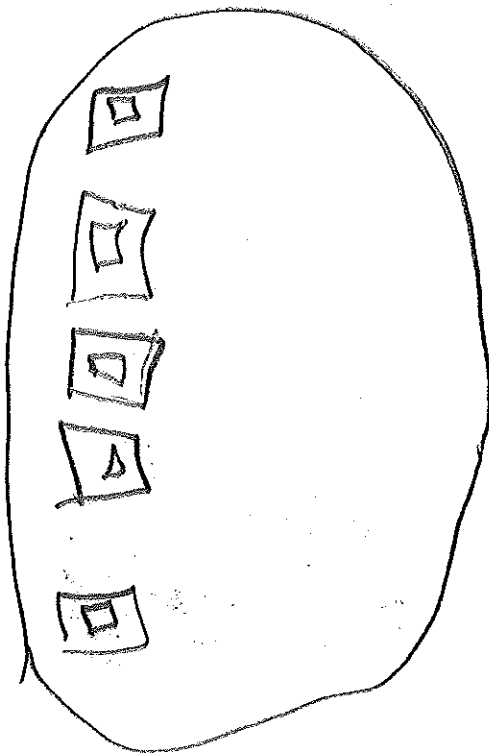


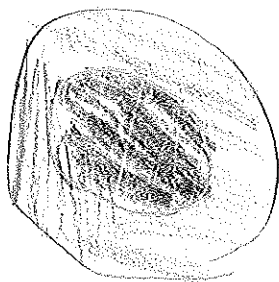
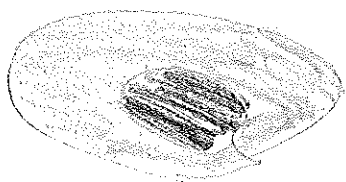
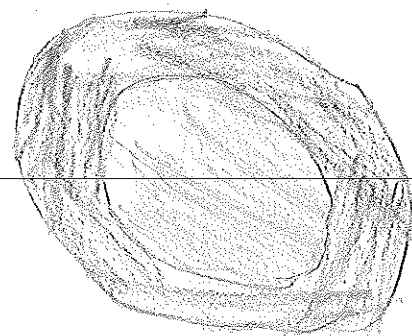
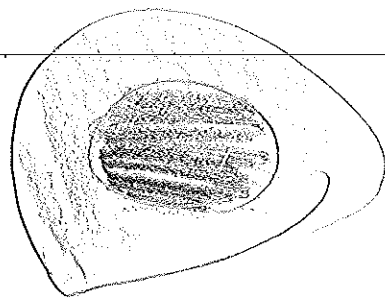
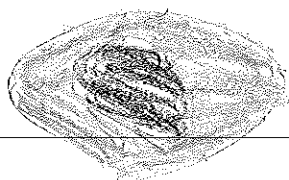
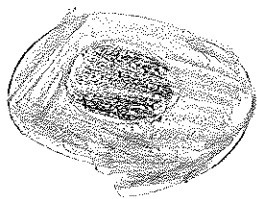
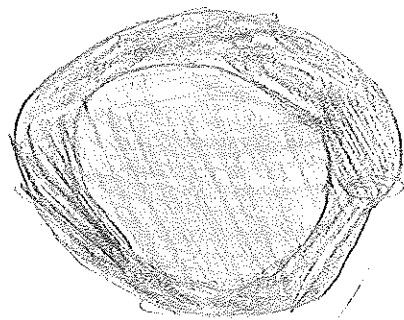
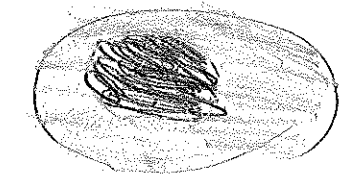
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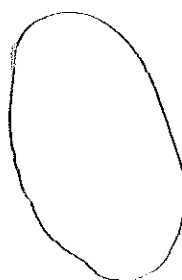
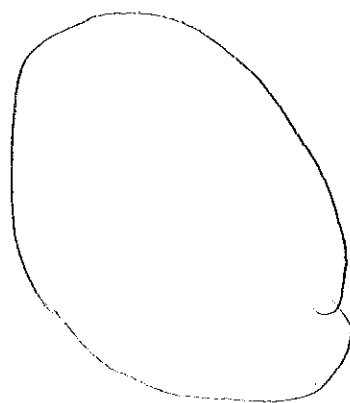
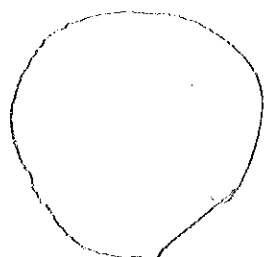
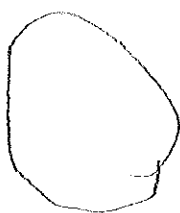
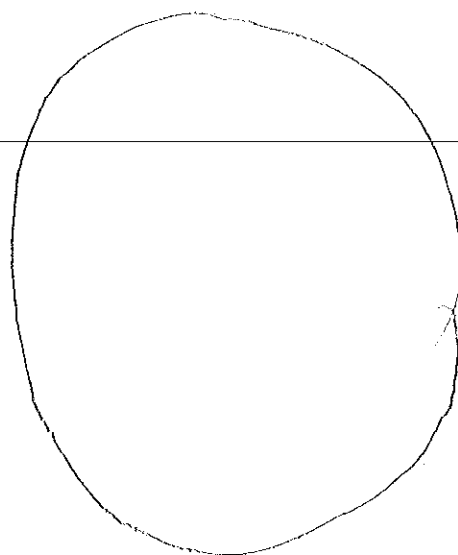
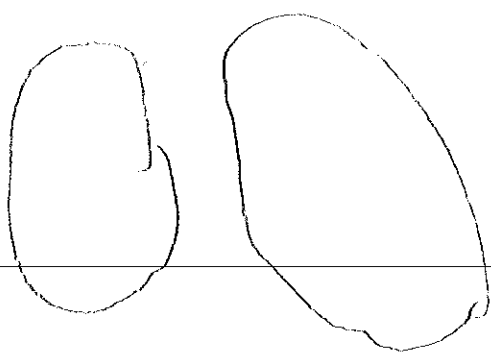
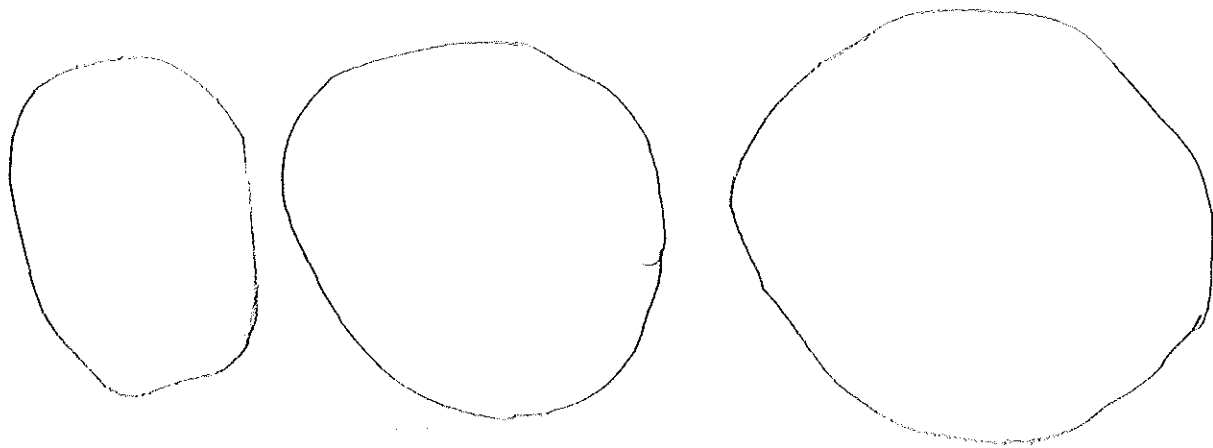
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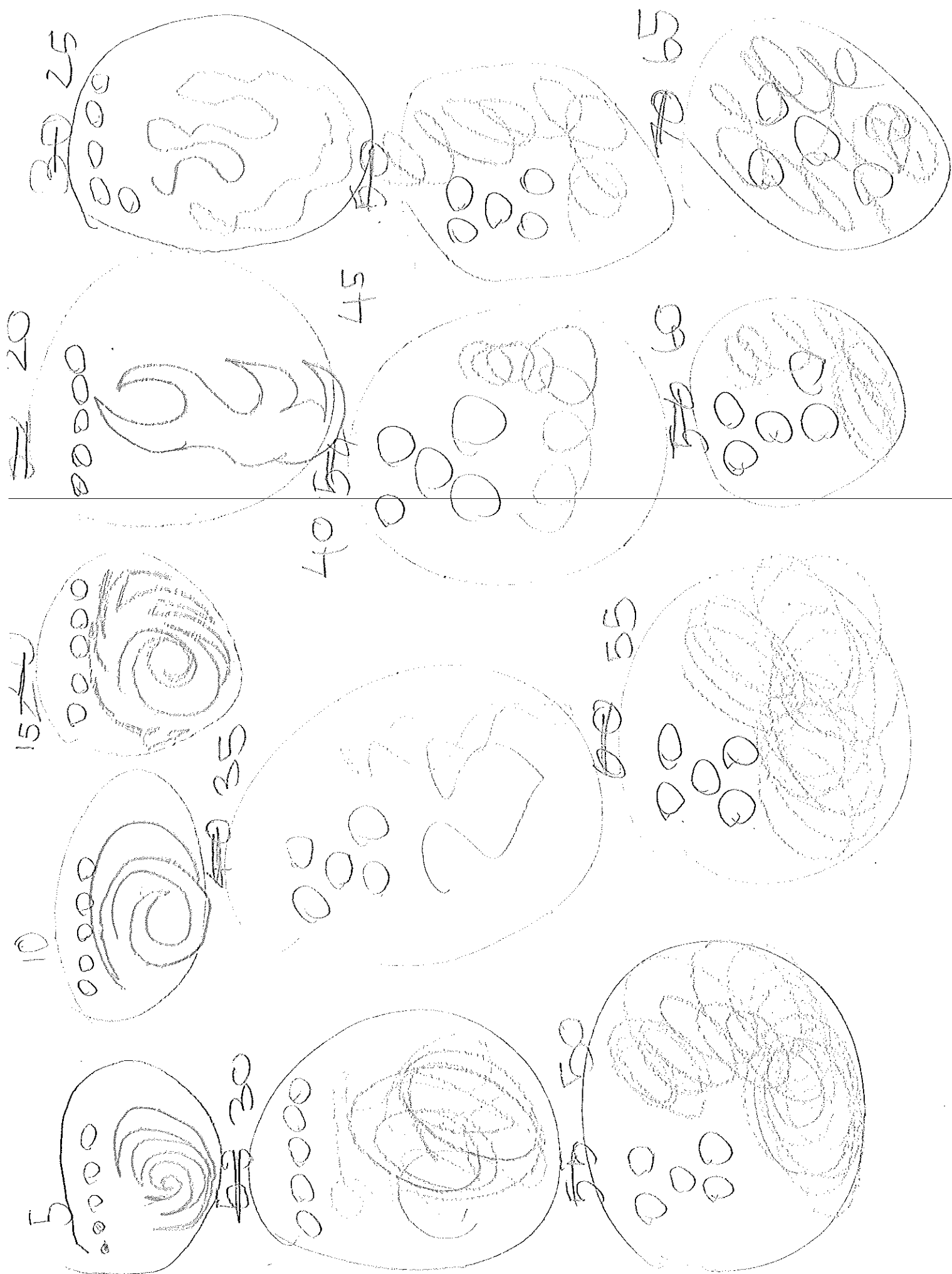




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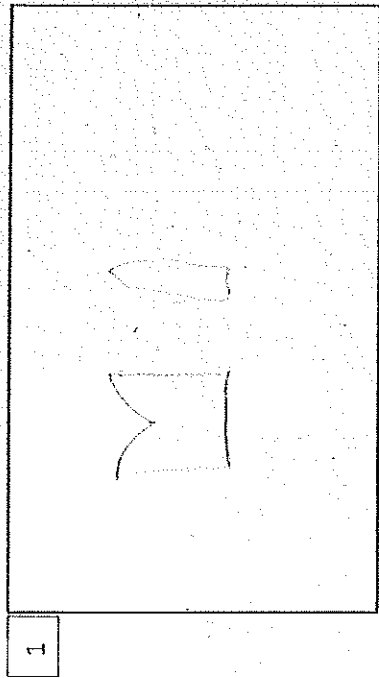
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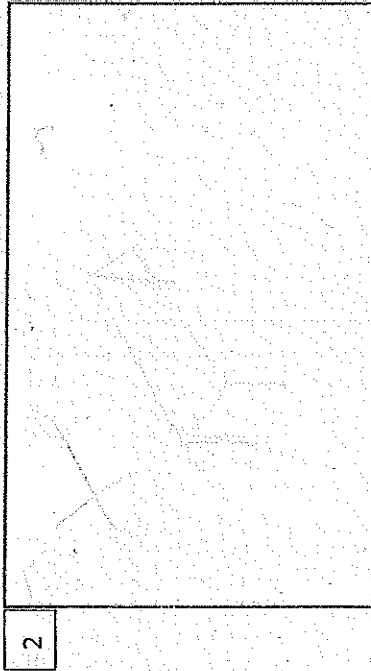
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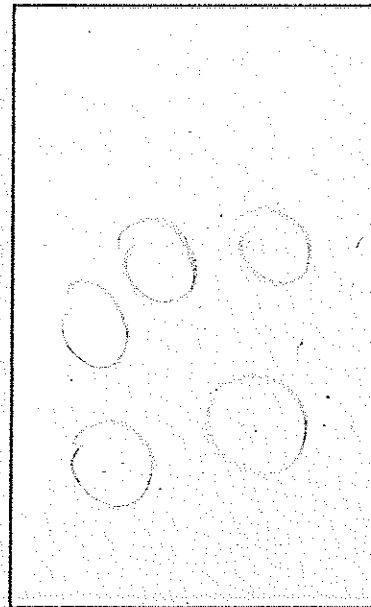
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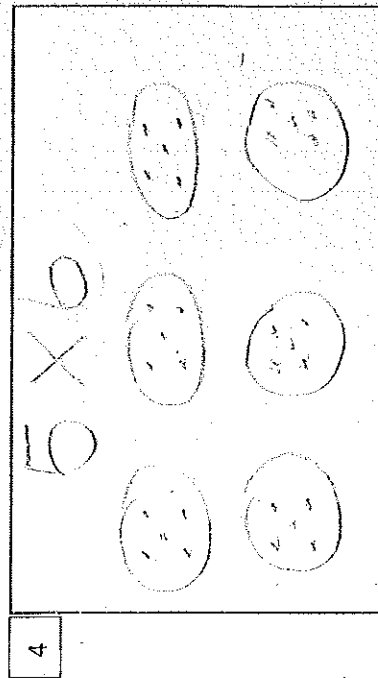
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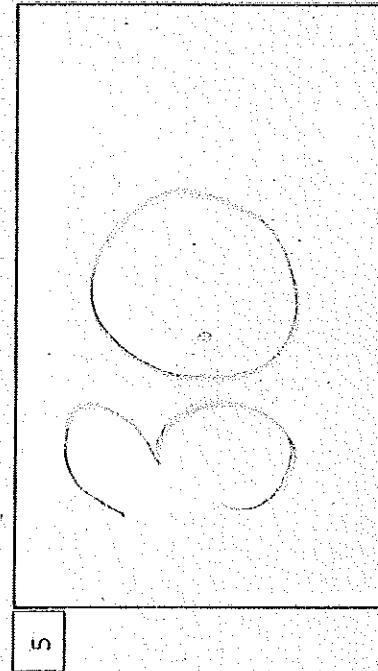
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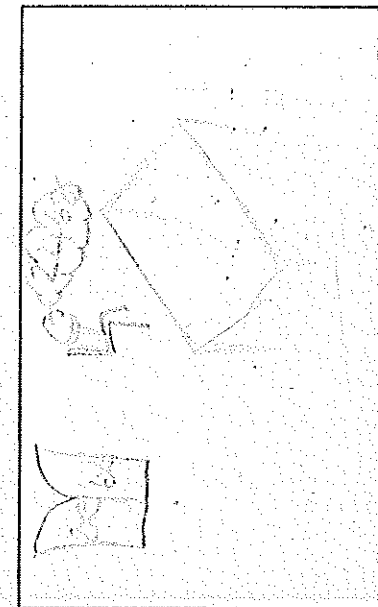
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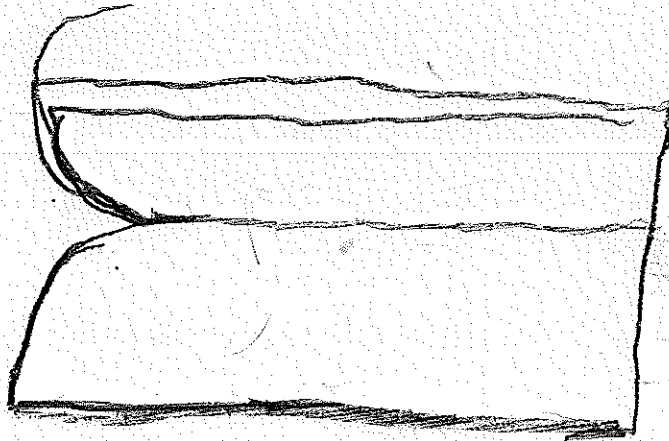
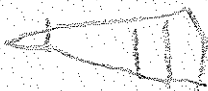
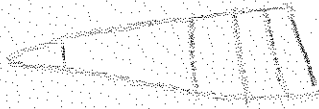
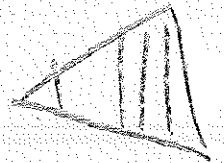
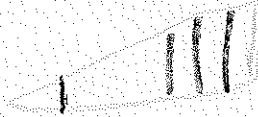
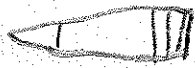
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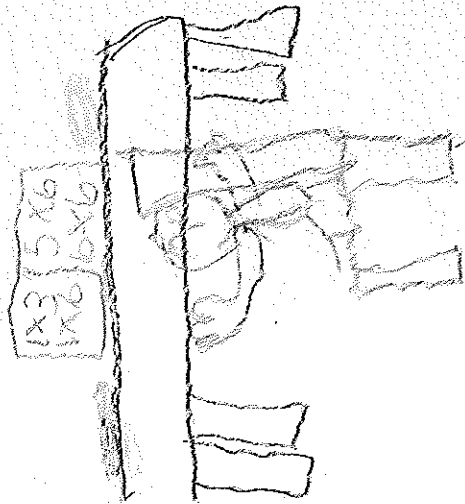
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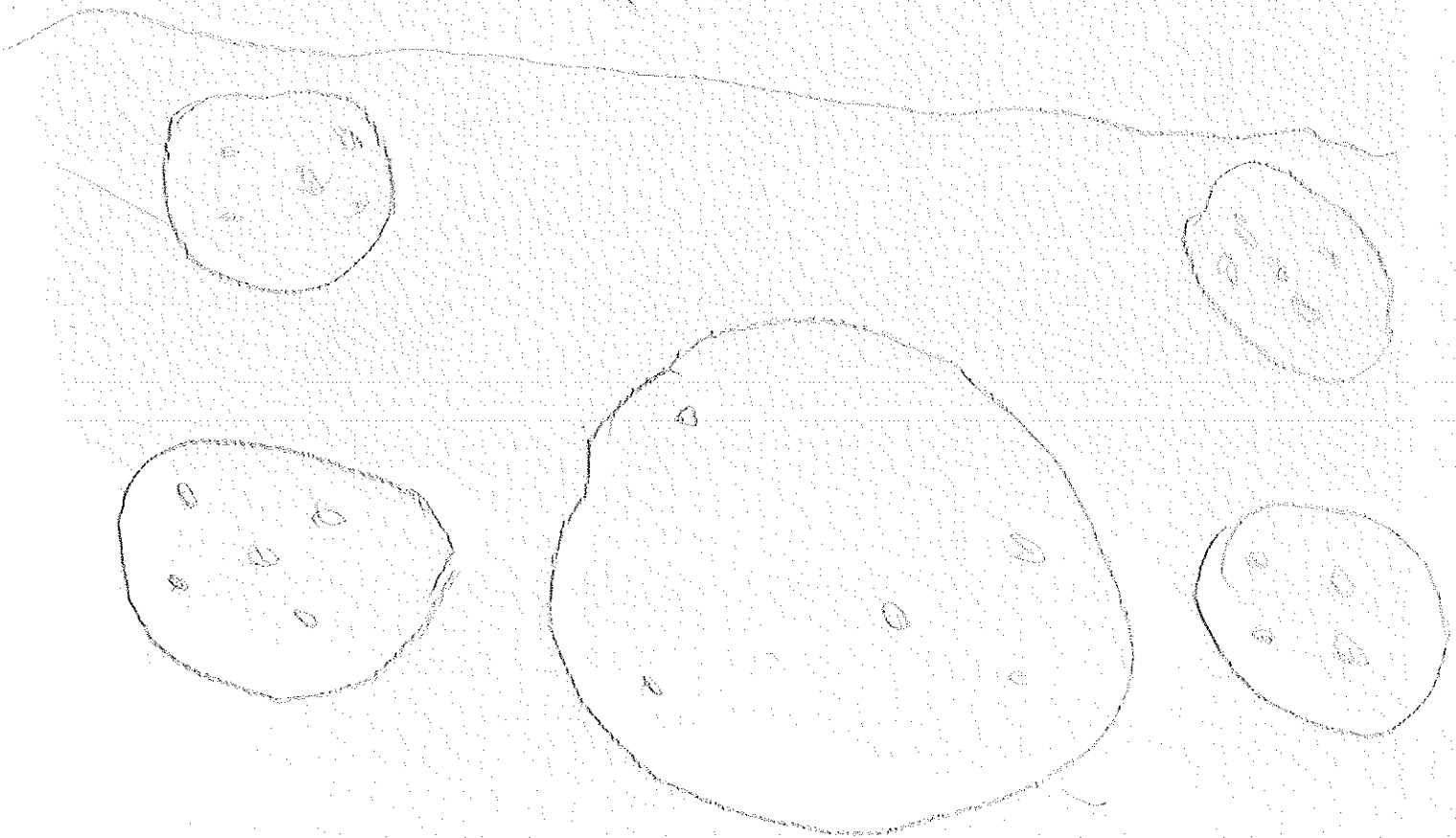
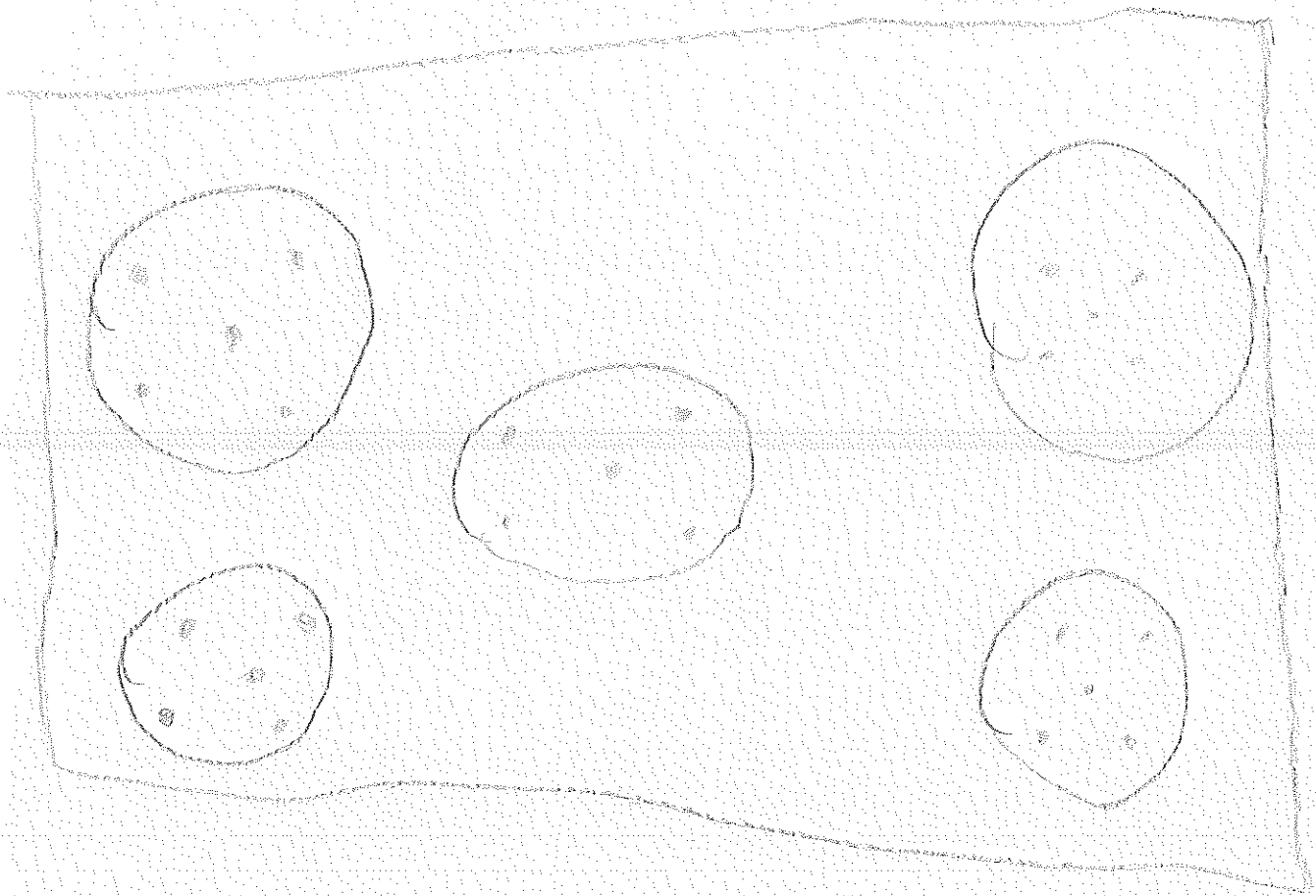
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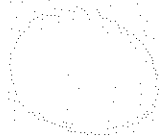
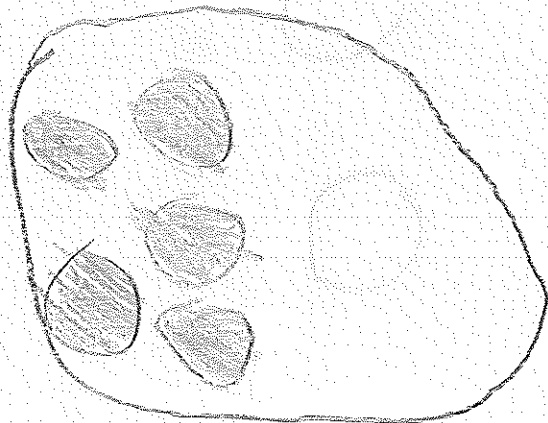
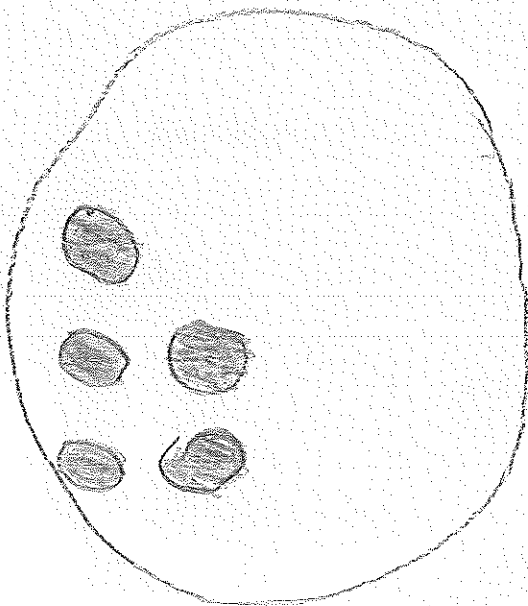
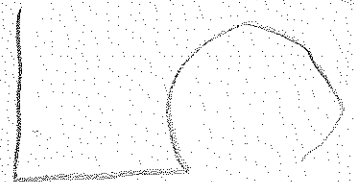
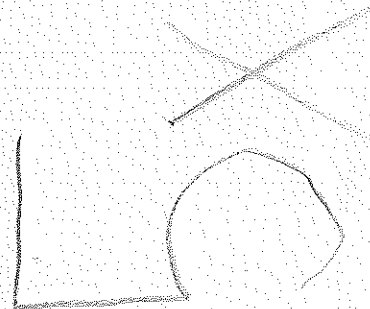
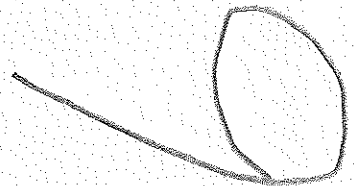
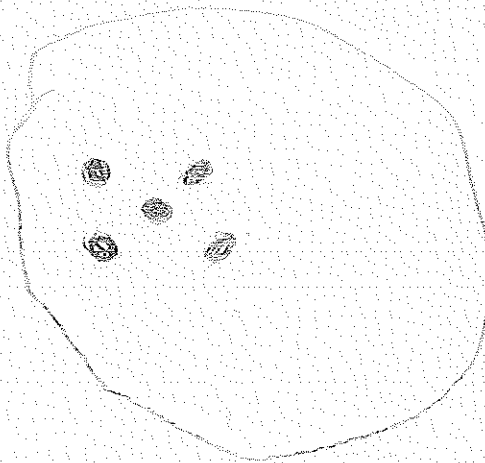
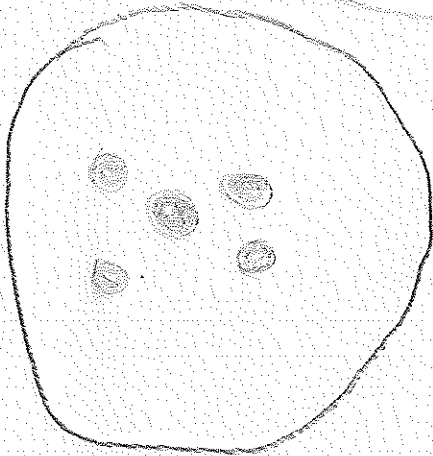
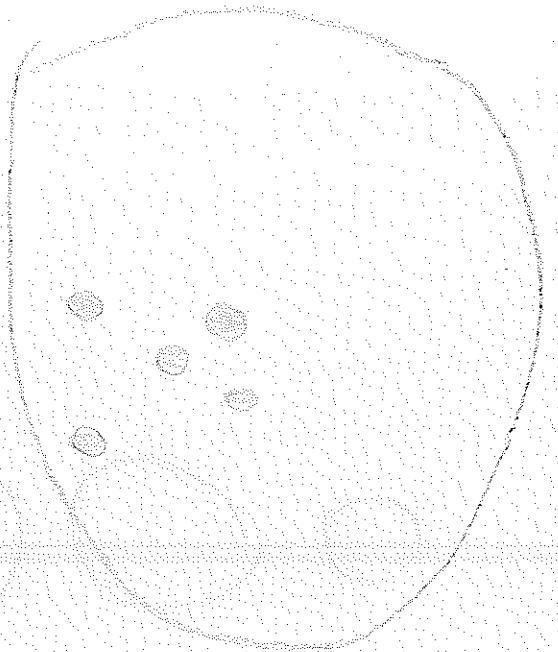
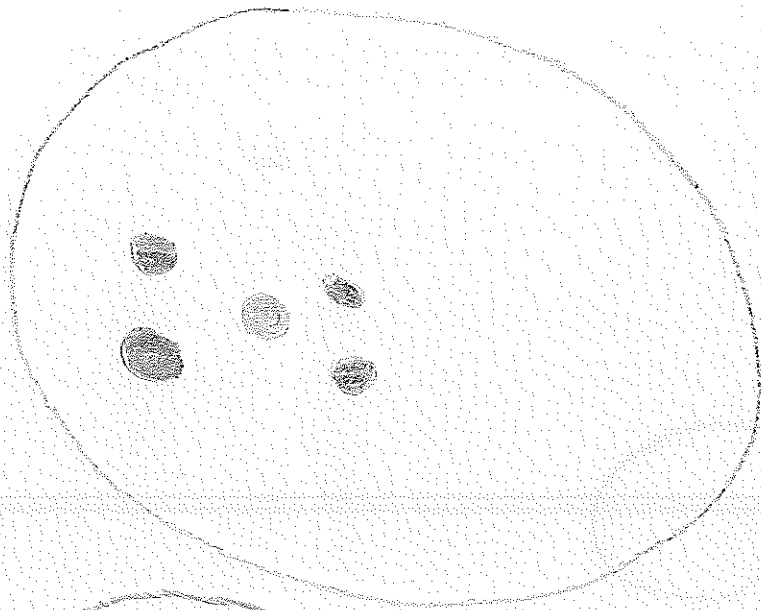


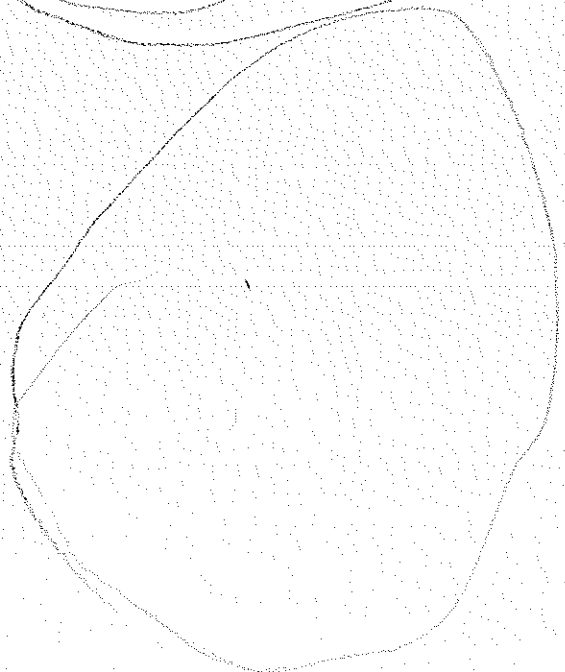
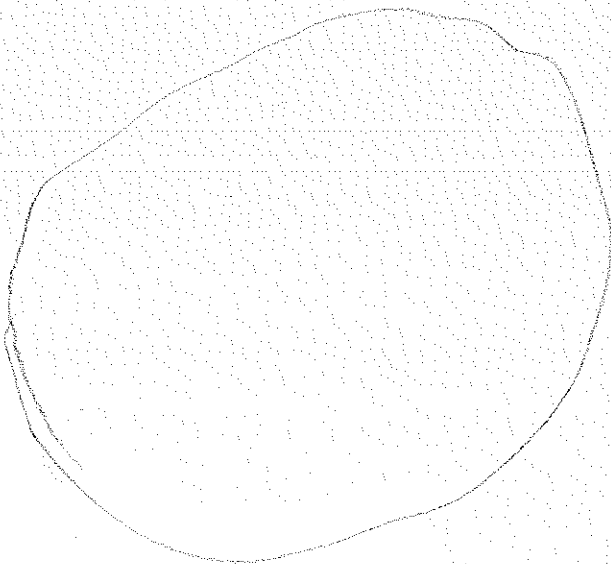
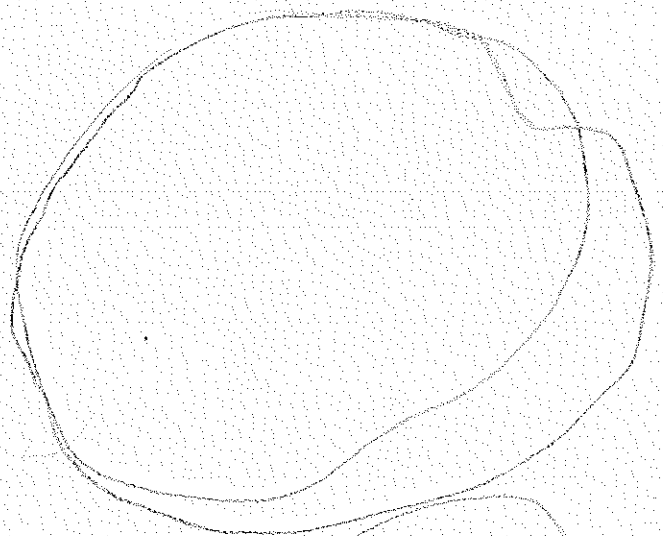
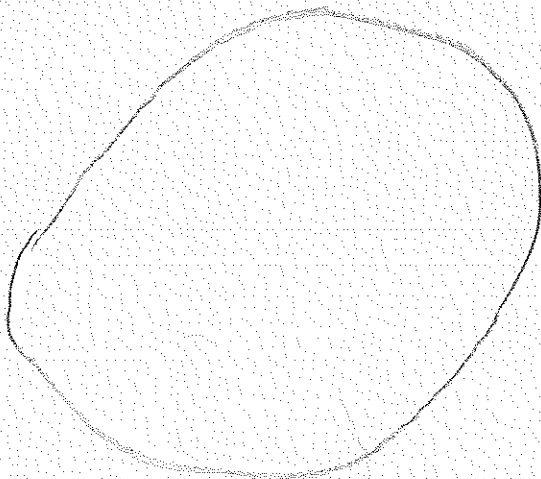
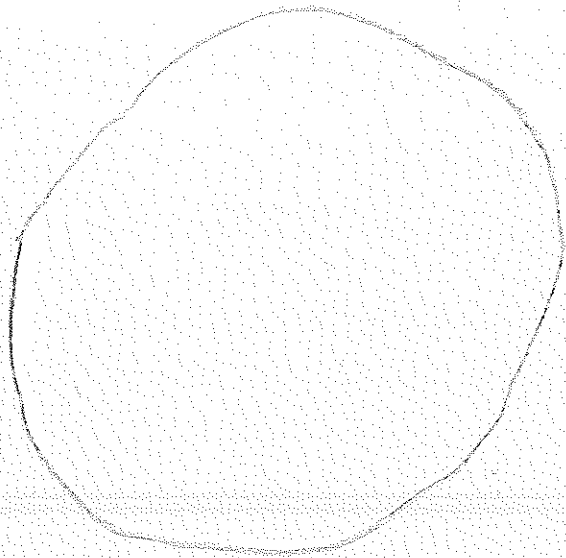
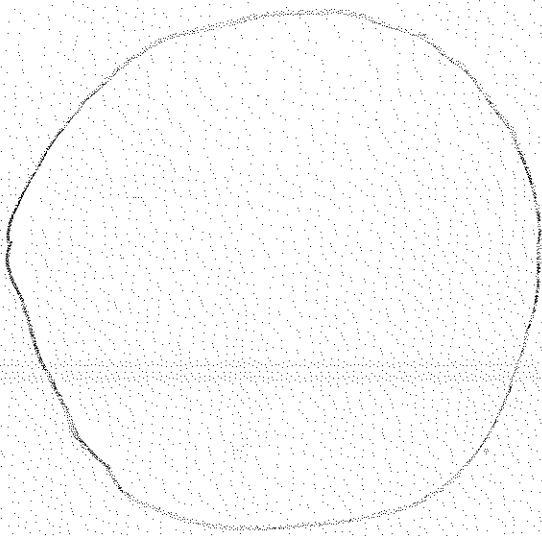
wiskinde
boek

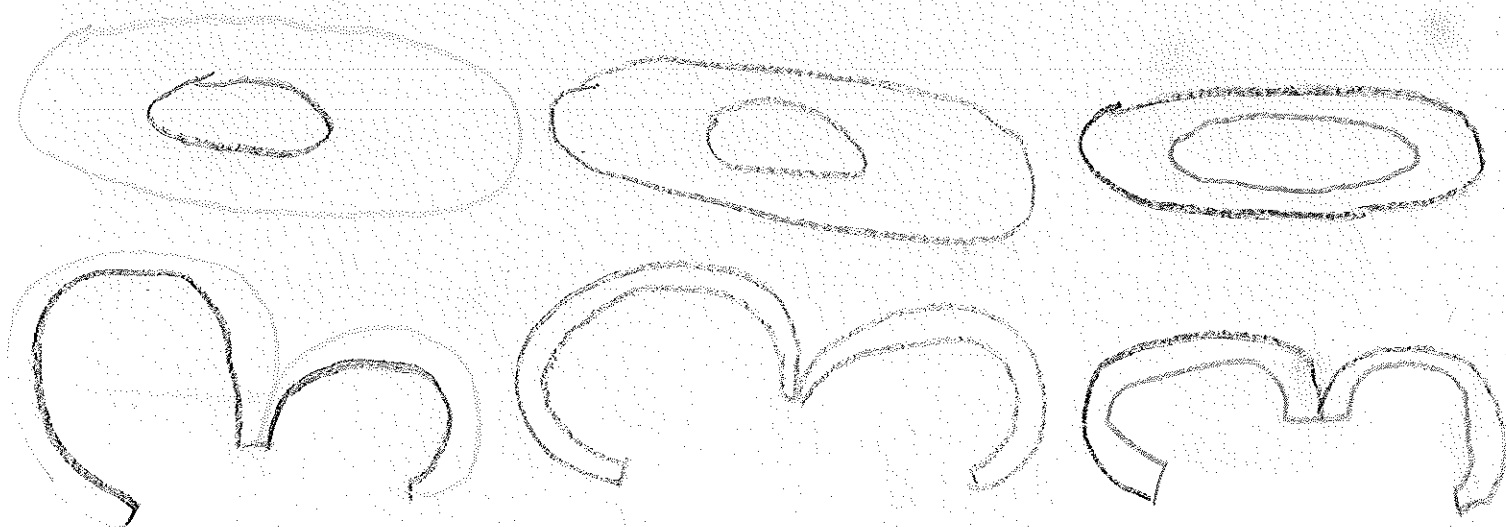
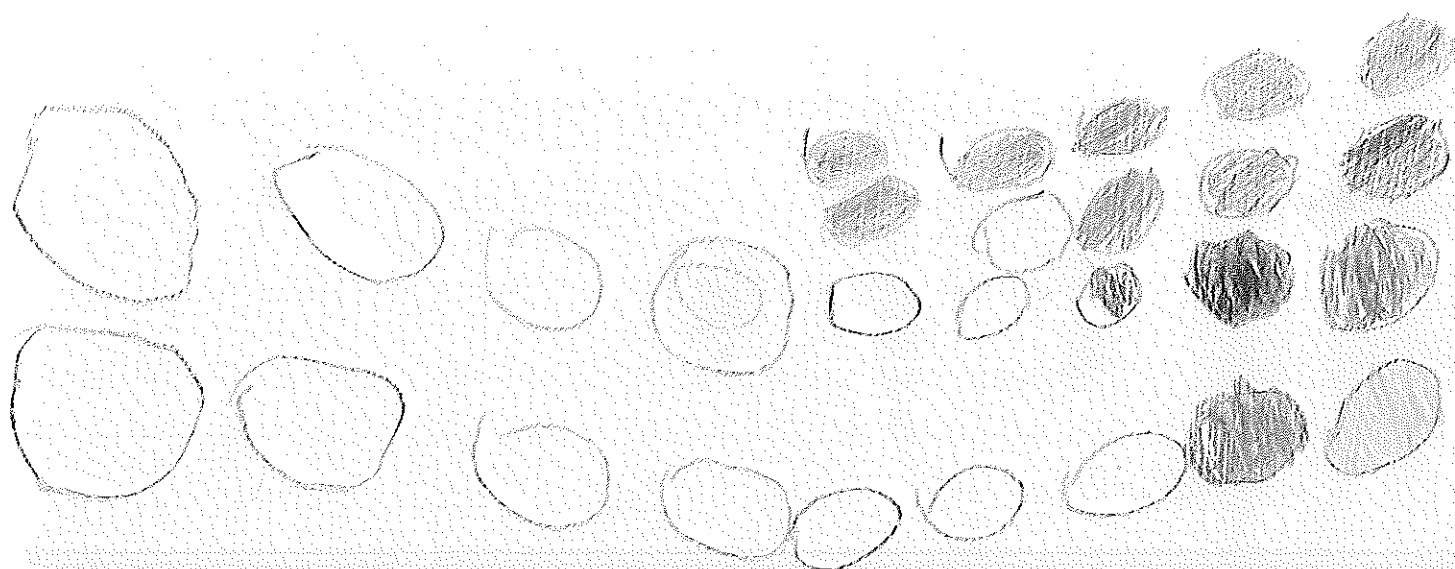
$$10 + 9 - 29 + 2 = 0$$

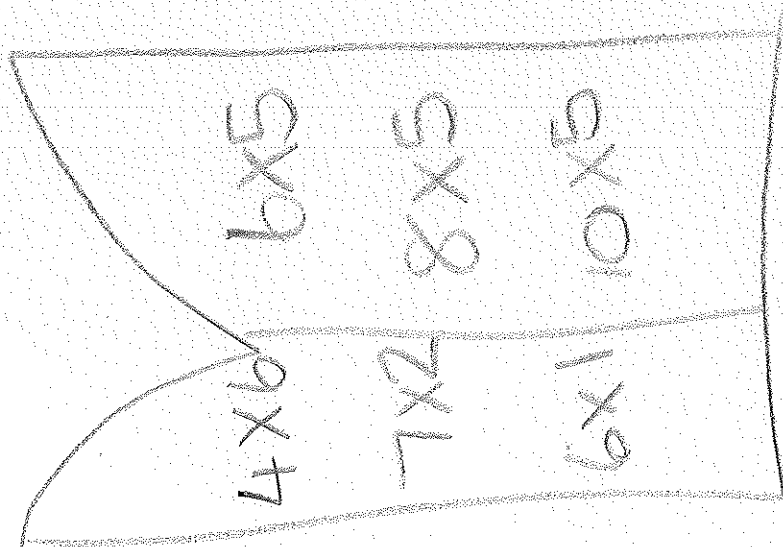
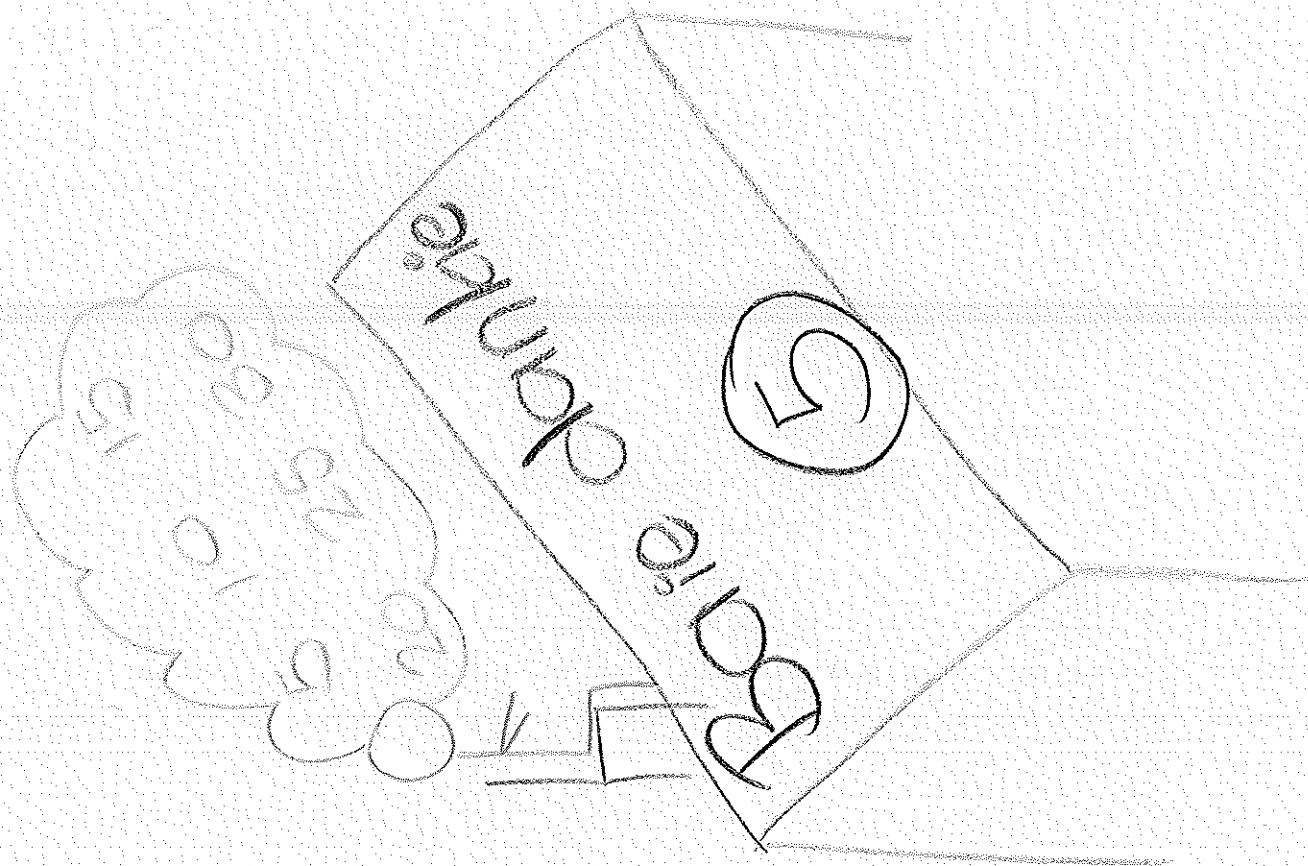












STORYBOARDING: TEACHERS

1

Digital storytelling as Mathematics teaching strategy to encourage positive learner engagement in the Foundation Phase

SESSION 2 Storyboarding

Planning for a digital story:

Title of story: Geld slim

Description of image: Spaarvarkie . 1 (pink) Text: Ek gaan vandag met my eie geld betaal.	Description of image: Voorkant van 2 Pick 'n Pay Text: Vandag kies ek en moet self betaal.
Description of image: Speelgoed rak 3 (karretjies.) Text: Sjoe, hier is baie om van te kies. Mamma is nie hier om my te help nie.	Description of image: Maak varkie oop met geld wat wys Text: Ek het R145, wat kan ek koop.
Description of image: Legoblokkies 5 (R170) Text: Ek wil graag van die he. ~~he~~	Description of image: Seuntjie met sprookborrel (H18) Text: Ag NEE, ek het te min geld.
Description of image: Seuntjie (groot) Text: Wag 'n bietjie, 'n radio beheer karretjie.	Description of image: Remtekar met prys (R105) Text: Dan kan ek nog 'n jokelode ook koop.

Overall aim with story: Om selfstandig met geld te werk.

Characters: Spaarvarkie, Seuntjie, Tannie by til,

Digital storytelling as Mathematics teaching strategy to encourage positive learner engagement in the Foundation Phase

SESSION 2
Storyboarding

Planning for a digital story:

Title of story: _____

Description of image: Gelukkige seun Spruukbarrel. (HTE) 10st+10 (Hou sjokolade vas) Text: Dan gaan daar kleingeld ook oorby. Wat??	Description of image: (Tannie by die til) Text: Jy is 'n groot seun as jy met jou eie geldjies kan koop.
Description of image: Seun met 3 vrou gee kleingeld Text: Hebeel kleingeld moet ek jou gee.	Description of image: Seun wat op vingers tel Text: Spe tannie! ^{mmmm} Ek weet!
Description of image: Seun met 5 sakkie wat uitloop Text: Moetjies vandag het ek self my goedjies gekoop. Ek hoop jy kan al self met jou geld werk.	Description of image: 6 Text:
Description of image: 7 Text: My juf het my	Description of image: 8 Text: mooi v geld geleer.

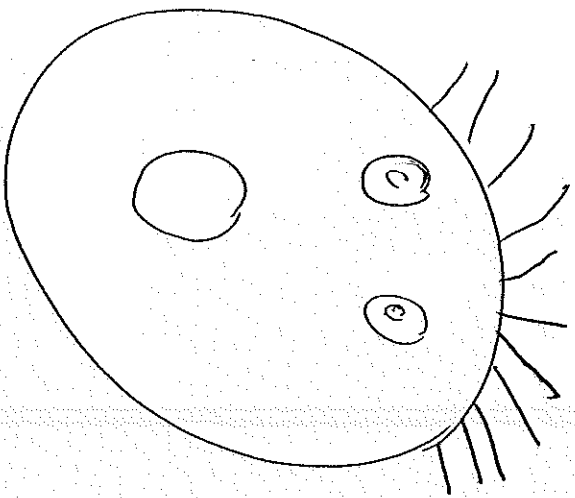
Overall aim with story: _____

Characters: _____

DRAW-AND-TALK ACTIVITY

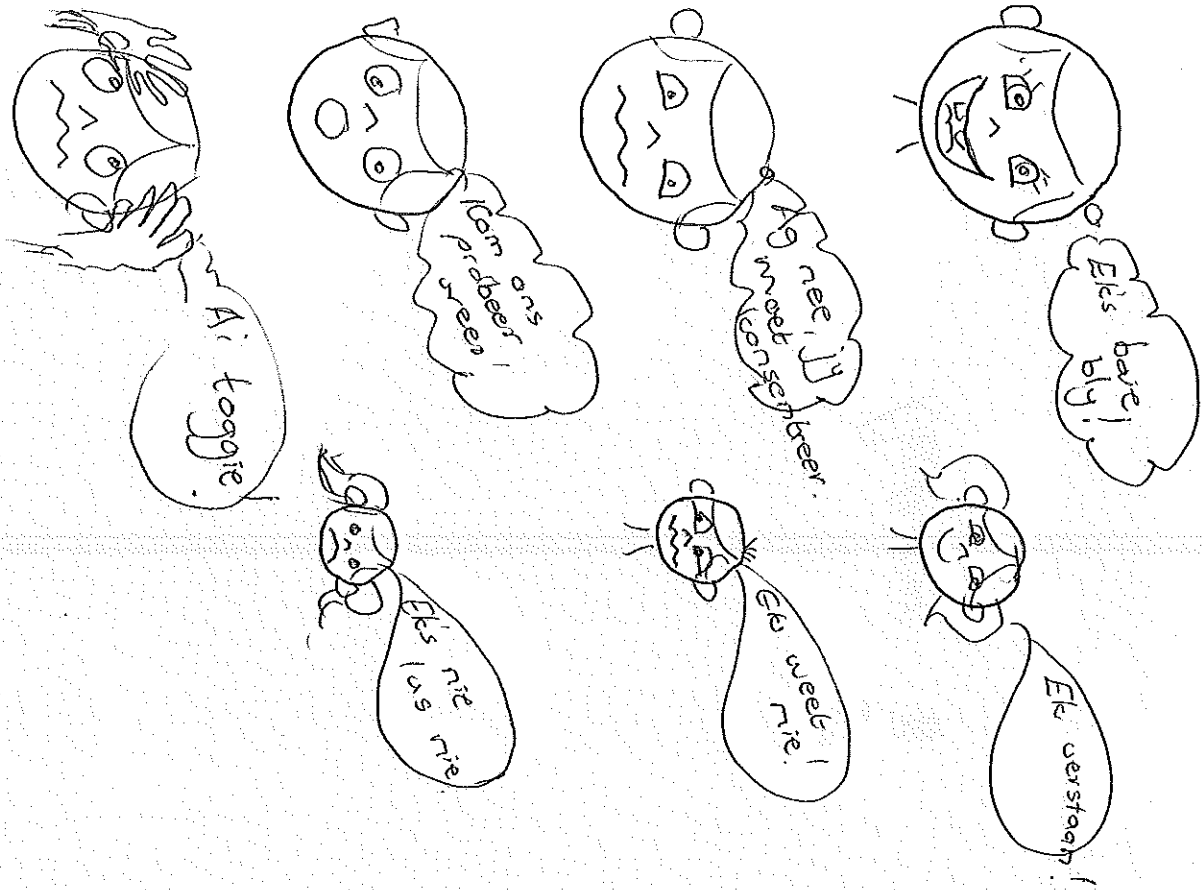


- Baie begrippe
- Tyd
- Inoefening
- Geduld.
- Leerders leer op verskillende maniere, party vinniger as ander.



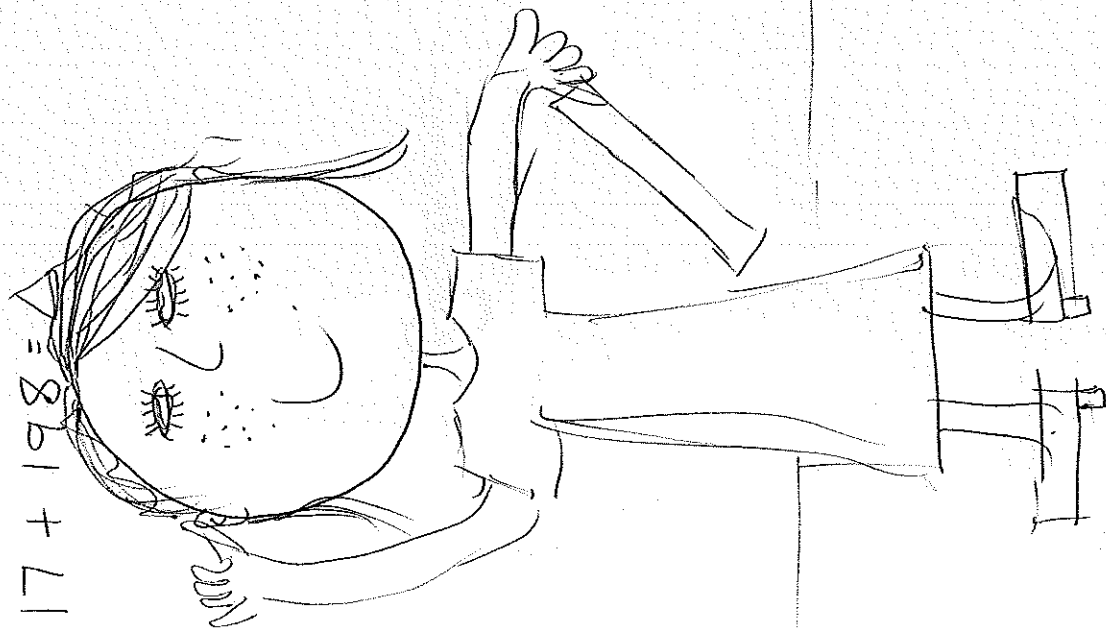
* Voel vreeslik gefrustreerd wanneer wiskunde aangebied. Voel of ek my hare in stompies wil uitruk, want die kinders verstaan dit glad nie.

Te veel werk, te min tyd
Syllabus maak dit moeilik, want daar is nie genoeg riglyne vir ons as onderwysers om dit verstaanbaar vir kinders te maak nie.

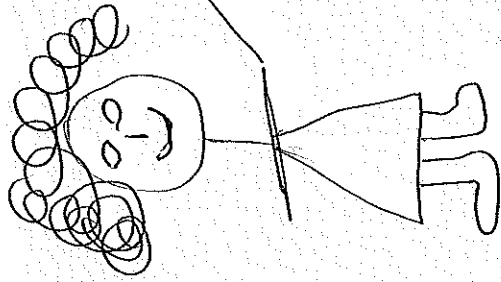
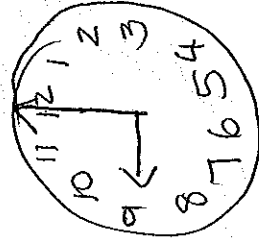
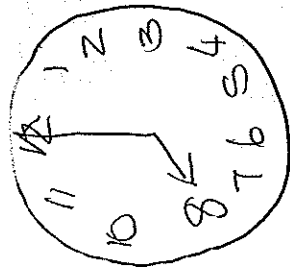


Ek's opgewonde
 te leer. Kinders am aan hulle iets
 nie, maak dat my baie konsentreer
 As hy nie wil werk nie maak dit my
 kwaad omdat hulle met hul verstand
 mors!

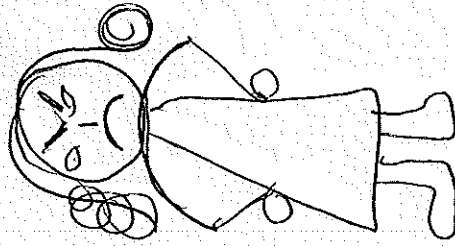
417 + 198 = 615



- Vasberade
- Werk vir 'n doel
- Komaan byt vas jy kan
- Geduld en nog geduld
- Sannie voel dalk soos ek al gevoel het, probeer weer verduidelik.
- Positiwiteit wel sukses!



$2+2=\square$
 $4+\square=8$
 $7+2+\square=10$



Onderbrekings is frustrerend
aangesien mens beperkte tyd
het om 'n magdom werk
vas te lê.

Gebreke aan tyd en te
moeilike bewegings word
bemeester moet word
weethou jou daarvan om
die "basics" soos by
getalbegrip ens vas te
lê

Dit lei tot frustrasie

ANNEXURE F: DIGITAL STORIES (VIDEO LINKS)

Annexure F

Links to digital stories made by participants (on YouTube):

1. 5 x6 Tables: https://youtu.be/rG30SDL3N_g
2. Ordering numbers: <https://youtu.be/ggQj4ZkjDpk>
3. Money: <https://youtu.be/Ze-3n0NbAzs>